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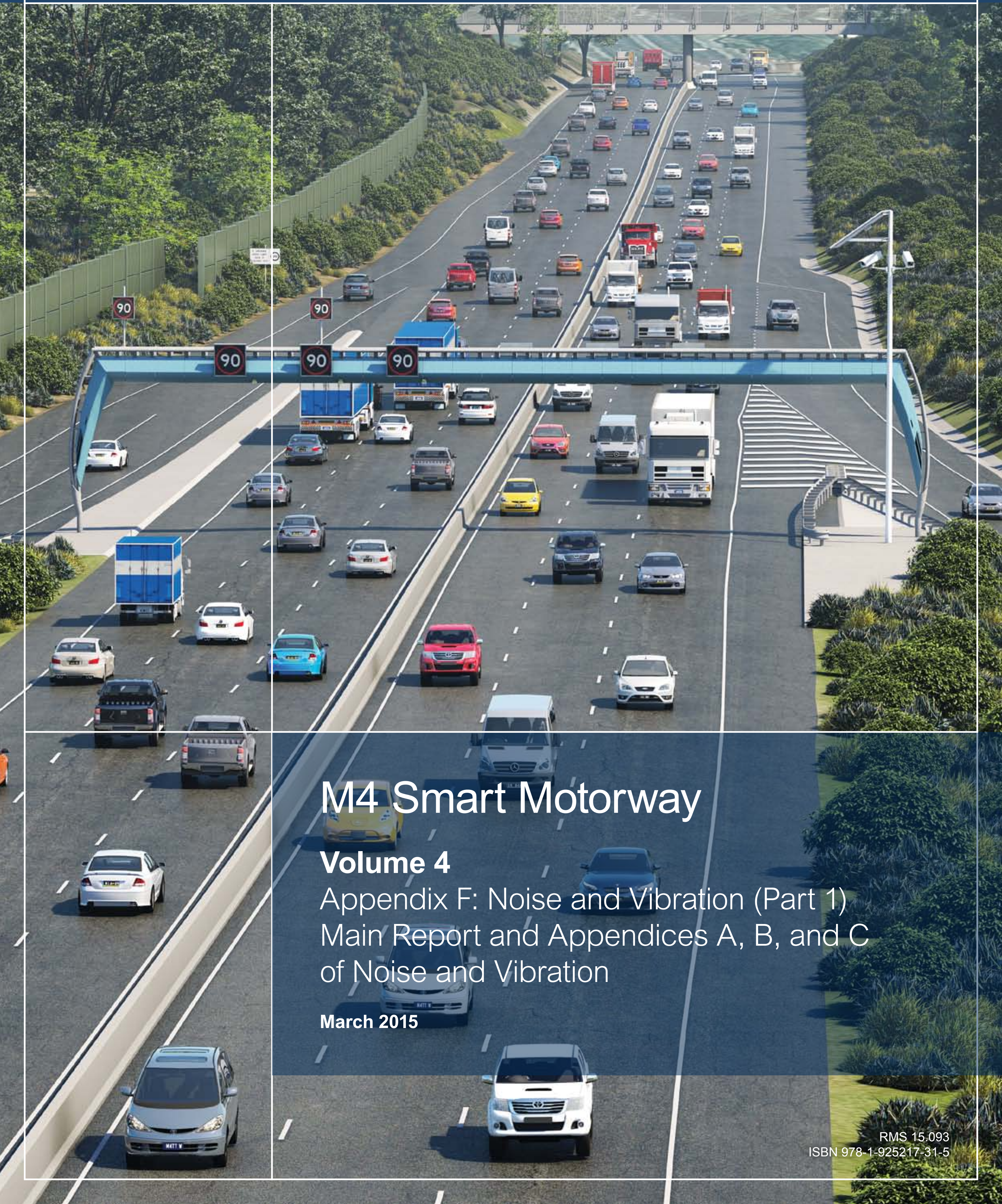

M4 Smart Motorway

Volume 4

Appendix F: Noise and Vibration (Part 1)
Main Report and Appendices A, B, and C of Noise and Vibration

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Appendix F

Noise and Vibration (Part 1)

Main Report and Appendices A, B and C of Noise and Vibration

M4 Smart Motorway

Construction and Operational Road Traffic

Noise and Vibration Impact Assessment

Report Number 610.12109-R1

5 March 2015

Roads and Maritime Services
Level 9, 101 Miller Street
NORTH SYDNEY NSW 2060

Version: Revision 4

M4 Smart Motorway

Construction and Operational Road Traffic

Noise and Vibration Impact Assessment

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Executive Summary

PROJECT DESCRIPTION

The M4 Smart Motorway project (M4SM) involves construction and operational changes associated with the widening and upgrade of the existing M4 Motorway interchanges between Lapstone at the foot of the Blue Mountains to Pitt Street, Mays Hill.

The project assessment area is effectively divided up into ten (10) separate sections, each of which centres on an individual interchange. Overall the main infrastructure changes which are pertinent to noise and vibration include:

- Widening, lengthening and re-alignment of all entry ramps to the M4 Motorway to allow safe merging of vehicles and accommodate the Intelligent Traffic System (ITS) and ramp metering.
- Widening, lengthening and re-alignment of key exit ramps to the M4 Motorway.
- Mainline widening on the main M4 Motorway carriageway between the Roper Road and Westlink M7 interchanges.
- Intelligent Traffic System (ITS) – Vehicle detection systems, Variable Speed Limit Signage (VSLS), Variable Message Signage (VMS) and Lane Use Management Systems (LUMS) would allow management of vehicle traffic entering, exiting and travelling on the M4 Motorway to improve safety and travel times.

A comparison between the Build and No Build options indicates that the M4SM project is forecast to generally increase the volume of vehicles using the M4 Motorway.

Within each of the M4SM interchange areas, the surrounding land use is predominantly residential. Other sensitive receivers include places of worship, educational facilities, child care centres, aged care facilities and open areas used for passive or active recreation.

Noise from the construction and operation of the proposal are required to be assessed in accordance with the guidelines provided by:

- The NSW *Road Noise Policy* (RNP) ((NSW) Environment Protection Agency (EPA), 2011) for operational noise impacts, with further guidance from:
    - Noise Criteria Guideline (NCG) (Roads and Maritime Services, 2014)
    - Noise Mitigation Guideline (NMG) (Roads and Maritime Services, 2014)
- The *Interim Construction Noise Guideline* (ICNG) ((NSW) Department of Environment and Climate Change (DECC), 2009) for construction related noise impacts.
- *Assessing Vibration: A Technical Guideline* ((NSW) Department of Environment and Conservation (DEC), 2006) for construction related vibration impacts.

Executive Summary

EXISTING ENVIRONMENT

Noise monitoring (both operator-attended and continuous unattended logging) was undertaken at twenty six locations within the project area during February/March 2013 and at supplementary locations immediately adjacent to the M4 carriageway during November 2014. The purpose of the noise monitoring is to assist in the validation of the operational noise model (which predicts noise to all identified buildings/receivers adjacent to the motorway), and as a basis for assessing potential noise impacts during construction. Locations were typically chosen close to the motorway (to minimise non-road related noise) where access to a suitable location was available. The number and locations for the noise monitoring were considered appropriate. The noise levels display a typical diurnal trend with lower noise levels during the night-time than the daytime and evening periods. This is characteristic of urban and suburban areas where the ambient noise environment is primarily influenced by road traffic.

ASSESSMENT OVERVIEW

Each interchange area has been considered as a separate study area corresponding to the extent of physical works within the interchange. Sections of the corridor outside of these interchanges do not form part of this assessment.

Model validation of existing situation (ie during the noise logger survey periods) indicated that traffic congestion on the M4 motorway reduces noise levels compared to those which would be predicted for traffic flowing at the posted speed. This assessment conservatively assumes that no congestion will be apparent for the Build scenarios. This approach means that the congestion factor contributes to the predicted noise increase due to the project. The impact of this is seen more at the interchanges to the east (Burnett, Coleman and Cumberland) as the heavy congestion period in the early morning period of the night-time contains the majority of the night-time vehicles.

The M4SM project is generally forecast to moderately increase main carriageway traffic volumes for both the year of project opening (2021) and the future assessment year (2031). Variations to this trend are apparent at ramps and secondary roads for which traffic forecasts vary, showing either increases or decreases in volume. Noise impacts are also due to the change in road alignment, which moves the traffic closer to receivers and/or reduces the screening benefit from the existing ground topography and noise walls.

The predicted ‘Build scenario’ noise levels at receivers adjacent to the motorway are generally above the NCG controlling criteria at the directly adjacent receivers.

An increase in the number of maximum noise events is predicted in line with the increase in traffic volumes.

Noise mitigation

The eligibility of receivers for consideration of additional noise mitigation is determined before the benefit of noise barrier optimisation is included. As a result the project must consider additional mitigation for these eligible receivers, unless predicted noise with optimised noise barriers in place reduces the receiver noise level to below the NCG controlling criterion. Consequently, even if noise barrier improvements reduce the receiver noise level to below the ‘acute’ level, or reduce the increase due to the project to 2.0 dB or less, eligible receivers would still require property treatment where they remain over the NCG criteria.

The assessment of the project with existing noise barriers indicates that the number of receivers considered eligible for additional noise mitigation equals 292 receivers (279 residential and 13 other sensitive receivers).

Executive Summary

Priority noise mitigation measures (road design/traffic management and quieter pavement surfaces) have been considered for all sensitive receivers where predicted noise levels in the Build scenarios are above the NCG controlling criteria. The use of a low noise pavement on the widened section of M4 Motorway between the M7 and Roper Road is proposed as part of the design of the project in order to mitigate road traffic noise at source and therefore benefit receivers adjacent to the motorway.

Additional feasible and reasonable noise mitigation measures, including noise barriers and property treatments, have been considered for qualifying receivers.

Noise barriers have been recommended on the basis of guidance contained in the *Noise Mitigation Guideline* and further feasible and reasonable considerations undertaken with guidance from Roads and Maritime.

The assessment counts each floor of properties as individual 'receivers'. When the benefit of the recommended noise barriers is included, a total of **176** receivers (154 individual buildings) are predicted to be eligible for consideration of property treatment as part of the M4SM project. Each interchange assessment area has the following number of eligible receivers:

Interchange Area	**Number of receivers eligible for consideration of property treatment**	
	Residential	**Other Sensitive**
Burnett Street Interchange	5 (4 individual buildings)	5 (4 individual buildings within the place of worship)
Coleman Street Interchange	12 (12 individual buildings)	4 (3 individual buildings at the Sydney Murugan Temple and 1 individual building at Essington Christian Academy)
Cumberland Highway Interchange	67 (59 individual buildings)	-
Prospect Highway Interchange	2 (2 individual buildings)	1 (1 individual building at the cemetery)
Reservoir Road Interchange	3 (2 individual buildings)	-
Roper Road to M7 Motorway including add lanes	47 (41 individual buildings)	1 (1 individual building at the cemetery)
Mamre Road Interchange	24 (20 individual buildings)	-
Northern Road Interchange	2 (2 individual buildings)	2 (2 individual buildings at the educational facility)
Mulgoa Street Interchange	1 (2 individual building)	-
Russell Street Interchange	0	-

Executive Summary

The above results are driven by ‘acute’ receivers within the project area as well as project noise level increases due to the combination of congestion effects and traffic changes. It is not unusual in urban road projects for a relatively large number of receivers to be impacted by noise. This is consistent with the findings of this assessment.

The noise assessment considered the proposed physical works and adopted noise catchments as specified by RMS where a change in noise level as a result of the proposal was considered likely. In general, these catchments are immediately adjacent to the works areas. Following development of the opening year and future year noise models both with and without the project (ie Build and No Build), potential additional impacts have been identified outside of the adopted noise catchments. These changes in noise impacts are partly related to the improved operating performance of the motorway, namely, under a smart motorway the average operating speeds may increase in some areas with the potential to increase noise levels. Receivers adjacent to such areas have been identified by RMS as needing to be considered for treatment in accordance with the noise mitigation guide (NMG) during the detailed design.

Areas identified for further investigation include the following:

- NCA01 on the southern side of the motorway adjacent the Burnett Street interchange
- NCA01/03 on the southern side of the motorway adjacent the Coleman Street interchange
- NCA20 at receivers adjacent to the EB on-ramp from Roper Road

No treatment options have currently been explored for these areas; however, they will be investigated as part of the detailed design.

CONSTRUCTION NOISE AND VIBRATION

It is likely that construction works would be required outside of standard construction hours. The approach taken in this assessment has been to identify noise impacts of representative construction activities in all time periods, to inform scheduling of works to minimise impacts on sensitive receivers where practicable.

Consistent with the requirements of the ICNG, the construction noise impacts are based on a realistic worst-case assessment. For most activities, it is expected that the construction noise levels would be lower than have been predicted in this report.

Due to the proximity of residential and other noise sensitive receivers to noise generating construction works, some construction scenarios have the potential to result in high noise impacts. The linear movement of the construction works within each interchange area means that, at most locations, the duration of the noisiest activities would be of limited duration.

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APPENDICES

Glossary

Item	Description
AS	Australian Standard
BS	British Standard
CEMP	Construction Environmental Management Plan
CNVMP	Construction Noise And Vibration Management Plan
CORTN	Calculation of Road Traffic Noise
dBA	A-weighted decibels
DECC	Department of Environment and Climate Change NSW – Now EPA
DECCW	Department of Environment, Climate Change and Water NSW – Now EPA
DGA	Dense Graded Asphalt
DGRs	Director-General’s Requirements
DIN	Deutsches Institute fur Normung
DP&E	(NSW) Department of Planning and Environment
ECRTN	Environmental Criteria for Road Traffic Noise (replaced by the RNP)
EIS	Environmental Impact Statement
ENMM	Environmental Noise Management Manual
EPA	(NSW) Environment Protection Authority
EPL	Environment Protection Licence
ICNG	Interim Construction Noise Guideline
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(1hour)	The ‘energy average noise level’ evaluated for a specific one-hour period.
LAeq(9hour)	The ‘energy average noise level’ evaluated over the night-time period (10.00 pm to 7.00 am).
LAeq(15hour)	The ‘energy average noise level’ evaluated over the daytime period (7.00 am to 10.00 pm). The LAeq can be likened to a noise dose representing the cumulative effects of all the noise events occurring in the relevant time period.
LAmax	The maximum noise level from road traffic noise occurring at a particular location.
NATA	National Association of Testing Authorities
NCA	Noise Catchment Area
NCG	Noise Criteria Guideline
NMG	Noise Mitigation Guideline
NML	Noise Management Level.
OEH	Office of Environment and Heritage – now EPA
OGA	Open Graded Asphalt
OOHW	Out of Hours Work
RBL	Rating Background Level
RMS	Root Mean Square
Roads and Maritime	(NSW) Roads and Maritime Services
SLR	SLR Consulting Australia
SPL	Sound Pressure Level

Glossary

Item	Description
TNB	The ‘total noise benefit’ (TNB) for each barrier height. This is the sum of the dBA reductions achieved at all residences and other noise-sensitive receptors within each segment.
TNBA	The “total benefit per unit barrier area” (TNBA) is the “total noise benefit” (TNB) divided by the total area of the barrier in the road section being examined.
MBV	The “marginal benefit value” (MBV) for a particular barrier height option is the increase in “total noise benefit” (TNB) divided by the increase in barrier height or area. (The methodology assumes barrier costs are proportional to barrier areas and are hence proportional to barrier heights, even though other factors such as barrier material will also have an influence on costs.)
SWL	Sound Power Level
VDV	Vibration Dose Value

1 INTRODUCTION

1.1 Background

The M4 Smart Motorway project (M4SM project) involves construction and operational changes associated with the widening and upgrade of the existing M4 Motorway from Lapstone to Pitt Street, Mays Hill.

The (NSW) Roads and Maritime Services (Roads and Maritime) is proposing to also introduce intelligent technology to the M4 Motorway, known as a managed motorway system.

1.2 Scope of this report

SLR Consulting Australia (SLR) has been engaged by Roads and Maritime to assess the potential noise and vibration impacts associated with the construction and operation of the M4SM project. This report has been prepared to inform the environmental assessment and be included in the Review of Environmental Factors (REF) as a technical paper.

The assessment of noise and vibration includes:

- Ambient noise surveys to determine the existing noise environment within the project area (refer to **Section 3**).
- Identification of receivers along the alignment that are potentially sensitive to noise and vibration (refer to **Section 3**).
- Prediction of noise and vibration from the construction (refer to **Section 19** to **Section 23**) and operation (refer to **Section 4** to **Section 18**) of the motorway, and assessment of the potential noise and vibration impacts in accordance with the relevant legislation and guidelines.

1.3 Relevant guidelines

Noise from the operation of the proposal is required to be assessed in accordance with guidelines provided in the NSW *Road Noise Policy* (RNP) ((NSW) Environment Protection Agency (EPA), 2011) [i] as interpreted by Roads and Maritime in the *Noise Criteria Guideline* (NCG) (Road and Maritime, 2014)[ii]. The NCG provides a consistent approach to identifying road noise criteria for Roads and Maritime Services projects and meets the intention of the RNP. Guidance for additional noise mitigation is taken from the *Noise Mitigation Guideline* (NMG) (Roads and Maritime, 2014)[iii]. Guidance for assessing the potential for sleep disturbance from maximum noise events is taken from *Practice Note III* in the *Environmental Noise Management Manual* (ENMM) (Roads and Maritime, 2001)[iv].

Construction noise has been assessed in accordance with the *Interim Construction Noise Guideline* (ICNG) ((NSW) Department of Environment and Climate Change (DECC), 2009) [v]. Construction road traffic noise has been assessed taking guidance from the noise assessment procedure contained in the RNP. Vibration from construction has been assessed in accordance with *Assessing Vibration: A Technical Guideline* ((NSW) Department of Environment and Conservation (DEC), 2006)[vi].

1.4 Terminology

The assessment has used specific acoustic terminology, and an explanation of common terms is included as **Appendix A**.

2 PROJECT DESCRIPTION

2.1 Overview

The M4SM project proposes to upgrade the existing M4 Motorway and to provide an intelligent management system. The project area runs from Lapstone at the foot of the Blue Mountains to the Pitt Street overpass in Parramatta where it connects to the WestConnex scheme as shown in **Figure 1**.

The WestConnex scheme is a 33 kilometre long tolled motorway, linking Sydney's west and south west with Sydney Airport and the Port Botany precinct.

Figure 1 M4SM and WestConnex scheme

Source: RMS Website, 2014

The key features of the M4SM proposal include:

- Widening, lengthening and re-alignment of all entry ramps to the M4 Motorway to allow safe merging of vehicles and accommodate the Intelligent Traffic System (ITS) and ramp metering.
- Widening, lengthening and re-alignment of key exit ramps to the M4 Motorway.
- Mainline widening on the main M4 Motorway carriageway between the Roper Road and Westlink M7 interchanges.
- Intelligent Traffic System (ITS) – Vehicle detection systems, Variable Speed Limit Signage (VSLS), Variable Message Signage (VMS) and Lane Use Management Systems (LUMS) would allow management of vehicle traffic entering, exiting and travelling on the M4 Motorway to improve safety and travel times.

2.2 Description of existing M4 Motorway

Within the M4SM project area, the motorway is surrounded by various sections of dense residential areas together with notable sections of commercial and industrial uses.

The existing lanes and posted speed limits for the eastbound and westbound directions are shown in **Table 1** and **Table 2**.

Table 1 Existing eastbound M4 Speed zones

Section	Lanes	Posted Speed Limit (km/h)
Russell Street to Mulgoa Road	2	110
Mulgoa Road to M7	3	110
M7 to Ettalong Road overpass bridge	3	100
Ettalong Road overpass bridge to Cumberland Highway	3	90
Ettalong Road overpass bridge to Pitt Street	4	90

Table 2 Existing westbound M4 speed zones

Section	Lanes	Posted Speed Limit (km/h)
Pitt Street to Coleman Street overpass bridge	4	90
Coleman Street overpass bridge to Ettalong Road overpass bridge	3	90
Coleman Street overpass bridge to M7	3	100
M7 to Mulgoa Road	3	110
Mulgoa Road to Russell Street	2	110

RMS has indicated that the prevailing pavement on the M4 Motorway is Open Graded Asphalt of varying age.

3 DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 Existing environmental noise

The existing ambient noise environment surrounding the project route is variable, with road traffic noise the primary contributor. The noise levels display a typical diurnal trend with noise levels during the night-time lower than the daytime and evening periods. This is characteristic of urban and suburban areas where the ambient noise environment is primarily influenced by road traffic.

The project area has been divided into multiple Noise Catchment Areas (NCAs). These NCAs reflect the changing land uses and ambient noise environments adjacent to the project and are detailed in **Table 3**.

Table 3 Noise catchment areas and surrounding land uses

NCA	Minimum Distance (m)[1]	Description
Burnett Street Interchange		
NCA01	25	Southern side of the motorway between Pitt Street and Coleman Street. Construction works are on the northern side of the motorway corridor.
NCA02	25	Northern side of the motorway between Pitt Street and Coleman Street. Construction works are on the northern side of the motorway corridor.
Coleman Street Interchange		
NCA03	20	Southern side of the motorway in the vicinity of Coleman Street. Construction works are on the northern side of the motorway corridor.
NCA04	20	Northern side of the motorway in the vicinity of Coleman Street. Construction works are on the northern side of the motorway corridor.
Cumberland Highway Interchange		
NCA05	30	Southern side of the motorway in the vicinity of Cumberland Street. Construction works are on both the southern and northern side of the motorway corridor.
NCA06	15	Northern side of the motorway in the vicinity of Cumberland Street. Construction works are on both the southern and northern side of the motorway corridor.
Prospect Highway Interchange		
NCA07	65	Southern side of the motorway in the vicinity of Prospect Highway. Construction works are on both the southern and northern side of the motorway corridor.
NCA08	75	Northern side of the motorway in the vicinity of Prospect Highway. Construction works are on both the southern and northern side of the motorway corridor.
Reservoir Road Interchange		
NCA09	130	Southern side of the motorway in the vicinity of Reservoir Road. Construction works are on both the southern and northern side of the motorway corridor.
NCA10	80	Northern side of the motorway in the vicinity of Reservoir Road. Construction works are on both the southern and northern side of the motorway corridor.
Roper to M7 Interchanges		
NCA11	375	Southern side of the motorway in the vicinity of the M7 intersection. Construction works are on both the southern and northern side of the motorway corridor.
NCA12	90	Northern side of the motorway in the vicinity of the M7 intersection. Construction works are on both the southern and northern side of the motorway corridor.
NCA13	360	Southern side of the motorway to the west of the M7 intersection. Construction works are on both the southern and northern side of the motorway corridor.
NCA14	55	Northern side of the motorway to the west of the M7 intersection. Construction works are on both the southern and northern side of the motorway corridor.

NCA	Minimum Distance (m)[1]	Description
NCA15	n/a	Southern side of the motorway in the vicinity of Hanson Wallgrove Quarry. Construction works are on both the southern and northern side of the motorway corridor.
NCA16	65	Northern side of the motorway in the vicinity of Hanson Wallgrove Quarry. Construction works are on both the southern and northern side of the motorway corridor.
NCA17	n/a	Southern side of the motorway to the west of Hanson Wallgrove Quarry. Construction works are on both the southern and northern side of the motorway corridor.
NCA18	65	Northern side of the motorway to the west of Hanson Wallgrove Quarry. Construction works are on both the southern and northern side of the motorway corridor.
NCA19	65	Southern side of the motorway in the vicinity of Roper Road. Construction works are on the northern side of the motorway corridor.
NCA20	30	Northern side of the motorway in the vicinity of Roper Road. Construction works are on the northern side of the motorway corridor.
Mamre Road Interchange		
NCA21	25	Southern side of the motorway in the vicinity of Mamre Road. Construction works are on both the southern and northern side of the motorway corridor.
NCA22	50	Northern side of the motorway in the vicinity of Mamre Road. Construction works are on both the southern and northern side of the motorway corridor.
NCA23	130	Southern side of the motorway to the west of Mamre Road. Construction works are on both the southern and northern side of the motorway corridor.
NCA24	75	Northern side of the motorway to the west of Mamre Road. Construction works are on both the southern and northern side of the motorway corridor.
Northern Road Interchange		
NCA25	100	Southern side of the motorway in the vicinity of The Northern Road. Construction works are on both the southern and northern side of the motorway corridor.
NCA26	45	Northern side of the motorway in the vicinity of The Northern Road. Construction works are on both the southern and northern side of the motorway corridor.
NCA27	30	Southern side of the motorway to the west of The Northern Road. Construction works are on both the southern and northern side of the motorway corridor.
NCA28	40	Northern side of the motorway to the west of The Northern Road. Construction works are on both the southern and northern side of the motorway corridor.
Mulgoa Road Interchange		
NCA29	25	Southern side of the motorway in the vicinity of Mulgoa Road. Construction works are on the northern side of the motorway corridor.
NCA30	30	Northern side of the motorway in the vicinity of Mulgoa Road. Construction works are on the northern side of the motorway corridor.
NCA31	45	Southern side of the motorway to the west of Mulgoa Road. Construction works are on the southern side of the motorway corridor.
NCA32	35	Northern side of the motorway to the west of Mulgoa Road. Construction works are on the southern side of the motorway corridor.
Russell Street Interchange		
NCA33	35	Southern side of the motorway in the vicinity of Russell Street. Construction works are on the northern side of the motorway corridor.
NCA34	35	Northern side of the motorway in the vicinity of Russell Street. Construction works are on the northern side of the motorway corridor.

Note 1: Approximate minimum horizontal offset distance from the nearest receiver building facade (receiver of any type) to the centre of the nearest lane of the motorway/access ramps (including future works), in locations where construction works are occurring.

The project area for each interchange includes the roads where physical works occur and may be extended to close-by landmarks such as cross streets, parks and reserves or utility corridors to provide a logical endpoint. Roads and Maritime have identified the study area associated with each interchange. The location of the various assessment areas and sensitive receivers are shown in detail in **Appendix B**.

3.2 Identification of noise and vibration sensitive receivers

The sensitivity of receivers to noise and vibration is dependent upon the occupancy type and the nature of the activities performed within the affected premises. Sensitivity to noise is a subjective response varying for different individuals and can depend on the existing noise environment.

For the purpose of this assessment, receivers potentially sensitive to noise and vibration have been categorised as:

- Residential.
- Education Institutions.
- Child-care Centres.
- Commercial.
- Hospitals (wards or other uses including medical centres).
- Places of Worship.
- Industrial.
- Other (such as cinemas, theatres, recreation areas).

This assessment considers all residences to be sensitive receivers during both construction and operation. All commercial receivers are considered to be sensitive to construction noise and vibration impacts.

Other receivers sensitive to noise and vibration (other than residential dwellings or commercial premises) are detailed in **Table 4**.

Table 4 Other noise and vibration sensitive receivers

NCA	Address	Description	Type
NCA02	Auburn & Young Street, Parramatta	Parramatta West Public School	Other (Educational)
	13 Margaret Street, Mays Hill	Freame Park	Other (Outdoor Active)
	Crimea Street, Parramatta	Burra Reserve	Other (Outdoor Passive)
	139A Burnett Street, Parramatta	Antiochian Orthodox Church	Other (Place of Worship)
	59/63 Pitt Street, Parramatta	Street Level Christian Community Inc.	Other (Place of Worship)
NCA03	7 Coleman Street, Merrylands	Westmead Rehabilitation Hospital	Other (Medical)
NCA04	16 Hawkesbury Road, Westmead	Childcare Centre	Other (Childcare)
	12 Bridge Road, Westmead	Educational Facility	Other (Educational)
	2-8 Bridge Road, Westmead	Foursquare Church/Essington Christian Academy	Other (Place of Worship)
	217 Great Western Highway, Mays Hill	Sydney Murugan Temple	Other (Place of Worship)

NCA	Address	Description	Type
NCA05	45 Old Prospect Road, South Wentworthville	Medical Facility	Other (Medical)
	36 Gregory Street, Greystanes	Gregory Park	Other (Outdoor Active)
	7-11 Carolyn Street, Greystanes	Carolyn Street Park	Other (Outdoor Active)
	18 Chelmsford Road, South Wentworthville	Baptist Church of NSW	Other (Place of Worship)
NCA06	46-48 Smith Street, Wentworthville	Ringrose Park	Other (Outdoor Active)
NCA07	533 Reservoir Road, Prospect	Place of Worship	Other (Place of Worship)
NCA08	Lot 222 Ponds Road, Propsect	Place of Worship	Other (Place of Worship)
NCA09	32 Cricketers Arms Road, Blacktown	Greater Union Blacktoen Drive-In	Other (Drive-in Cinema)
NCA14	1 Cuvee Place, Minchinbury	Childcare Centre	Other (Childcare)
	24 Barossa Drive, Minchinbury	Berruex Reserve	Other (Outdoor Active)
	28 Wallgrove Road, Minchinbury	Building on Pinegrove Memorial Park Lawn Cemetery	Other (Place of Worship)
NCA22	146B Shephard Street, Colyton	Shepherd Street Park	Other (Outdoor Active)
	Monfarville Street, St Marys	Monfarville Reserve	Other (Outdoor Active)
NCA23	Samuel Marsden Road/Flinders Avenue, Orchard Hills	Samuel Marsden Reserve	Other (Outdoor Active)
NCA26	1 Simeon Road, Orchard Hills	Penrith Christian School	Other (Educational)
	79-101 Kingswood Road, Orchard Hills	Orchard Hills Public School	Other (Educational)
NCA31	1 Factory Road, Regentville	Kids Academy	Other (Childcare)
NCA33	1 Leonay Parade, Leonay	Emu Sports Club	Other (Outdoor Active)
NCA34	49 Forbes Street, Emu Plains	Our Lady of the Way Primary School	Other (Educational)
	54 Tattersall Place, Emu Plains	Hollier Reserve	Other (Outdoor Active)

Note 1: Assessment criteria are evaluated at the most affected point within the receiver boundary

3.3 Ambient noise surveys and monitoring locations

To quantify and characterise the existing ambient noise environment across the proposal area a baseline noise survey was undertaken from 13 February 2013 to 27 March 2013. A supplementary survey was undertaken at locations immediately adjacent to the carriageway from 4 November 2014 to 13 November 2014. The measured noise levels have been used to establish existing road traffic noise levels to allow for validation of the operational noise model, and as a basis for assessing potential noise impacts during construction.

The noise monitoring locations detailed in **Table 5** were selected to be representative of receivers and communities potentially affected by the construction and operation of the project.

Noise monitoring equipment was deployed with consideration of other noise sources that may influence the measurements, accessibility and security, and with the consent of relevant land owners. The noise monitoring locations are indicated on the site plan drawings in **Appendix B**.

Table 5 Ambient noise survey locations

Noise Monitoring Location ID	NCA	Noise Monitoring Location Address	Equipment Serial Number
Baseline Survey (13 February 2013 to 27 March 2013)[1]			
A4.1	NCA02	59 Auburn Street, Parramatta	20670
A4.2	NCA01	8 Yeend Street, Merrylands	27578
A5.1	NCA03	13/35 Brewer Crescent, South Wentworthville	23814
A5.2	NCA04	233A Great Western Highway, South Wentworthville	20665
A6.1	NCA06	18 Rawson Road, South Wentworthville	20667
A6.2	NCA05	29 Carolyn St, Greystanes	23245
A7.1	NCA08	44 Great Western Highway, Prospect	20673
A7.2	NCA07	24 Watch House Road, Prospect	23241
A8.1	NCA09	2 Yallock Place, Prospect	27523
A8.2	NCA10	63B 179 Reservoir Rd, Blacktown	20669
A9.2	NCA12	41 Pikes Ln, Eastern Creek	20668
A9.3	NCA14	25 Farrington Street, Minchinbury	20670
A9.4	NCA16	5 Tod Place, Minchinbury	23814
A9.5	NCA20	6 Shepard Street, Colyton	23244
A9.6	NCA19	2 Hartwell Court, St. Clair	20675
A10.1	NCA22	27 Caines Cr, St Marys	20673
A10.2	NCA21	29 Kunipipi St, St Clair	20667
A11.1	NCA25	289 Homestead Rd, Orchard Hills	23814
A11.2	NCA28	9 Pebworth Pl, South Penrith	20670
A11.3	NCA27	20 South St, Glenmore Park	23244
A11.4	NCA26	Penrith Christian School	20669
A12.1	NCA30	49 Hatchinson Cres, Jamisontown	23245
A12.2	NCA31	41-61 Factory Rd, Regentville	20675
A13.1	NCA34	6 Tattersall Pl, Emu Plains	21884
A13.2	NCA33	70 Pamela Ln, Leonay	20674
A13.3	NCA34	13 Palmer Pl, Emu Plains	23241
Supplementary Survey (4 November 2014 to 13 November 2014)			
ADD.06.x2	NCA06	RMS Land - Berith Rd, Greystanes	
ADD.09.x1	NCA14	RMS Land - Tirage Pl, Minchinbury	
ADD.09.x2	NCA20	RMS Land - Hewitt St, Colyton	

Note 1: Baseline Surveys were conducted during February and March 2013. See **Appendix C** for specific dates at each location.

3.4 Methodology for unattended noise monitoring

The noise loggers continuously measured noise levels in 15 minute sampling periods to determine the existing L_{Aeq}, L_{A90} and other relevant statistical noise levels during the daytime, evening and night-time periods.

The noise measurements were carried out with Svantek 957 Noise Loggers. The equipment was set up with microphones at 1.5 metres above the ground level. All microphones were fitted with wind shields.

All noise measurement instrumentation used in the surveys was designed to comply with the requirements of Australian Standard AS IEC 61672.1—2004 - *Electroacoustics—Sound level meters, Part 1: Specifications*[vii] and carried appropriate and current National Association of Testing Authorities (NATA) calibration certificates. The calibration of the loggers was checked both before and after each measurement survey and the variation in calibration at all locations was found to be within acceptable limits at all times.

The results of the noise monitoring have been processed to exclude noise identified as extraneous and/or data affected by adverse weather conditions (ie strong wind or rain) so as to establish representative noise levels in each area.

3.5 Unattended noise monitoring results

The results of the unattended ambient noise surveys are summarised in **Table 6** as the Rating Background Level (RBL) noise levels for the ICNG daytime, evening and night-time periods, and the LAeq (energy averaged) noise levels for the RNP daytime and night-time periods. The 24 hour daily noise levels at each monitoring location are graphically presented in **Appendix C**.

The noise levels display a typical diurnal trend with lower noise levels during the night-time than the daytime and evening periods. This is characteristic of urban and suburban areas where the ambient noise environment is primarily influenced by road traffic.

This is consistent with observed traffic flows on the existing M4 Motorway which have a relatively small reduction in traffic volumes during the evening compared to the daytime period, and a more significant reduction in volumes during the night-time.

Table 6 Summary of unattended noise logging results

Noise Monitoring Location	Noise Level (dB)				
	ICNG Defined Time Periods			RNP Defined Time Periods	
	Daytime - RBL	Evening - RBL	Night-time - RBL	Daytime - LAeq(15hour)	Night-time - LAeq(9hour)
A4.1	53	53	48	60	54
A4.2	57	57	51	61	58
A5.1	54	54	46	61	57
A5.2	56	55	47	62	58
A6.1	53	51	46	58	54
A6.2[3]	54	52	46	61	55
A7.1[3]	54	52	46	68	65
A7.2	52	51	46	59	53
A8.1	52	52	48	57	54
A8.2[3]	56	53	47	63	61
A9.2	50	49	48	57	56
A9.3[3]	51	56	49	60	57
A9.4	52	55	53	58	62
A9.5[3]	52	54	47	60	56
A9.6[3]	54	54	44	60	56
A10.1	55	51	43	59	54
A10.2[2]	49	46	39	55	50
A11.1	58	54	43	63	58
A11.2	45	44	36	53	47

Noise Monitoring Location	Noise Level (dB)				
	ICNG Defined Time Periods			RNP Defined Time Periods	
	Daytime - RBL	Evening - RBL	Night-time - RBL	Daytime - LAeq(15hour)	Night-time - LAeq(9hour)
A11.3	51	48	39	57	53
A11.4	56	50	42	61	58
A12.1[3]	50	46	36	61	57
A12.2	50	46	36	56	51
A13.1[3]	51	47	34	59	54
A13.2	50	45	35	59	49
A13.3	48	48	44	58	53
ADD.06.x2	70	66	55	76	74
ADD.09.x1	74	70	54	78	75
ADD.09.x2	68	62	43	77	74

Note 1: ICNG Governing Periods – Day: 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening: 6.00 pm to 10.00 pm; Night: 10.00 pm to 7.00 am Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: RNP Assessment Time Periods – Day: 7.00 am to 10.00 pm; Night: 10.00 pm to 7.00 am.

Note 3: Monitoring location near to building facade. Measured noise levels considered to represent facade affected noise levels which are up to 2.5 dB higher than the equivalent free-field condition.

3.6 Attended airborne noise measurements

Attended measurements of ambient noise were completed during the noise logging survey to determine the various noise sources that influence the existing noise environment. During each measurement the observer noted the various noise sources and the contributing noise level.

At each location the attended measurements were performed for 15 minutes using a calibrated Brüel and Kjær 2260 Precision Sound Level Meter. Wind speeds were less than 5 m/s at all times, and all measurements were performed at a height of 1.5 metres above ground level.

Calibration of the sound level meter was checked before and after each measurement and the variation in calibration at all locations was found to be within acceptable limits at all times.

The noise environment at each of the attended monitoring locations is summarised in **Table 7**. Detailed observation notes are also provided in **Appendix C**.

Table 7 Summary of attended noise monitoring results

Measurement Details	Measured Noise Levels (dB)			Description of Ambient Noise Source – Typical LAmax Levels
	LA90	LAeq	LAmax	
A4.1	54	57	69	M4 Heavy-vehicle road traffic: 59-62dBA, Local road traffic: 62 - 66 dBA, Insects: 60 – 68 dBA
A4.2	57	60	72	M4 Heavy-vehicle road traffic: 62-67dBA, Local road traffic: 63 - 66 dBA, Insects: 60 – 62 dBA
A5.1	58	62	81	M4 Heavy-vehicle road traffic: 61-72dBA, Light vehicle traffic: 60 - 62 dBA, Birds: 57 – 58 dBA
A5.2	58	64	87	M4 Heavy-vehicle road traffic: 64-70dBA, Light vehicle traffic: 65 - 67 dBA, Birds: 70 dBA

Measurement Details	Measured Noise Levels (dB)			Description of Ambient Noise Source – Typical LAmax Levels
	LA90	LAeq	LAmax	
A6.1	52	56	70	M4 Heavy-vehicle road traffic: 55-70dBA, M4 Light-vehicle road traffic: ~54-55 dBA, Birds: 55 – 65 dBA
A6.2	54	61	68	M4 Heavy-vehicle road traffic: 64-68 dBA, M4 Light-vehicle road traffic: ~50-52 dBA, Insects: 54 – 63 dBA
A7.1	56	69	86	Heavy-vehicle road traffic: 81-86 dBA, Light-vehicle road traffic: 72-78 dBA, Insects: 53-55 dBA
A7.2	51	58	77	Heavy-vehicle road traffic: 61-77 dBA, Light-vehicle road traffic: 50-54 dBA, Insects: 51-54 dBA
A8.1	55	58	70	Heavy-vehicle road traffic: 59-64 dBA, Air traffic: 55-70 dBA, Birds: 66-67 dBA, Insects: ~57 dBA
A8.2	55	62	85	Heavy-vehicle road traffic: 62-75 dBA, Light-vehicle road traffic: 54-77 dBA, Motorcycles: 85 dBA
A9.2	53	56	66	Heavy-vehicle road traffic: 55-61 dBA, Light-vehicle road traffic: ~54 dBA, Motorcycle: 59-60 dBA, Air traffic: 55-57 dBA, Birds: 55-57 dBA
A9.3	49	51	63	Heavy-vehicle road traffic: 50-55 dBA, Light-vehicle road traffic: ~49-52 dBA, Motorcycle: 55-57 dBA, Insects: 50-51 dBA
A9.4	53	56	63	Heavy-vehicle road traffic: 56-63 dBA, Light-vehicle road traffic: ~53-54 dBA, Insects: ~56 dBA, Birds: 53-59
A9.5	54	57	66	Heavy-vehicle road traffic: 55-65 dBA, Air Traffic: 56-58 dBA, Insects: ~56 dBA
A9.6	54	57	66	Heavy-vehicle road traffic: 59-66 dBA, Light-vehicle road traffic: 56-58 dBA, Motorcycles: 58-60 dBA, Air Traffic: 61 dBA, Birds: 56-63 dBA
A10.1	55	57	67	Heavy-vehicle road traffic: 58-65 dBA, Light-vehicle road traffic: ~56-58 dBA, Birds: 56-67 dBA
A10.2	49	54	75	Heavy-vehicle road traffic: 56-68 dBA, Light-vehicle road traffic: ~51-58 dBA, Air traffic: 54 dBA, Dog bark: 75 dBA
A11.1	55	61	71	Heavy-vehicle road traffic: 60-71 dBA, Light-vehicle road traffic: ~56 dBA, Insects: <55 dBA
A11.2	45	53	72	Heavy-vehicle road traffic: 52-71 dBA, Light-vehicle road traffic: ~52 dBA, Birds: 47-52 dBA

Measurement Details	Measured Noise Levels (dB)			Description of Ambient Noise Source – Typical LAmax Levels
	LA90	LAeq	LAmax	
A11.3	51	56	66	Heavy-vehicle road traffic: 58-63 dBA, Light-vehicle road traffic: 50-58 dBA, Insects: ~55 dBA
A11.4	55	60	73	Heavy-vehicle road traffic: 58-70 dBA, Light-vehicle road traffic: ~55 dBA, School playground: 50-73 dBA
A12.1	58	66	81	Heavy-vehicle road traffic: 65-73 dBA, Light-vehicle road traffic: ~65 dBA, Insects: <55 dBA
A12.2	50	56	78	Heavy-vehicle road traffic: 55-78 dBA, Light-vehicle road traffic: 50-59 dBA, Motorcycles: 57-59 dBA, Birds: 50-58 dBA
A13.1	57	65	70	Heavy-vehicle road traffic: 61-70 dBA, Light-vehicle road traffic: 60-65 dBA, Insects: ~65 dBA
A13.2	48	63	69	M4 Heavy-vehicle road traffic: 54-69dBA, Light road traffic: 48 - 54 dBA, Insects: 60 – 67 dBA
A13.3	47	55	75	Heavy-vehicle road traffic: 53-63 dBA, Light-vehicle road traffic: ~52 dBA, Birds: 68 dBA, Distant construction: 57 dBA
ADD.06.x2	75	78	94	M4 Light-vehicle road traffic: typically ~76-79 dBA; M4 Heavy-vehicle road traffic: 79-94 dBA; Motorcycle: 84 dBA
ADD.09.x1	75	78	87	M4 Light-vehicle road traffic: typically ~76-80 dBA; M4 Heavy-vehicle road traffic: 80-87 dBA
ADD.09.x2	67	78	88	M4 Light-vehicle road traffic: typically ~75-78 dBA; M4 Heavy-vehicle road traffic: 81-88 dBA

4 OPERATIONAL NOISE GOALS AND NOISE MITIGATION GUIDANCE

4.1 Introduction

The most common form of noise experienced by people is termed ‘airborne’ noise, indicating that it propagates between the source and receiver primarily through the air. This is the main form of noise that occurs adjacent to a road corridor or construction site.

The primary source of airborne noise from road traffic sources originates from the engine at low speed and from the interaction of the tyre and road at higher speeds. Heavy vehicle (trucks) exhausts are also a significant source of airborne noise during heavy acceleration or engine braking events.

The key influences on road traffic airborne noise are the speed of the passing vehicles, the condition of the pavement surface, the volume of traffic on the road and the number of heavy vehicles. The level of airborne noise experienced at a receiver is also dependent upon the distance to the road corridor and the presence of any natural or man-made barriers between the corridor and the receiver which can impede the propagation of noise.

4.2 Operational noise metrics

The noise metrics applied in the modelling and assessment of airborne noise from road traffic are:

$L_{Aeq(15hour)}$ the ‘energy average noise level’ evaluated over the daytime period (7.00 am to 10.00 pm). The L_{Aeq} can be likened to a noise dose representing the cumulative effects of all the noise events occurring in the relevant time period.

$L_{Aeq(9hour)}$ the ‘energy average noise level’ evaluated over the night-time period (10.00 am to 7.00 am).

$L_{Aeq(1hour)}$ the ‘energy average noise level’ evaluated for a specific one-hour period.

L_{Amax} The maximum noise level from road traffic noise occurring at a particular location.

The subscript ‘A’ indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

4.3 Noise criteria – Roads and Maritime Noise Criteria Guideline

The Noise Criteria Guideline (NCG) documents Roads and Maritime Services' interpretation of the NSW Road Noise Policy (RNP). The NCG provides a consistent approach to identifying road noise criteria for Roads and Maritime Services projects. These approaches meet the intention of the RNP.

Criteria for road projects comprising of new and redeveloped road segments are assigned with reference to the RNP.

Although it is not mandatory to achieve the noise assessment criteria in the NCG, project proponents need to provide justification if it is not considered feasible or reasonable to achieve them.

The guideline recognises that there are generally more opportunities to minimise noise impacts from new roads and road corridors, especially those in greenfield locations, through judicious road design and land use planning. The scope to reduce noise impacts from existing roads and corridors is typically more limited. The NCG criteria are applicable both at the time of project opening and also in a future design year, typically taken to be ten years after project completion.

4.3.1 Noise assessment criteria

The M4SM project area is considered an existing freeway. The M4SM project has been considered a redevelopment project. The NCG assessment criteria (consistent with the RNP) for residences adjacent to such projects are summarised in **Table 8**.

Table 8 NCG criteria – residential

Road Category	Type of Project/Land Use	Assessment Criteria (dB)	
		Daytime (7 am – 10 pm)	**Night-time (10 pm – 7 am)**
Freeway/ arterial/ sub-arterial roads	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	LAeq(15hour) 60 (external)	LAeq(9hour) 55 (external)

The project has the potential to impact on a number of other sensitive receivers that are situated within the project area. These are detailed in **Table 9**. Further information on the other sensitive land use receivers are provided in **Section 3.2**.

Table 9 NCG criteria – other sensitive land uses

Existing Sensitive Land Use	Assessment Criteria (dB)		Additional Considerations
	Daytime (7 am – 10 pm)	**Night-time (10 pm – 7 am)**	
School Classrooms	LAeq(1hour) 40 (internal)	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Places of Worship	LAeq(1hour) 40 (internal)	LAeq(1hour) 40 (internal)	The criteria are internal, ie the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established which activities in these areas may be affected by road traffic noise.
Open Space (Active Use)	LAeq(15hour) 60 (external) when in use	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
Open Space (Passive Use)	LAeq(15hour) 55 (external) when in use	-	Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading.

Existing Sensitive Land Use	Assessment Criteria (dB)		Additional Considerations
	Daytime (7 am – 10 pm)	Night-time (10 pm – 7 am)	
Childcare facilities	Sleeping rooms $L_{Aeq(1hour)}$ 35 (internal) Indoor play areas $L_{Aeq(1hour)}$ 40 (internal) Outdoor play areas $L_{Aeq(1hour)}$ 55 (external)	-	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged care facilities	60	55	Residential land use noise assessment criteria should be applied to these facilities.

For sensitive receivers such as schools, places of worship and childcare facilities, the NCG criteria presented in **Table 9** are based on internal noise levels. A minimum (conservative) outside-to-inside attenuation of 10 dB, on the basis of open window(s) for natural ventilation, has been assumed to determine external noise criteria for such receivers.

The noise models predict noise levels for $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ intervals (day and night). Where receivers have 1-hour criteria, the predicted $L_{Aeq(period)}$ noise levels are converted to $L_{Aeq(1hour)}$ by considering the difference between the $L_{Aeq(15hour)}$ or $L_{Aeq(9hour)}$ and the $L_{Aeq(1hour)}$ in the noise logging data associated with the project validation. The difference in dB is then used as a conversation factor to compare the predicted noise levels against the 1-hour criteria. The factors used for this assessment are outlined in **Section 5.10**.

In addition to the noise criteria in **Table 8** and **Table 9**, the RNP describes a ‘Relative Increase Criteria’ of 12 dB above existing traffic noise. This criterion is primarily intended to protect existing quiet areas from excessive changes in amenity. For a road in the same location and with the same mix of traffic, the existing noise levels would not be 12 dB below the NCG criteria for redeveloped road. Therefore the RIC does not apply for this Project.

4.3.2 Potential road traffic noise impacts on the surrounding road network

The scope of this assessment considers potential increases in the traffic noise on the surrounding road network within each of the interchange assessment areas.

4.3.3 Sleep disturbance

Guidance for the assessment of sleep disturbance given in the RNP is reproduced as follows:

> *Triggers for, and effects of sleep disturbance from, exposure to intermittent noise such as noise from road traffic are still being studied. There appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise. The NSW Roads and Traffic Authority’s Practice Note 3 (NSW Roads and Traffic Authority 2008) outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance.*

The protocol for assessing the potential for sleep disturbance, detailed within *Practice Note III* of the ENMM, is determined by performing an L_{AFmax} – $L_{Aeq(1hr)}$ calculation on individual vehicle passby noise measurements. A maximum noise level event is then defined as a passby for which the night-time L_{AFmax} – $L_{Aeq(1hr)}$ difference is greater than 15 dB.

With regard to reaction to potential sleep disturbance events, the RNP gives the following guidance:

From the research on sleep disturbance to date it can be concluded that:

- *maximum internal noise levels below 50–55 dB are unlikely to awaken people from sleep*
- *one or two noise events per night, with maximum internal noise levels of 65–70 dB, are not likely to affect health and wellbeing significantly.*

It is generally accepted that internal noise levels in a dwelling with the windows open are 10 dB lower than external noise levels. Based on this conservative minimum attenuation of 10 dB, the first conclusion above suggests that short term external noise levels of 60 dB to 65 dB L_{AFmax} are unlikely to cause awakening reactions.

The second conclusion suggests that one or two noise events per night with maximum external noise levels of 75 dB to 80 dB L_{AFmax} are not likely to affect health and wellbeing significantly.

4.4 Noise Mitigation Guideline (NMG)

The Noise Mitigation Guideline (NMG) was issued by RMS in December 2014 and replaces Practice Note (iv), (iv-a) and (iv-c) of the Environmental Noise Management Manual (ENMM).

Then NMG provides guidance in managing and controlling road traffic generated noise.

The NMG recognises that the criteria recommended by the RNP are not always practicable and that it is not always feasible or reasonable to expect that they should be achieved.

The NMG notes that the most effective way of minimising noise from vehicles and traffic is to control vehicle noise at the source. Where source measures are not practical, or do not provide sufficient noise reduction, additional methods are required to reduce levels to within acceptable margins. Such additional methods may include the use of noise barriers and/or consideration for architectural treatment of residences.

When the total noise level in the build year is 5 dB or more above the NCG criterion it is considered to have exceeded the cumulative limit. Receivers where this exceedance occurs qualify for consideration of noise mitigation.

In operational road traffic noise assessments, consideration for noise mitigation treatment is typically given to properties that experience an exceedance of the cumulative limit in the Build scenario even when there is no change in noise level due to the project.

In the NMG a receiver with noise levels at or above 65 dBA $L_{Aeq(15hour)}$ or 60 dBA $L_{Aeq(9hour)}$ may be referred to as ‘acute’. If the contribution from the road project is ‘acute’ then the receiver qualifies for consideration of noise mitigation. For redeveloped road projects the cumulative limit criteria are taken to be the same as the ‘acute’ criteria. For the purposes of this report, the term ‘acute’ will be used.

4.5 Guidance for consideration of reasonable additional noise mitigation

For this project (ie redevelopment road project without transition zones), Roads and Maritime consider it reasonable to consider additional noise mitigation (beyond the adoption of road design and traffic management measures) where:

Trigger 1

- The predicted Build noise level exceeds the NCG controlling criterion for redeveloped roads and the noise level increase due to the project (ie the noise predictions for the Build minus the No Build) is greater than 2 dB.

or:

Trigger 2

- The predicted Build noise level exceeds the cumulative limit, taken to be consistent with the ‘acute’ definition (≥ 65 dB $L_{Aeq(15hour)}$ or ≥ 60 dB $L_{Aeq(9hour)}$) regardless of the incremental impact of the project.

The above triggers are consistent with the NMG noting that the eligibility of receivers for consideration of additional noise mitigation is determined before the benefit of project noise barrier optimisation is included. The corresponding requirement for the project is to provide additional mitigation for these eligible receivers, unless predicted noise with optimised noise barriers in place reduces the receiver noise level to below the corresponding NCG controlling criterion. Consequently, even if noise barrier improvements reduce the receiver noise level to below the ‘acute’ level, or reduce the increase due to the project to 2.0 dB or less, eligible receivers would still require property treatment where they remain over the NCG criteria.

5 PREDICTION OF AIRBORNE NOISE DURING OPERATION

5.1 Assessment procedure

The RNP requires that road traffic noise levels from road infrastructure projects are evaluated at two specific timeframes:

- Within one year of changed traffic conditions. For the M4SM project this is **2021**.
- For a future design year (typically ten years) after changed traffic conditions. For the M4SM project this is **2031**.

For each of the above timeframes, a comparison is to be made between the following two scenarios:

- The road traffic noise levels if the project proceeds (termed the Build option).
- The corresponding road traffic noise levels due to general traffic growth that would have occurred if the project had not proceeded (termed the No Build option).

RNP assessment scenarios

Based on the discussion above the following four scenarios were modelled for this assessment:

- **2021 No Build**
  Base 'do minimum' (2021) – the forecast road traffic volumes without the M4SM project.
- **2021 Build**
  M4SM (2021) – the forecast 'at opening' road traffic volumes including the M4SM project.
- **2031 No Build**
  Future 'do minimum' (2031) – the forecast road traffic volumes 10 years after the opening year due to general traffic growth that would have occurred without the M4SM project.
- **2031 Build**
  M4SM (2031) – the forecast '10 year after opening' road traffic volumes including the M4SM project.

The comparison for 2021 will indicate the potential for any noise issues at the commencement of the project, such as community reaction to significant changes in noise levels. The comparison for 2031 will indicate the potential for noise impacts in the longer term once the project is well established and the surrounding road network has stabilised.

5.2 Road noise prediction algorithms

Noise modelling of the project area was carried out using the *Calculation of Road Traffic Noise* (CORTN) (UK Department of Transport, 1988)[viii] algorithms incorporated in SoundPLAN V7.1. The modelling allows for traffic volume and mix, type of road surface, vehicle speed, road gradient, reflections off building surfaces, ground absorption and shielding from ground topography and physical noise barriers.

The algorithm output of CORTN (fundamentally an L_{A10} predictor) has been modified to calculate the relevant daytime $L_{Aeq(15hour)}$ and night-time $L_{Aeq(9hour)}$ road traffic noise emission levels at noise sensitive receivers, as required by the RNP.

The CoRTN traffic source line as modelled in SoundPLAN has also been modified to incorporate four effective noise sources (and associated heights) for each carriageway. This is because the three distinct noise sources of heavy vehicles (representing the tyres, engine and the exhaust, with different noise emission levels and different heights) are important in determining the noise propagation where barriers are present. The four effective noise sources comprise a *'CAR'* source with height of 0.5 metres above pavement and three *'TRUCK'* sources at three separate heights representing the noise emission from truck tyres (0.5 metres), truck engines (1.5 metres) and truck exhausts (3.6 metres).

The SoundPLAN noise models were set up to calculate noise levels at receiver points for all facades of each noise sensitive receiver identified within the project area.

5.3 Modelling of the road alignment

The noise model was constructed from a combination of survey road corridor ground topography, aerial photography and Light Detection and Ranging (LIDAR) information. All design information (altered road corridor, carriageway levels, modified ramps, etc) in areas where upgrade works are proposed within the project area was supplied by the project team.

No Build scenarios

The predictions for the No Build scenarios make use of the existing road alignment geometry of the M4 Motorway and surrounding road network. Existing noise barriers and features within the road corridor are also included in the No Build noise modelling scenarios.

Build scenarios

The Build scenarios make use of the proposed design of the project which includes proposed modifications to the access ramps, widening works of the motorway between Roper Road and the M7 interchange, modified noise wall locations and changes to existing cuttings / embankments etc.

5.4 Noise model validation

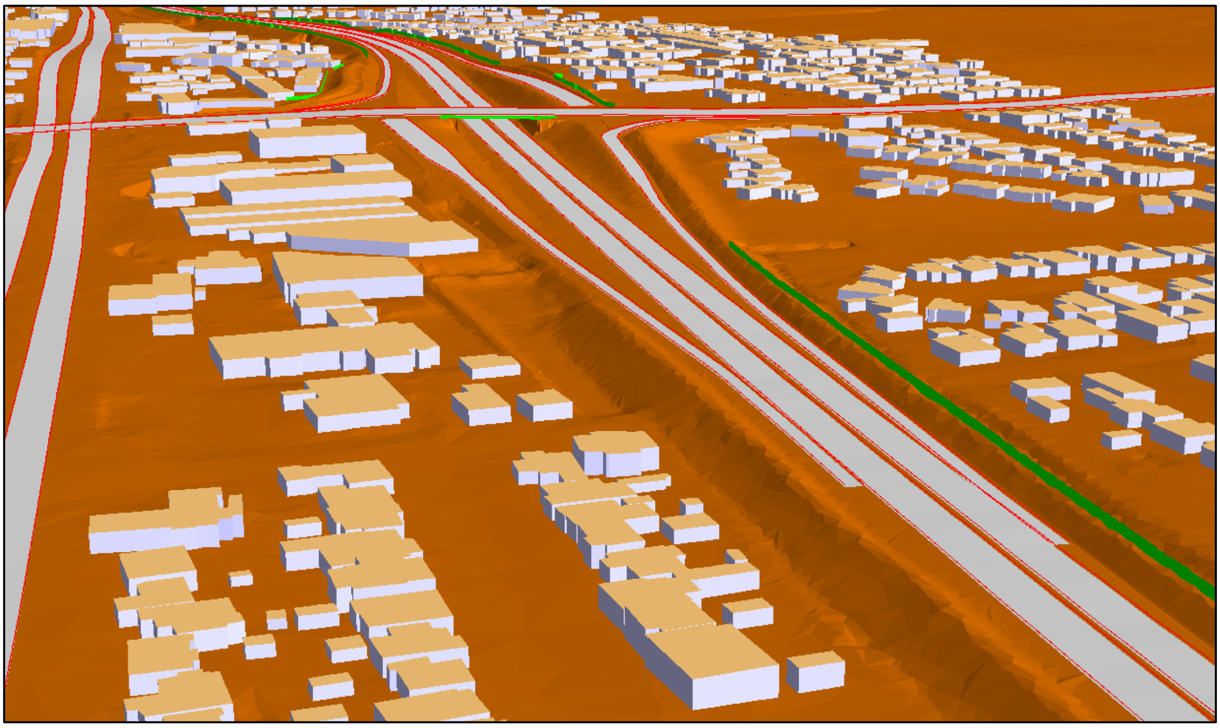
5.4.1 Overview

The noise modelling procedures and algorithms used in this assessment have been shown to give reliable results which are within normal accepted tolerances.

Comparison of measured and predicted levels has been performed by undertaking single point receiver calculations at noise model locations coinciding with the ambient monitoring locations. These locations have been limited to those with a direct line of sight or those near to the M4 with insignificant influence from secondary roads, and minimal complex screening in order to provide reasonable reliable prediction locations. Sections have been divided based on changes to the traffic conditions and surface, and consideration of selected logging data

An example screenshot from the validation noise modelling situation is provided in **Figure 2**.

Figure 2 Example M4SM Noise Model Screenshot



Note: View looking east to the intersection of the M4 Motorway with the Cumberland Highway.

5.4.2 Existing surface

The existing M4 Motorway OGA pavement surface is typically variable in its age and condition. Base inputs for the validation model are as follows:

- OGA @ -2.0dB all carriageway sections
- DGA @ 0dB on ramps

As the surface was observed to be variable in condition, a study was undertaken to estimate the current performance of the pavement sections (refer to **Section 5.4.4**).

5.4.3 Validation traffic data

Traffic counting was undertaken concurrently with the ambient noise monitoring survey. Traffic counting equipment was deployed on the main carriageway and ramp locations adjacent to noise logging locations. This data was supplemented with historical traffic counting undertaken by RMS, as appropriate.

The traffic data inputs for the validation situation are summarised in **Appendix D-1**.

The traffic counts are used for the purpose of validating the noise model and relate only to the period over which the noise logging was undertaken. Consequently, these are of limited use in providing long-term traffic volumes and speeds and should not necessarily be regarded as representative of existing volumes.

5.4.4 Free flow traffic model validation

Traffic data for the daytime period between 11.00 am and 3.00 pm was selected as representative of reasonably free flowing conditions and relatively high volume. Measured volumes and speeds (refer to **Appendix D1**) were modelled in this scenario and compared to measured noise levels to indicate the surface performance of the mainline M4 carriageways. A comparison of the measured and predicted free flow results is presented in **Table 10**.

Table 10 Comparison of measured and predicted noise levels - Free Flow conditions

Survey	Logger	Address	Measured LAeq (11am-3pm)	Predicted LAeq (11am-3pm)	Difference
Burnett to Cumberland					
2013	A04-02	8 Yeend Street, Merrylands	61.8	62.3	0.5
2013	A05-01	13/35 Brewer Crescent, South Wentworthville	62.7	63.2	0.5
2013	A06-01	18 Rawson Road, South Wentworthville	59.8	60.2	0.4
Cumberland to M7					
2014	ADD.06.x2	RMS land, M4 corridor	77.3	76.7	-0.6
2013	A07-02	24 Watch House Road, Prospect	60.4	59.9	-0.5
M7 to west of Mamre					
2014	ADD.09.x1	RMS land, M4 corridor	77.9	73.9	-4.0
2014	ADD.09.x2	RMS land, M4 corridor	77.3	74.6	-2.7
West of Mamre to Russell					
2013	A11-03	20 South St, Glenmore Park	57.6	60.1	2.5
2013	A12-02	41-61 Factory Rd, Regentville	57.0	59.0	2.0
2013	A13-01	6 Tattersall Pl, Emu Plains	60.8	60.7	-0.1

The median difference between predicted and measured noise levels of the free flow traffic model validation have been taken to represent the surface performance in each section. Noting that the free flow model included the standard OGA surface correction (-2 dB), this analysis indicates the following:

- The pavement surface from Burnett to Cumberland is performing at -2.5 dB
- The pavement surface from Cumberland to M7 is performing at -1.4 dB
- The pavement surface from M7 to west of Mamre is performing at +1.4 dB
- The pavement surface from west of Mamre to Russell is performing at -4.0 dB

5.4.5 Flow condition model validation

The effect of congestion is generally to reduce noise levels due to the slower vehicle speeds and a degree of acoustic shielding provided by the closely spaced vehicles on the carriageways. Posted speeds are used to determine the predicted noise level from which the flow condition corrections are determined.

Flow conditions validation was undertaken using measured traffic volumes for the 15-hour daytime and 9-hour night-time periods (refer to **Appendix D1**), in combination with posted speeds (refer to **Section 2.2**). The free flow surface correction (refer to **Section 5.4.4**) was also applied to the source lines. Comparison with the measured noise levels indicates the calibration factor to account for the flow condition (eg congestion effects) of the traffic during the survey period. A comparison of the measured and predicted survey flow conditions is presented in **Table 11**.

Table 11 Comparison of measured and predicted noise levels - survey flow conditions

Survey	Logger	Address	Measured LAeq (15hr)	Measured LAeq (9hr)	Predicted LAeq (15hr)	Predicted LAeq (9hr)	Difference DAY	Difference NIGHT
Burnett to Cumberland								
2013	A04-02	8 Yeend Street, Merrylands	61.1	58.4	60.8	57.3	-0.3	-1.1
2013	A05-01	13/35 Brewer Crescent, South Wentworthville	61.0	56.6	61.6	58.4	0.6	1.8
2013	A06-01	18 Rawson Road, South Wentworthville	58.0	54.2	59.2	56.1	1.2	1.9
Cumberland to M7								
2014	ADD.06. x2	RMS land, M4 corridor	76.1	73.7	76.2	73.3	0.1	-0.4
2013	A07-02	24 Watch House Road, Prospect	58.9	53.1	59.3	55.9	0.4	2.8
M7 to west of Mamre								
2014	ADD.09. x1	RMS land, M4 corridor	77.6	74.6	77.2	74.3	-0.4	-0.3
2014	ADD.09. x2	RMS land, M4 corridor	76.9	74.0	77.7	74.9	0.8	0.9
West of Mamre to Russell								
Traffic data shows minimal congestion in this area therefore no factor is proposed								

The median difference between the predicted and measured noise levels of the survey flow conditions have been taken to represent the flow condition correction for each road section. This analysis indicates the following:

- Survey flow conditions result in an overprediction within the section from Burnett to Cumberland. The observed higher overprediction at night is likely due to a large number of vehicles within the 5.00 am-7.00 am period where congestion has been observed in the traffic data.
- Survey flow conditions result in an overprediction within the section from Cumberland to the M7. The observed higher overprediction at night is likely due to large number of vehicles within the 5.00 am-7.00 am period where congestion has been observed in the traffic data.
- Only minor variations in flow conditions compared to those modelled at posted speeds was observed in the section from the M7 to west of Mamre.

5.5 Modelling of pavement surfaces

No Build scenario

RMS have advised that the existing pavement surface is to be repaired independently of the M4SM project in the following locations:

- M4 carriageway westbound at Mamre Road entry (from Ch 33080 to Ch 32340)

The No Build modelling assumes the standard surface performance of OGA (-2 dB) in these locations, and the corrections presented in **Section 5.4.4** for the remaining sections.

Build scenario

Where works are proposed within each interchange area, a resheet of the M4 carriageway with OGA (ie low noise) is proposed. This is apparent in the following sections:

- Widening section of the M4 carriageway between the M7 motorway interchange and Roper Road

Resheet of all project ramps will be DGA and will apply for the full extent of the ramp from the point where it has diverged from the main carriageway.

5.6 Modelling of traffic data

Traffic data for the RNP Build and No Build assessment scenarios for both project opening and the future design year was provided by the project team and is presented in **Appendix D-2**.

Reference should be made to the corresponding traffic and transport report for further details relating to the traffic forecast methodology and potential limitations of the data.

5.7 Modelling of congestion

RMS have confirmed that congestion for the Build scenario is expected to be minimal however it is considered difficult to accurately predict at this stage in the design process. This assessment conservatively assumes that no congestion will be apparent for the Build scenarios. The modelling therefore includes the congestion factor (refer to **Section 5.4.5**) for the No-Build scenarios only.

5.8 Modelling of managed ramp conditions

The introduction of managed access ramps with the M4SM project may result in interrupted flow conditions when the managed ramps are in use. This is generally expected to be during peak times when traffic demands are higher. The flow conditions during these periods are considered similar to those at signalised intersections which produce interrupted flow that may be characterised by periods of relatively low noise levels followed by periods of higher noise levels as vehicles accelerate away from the traffic lights[ix]. In the Pacific Highway case study by Brown (The Effect of Signalisation on Road Traffic Noise Levels – A Case Study[x]) essentially no difference in $L_{Aeq(18hour)}$ noise levels was found under signalisation compared to free flow conditions.

There is expected to be negligible change in $L_{Aeq(period)}$ due to the flow conditions introduced. The noise model therefore assumes free flowing traffic conditions on the ramps throughout the day and night-time periods.

The interrupted flow conditions may result in changes to the L_{Amax} noise levels (eg during acceleration events), however as the managed ramp systems are typically used during peak periods where LAeq noise levels are relatively high, further consideration of changes in noise level due to the managed ramps is not warranted at this stage. Should metered ramps be required in the low volume night-time periods, further assessment should be undertaken during detailed design based on the specific periods of use, and associated traffic volumes (including heavy vehicles) within these periods.

5.9 Modelling of noise barriers

Existing

Existing noise barrier locations and heights were derived from LIDAR data. This was supplemented by visual site inspection, where necessary, to determine the appropriateness of any barriers to be included in the model.

Build

The construction of the project results in a number of locations where the existing noise barriers are required to be relocated to allow for the widened alignment of the ramps. These locations are identified for each interchange in **Section 7**.

The modelled Build scenario noise barriers in these locations have relocated the existing barriers to a feasible location maintaining the same absolute top of barrier height as the existing barrier.

5.10 Summary of noise modelling parameters

A summary of the modelling parameters is provided in **Table 12**.

Table 12 Summary of noise model inputs and parameters

Input Parameter	Source of Data	
Ground topography	Combination of surveyed road corridor data and LIDAR point cloud survey	
Proportion of absorbing ground	0.75 (CORTN)	
Receiver Locations	Aerial photography and LIDAR point cloud	
Vehicle Speed (2021 and 2031 Build and No Build)	Main carriageway Access ramps Secondary	As sign posted
Source Heights and Source Correction (dB)	Car exhaust Truck tyres Truck engines Truck exhausts	0.5 m (0.0 dB) 0.5 m (-5.4 dB) 1.5 m (-2.4 dB) 3.6 m (-8.5 dB)
Road Surface Corrections	Refer to **Section 5.5**, applied to all modelled source lines as a surface correction	
Receiver Location (@ 1m from Facade)	Ground floor[2] First floor[2]	1.5m 4.5m
Facade Correction	+2.5 dB	
ARRB	-1.7 dB for facade conditions	
L_{A10} to L_{Aeq}	-3 dB	
$L_{Aeq(period)}$ to $L_{Aeq(1hour)}$ correction	$L_{Aeq(15hour)}$ to $L_{Aeq(1hour)}$ +5.0 dB $L_{Aeq(9hour)}$ to $L_{Aeq(1hour)}$ +6.0 dB	

Note 1: This is the standard correction for OGA.

Note 2: These are typical heights above ground level, the height of some receivers were adjusted according to site survey information.

5.11 Receivers included for assessment

In accordance with Roads and Maritime guidance, receiver noise levels are not required to be assessed where the project related roads are not predicted to contribute significantly to the total road traffic noise. This means that in certain locations where secondary roads are seen to be dominant, and the noise level contribution from the project is not significant, the receiver should be excluded from the assessment.

Notwithstanding the above, in assessment areas adjacent to secondary roads, noise levels are assessed where the project generates an increase in total road traffic noise (ie from No Build to Build) of greater than 2 dB, or where the noise levels due to the project road results in ‘acute’ noise levels.

6 REASONABLE AND FEASIBLE OPERATIONAL NOISE MITIGATION MEASURES

6.1 Procedure overview

As highlighted in the NMG, once noise has been minimised by feasible and reasonable methods during the corridor planning and road design stages, receivers with residual exceedances of the Noise Criteria Guideline (NCG) controlling criteria shall be assessed to determine if they qualify for noise mitigation.

For receivers that qualify for consideration of additional noise mitigation measures (refer to **Section 4.5**), potential noise mitigation measures are identified, in the order of preference from the list below:

1 Quieter pavement surfaces
2 Noise mounds
3 Noise walls
4 At property treatments.

The redevelopment of existing road corridors offers a limited range of noise control measures because of the inherent limitations to using corridor route adjustment, the proximity of existing residents to the road and limited road redesign options.

The priority of mitigation measures recognises that noise control at the source is preferable over noise path control and noise mitigation at the receiver.

The NMG notes that noise mitigation measures should be both feasible and reasonable.

Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the abatement measure. To make such a judgement, consideration may be given to noise impacts, noise mitigation benefits, the cost effectiveness of noise mitigation and community views.

6.2 NMG – feasible and reasonable

Where the noise goals in the Build scenarios are found to be exceeded as a result of a project, the project is required to adopt all feasible and reasonable mitigation measures to meet the targets.

The NMG defines what feasible and reasonable factors may be considered when investigating noise mitigation measures.

'Feasibility' relates to engineering considerations (what can be practically built) and may include:

- The inherent limitations of different techniques to reduce noise emissions from road traffic noise sources.
- Safety issues, such as restrictions on road vision.
- Road corridor site constraints such as space limitations.
- Floodway and stormwater flow obstruction.
- Access requirements.
- Maintenance requirements.

'Reasonableness' relates to the application of wider judgements. The factors to be considered are:

- The noise reduction provided and the number of people protected.

- The cost of mitigation, including the total cost and cost variations with different benefits provided.
- Community views and wishes.
- Visual impacts.
- Existing and future noise levels, including changes in noise levels.
- The benefits arising from the proposed road or road development.

6.3 Road design and traffic management

There are limited opportunities to acoustically optimise the design of the M4SM project given that the M4 Motorway is an existing motorway surrounded in most places by existing communities.

Similarly, traffic management strategies aimed at reducing noise are not considered to be a feasible option for the project given the high daily volumes of traffic that use the motorway in both the existing and future scenarios. The proposed traffic management of the access ramps has been discussed in **Section 5.8.**

6.4 Low noise pavement surfaces

As noted previously, the proposal includes resheeting of the M4 carriageway in OGA (ie low noise) at locations where pavement works are required on the main carriageways. These include the Roper Road to M7 interchange area where carriageway widening works are proposed.

This measure provides noise mitigation of road traffic noise at source and will be a benefit to all sensitive receivers in the vicinity compared to a higher noise pavement type.

6.5 Noise barriers and architectural treatments

Where the optimisation of the roadway design is insufficient to meet the target noise levels in the Build assessment scenarios, a project is required to apply all feasible and reasonable additional noise control methods (ie noise barriers and architectural treatments) in an attempt to meet the goals.

Where additional mitigation measures are identified as being required, preference is to be given to the use of ‘built’ wayside noise barriers, as all dwellings (and associated external/outdoor areas) behind the barriers benefit from the resulting reduction in noise.

The following sections discuss the design and optimisation of the project noise barriers and the resulting residual architectural treatments.

7 NOISE WALL DESIGN AND OPTIMISATION PROCESS

7.1 Assessment overview

In sensitive receiver locations where exceedances of the operational noise criteria are predicted, new or increased height noise barriers have been considered where more than three exceeding properties are found to be closely spaced. Where the number of exceeding receivers is found to be three or less, the specification of noise barriers is not considered to be a reasonable or cost-effective approach and architectural treatment of these receivers should be considered. This approach is consistent with the NMG.

Noise barriers are typically most efficient when the receivers being protected are located at ground floor level. As the height above ground of a receiver increases, the noise reduction due to the barrier is usually seen to reduce due to the increased line-of-sight over the top of the barrier to the road corridor (ie reduced path length difference).

It is not uncommon for upper floors of multi-storey buildings to see little to no reduction in noise levels from nearby barriers because of their elevation. The process of determining reasonable barrier heights would therefore generally be less likely to result in noise barriers being considered a reasonable option where the most affected receiver is located on the higher floors. With consideration of this, the assessment and optimisation of noise barriers for the project makes use of noise predictions at ground and first floor only.

7.2 NMG requirements

The underlying principle in the NMG document is to give preference to at-road noise mitigation measures over at-property measures.

The NMG approach identifies the number of receivers (noting that a two storey residence is counted as two receivers) that receive at-residence treatment versus barrier height to establish an initial design height and then conducts a weighted analysis to find the optimal mix of barrier height and at-property treatment. This prioritises at-road mitigation and minimises the use of at residence treatments, as per the intent of the RNP.

This approach first identifies the maximum barrier height (up to 8 m) where no receivers require at residence treatment. The initial design height is then established by identifying the height where, of the receivers that benefit from the noise barrier, two thirds no longer require at residence treatment. A value of two thirds has been chosen as further increases in barrier height have been shown to have diminishing benefits per increase in height increment.

Weightings are then applied which consider cost and the benefits the barrier provides to the wider community. The total points weighting at each barrier height is the sum of the weightings for barrier area, number of at property treatments and exceedances of the 50 dBA day or 45 dBA night World Health Organisation (WHO) criteria.

A low point in the weighting curve between the initial design height and the maximum barrier height corresponds to the most reasonable barrier height in terms of community benefit and weighted cost. The feasibleness and reasonableness of the design and maximum barrier heights are then reviewed.

As a guide, noise barriers are considered to be a reasonable noise mitigation option where they are capable of providing an insertion loss of:

- 5 dB at representative receivers for heights of up to 5 m high.
- 10 dB at representative receivers for heights above 5 m high and up to 8 m high.

In certain situations the requirements for the barrier cannot always be met. In this case further feasible and reasonable considerations are undertaken with guidance from Roads and Maritime.

8 OPERATIONAL ROAD TRAFFIC NOISE IMPACT ASSESSMENT OVERVIEW

The following sections present a summary of the operational road traffic noise impact assessment at each of the interchange areas - refer to assessment area maps (**Appendix B**).

Each interchange area has been considered as a separate study area. The distance between interchanges means that the noise impacts from each interchange do not overlap. Therefore, each interchange can be independently assessed. The following sections (**Section 8.1** to **Section 8.8**) discuss elements of the assessment which are common to all individual interchanges. These sections are intended to be read in conjunction with the detailed assessment of each specific interchange (**Section 9 to Section 18**). Sections of the corridor outside of these interchanges do not form part of this assessment.

8.1 Operational noise assessment with existing noise barriers

Noise impacts are initially identified with existing noise barriers in place (including relocated sections of existing noise barriers where required to accommodate the project design). Noise mitigation in the form of low noise pavement is proposed as part of the project and is therefore included at this stage of the assessment (refer to **Section 5.4**).

A summary of impacts is provided for each interchange area which identifies the change in noise levels and absolute level of traffic noise for the assessment scenarios at receivers where the noise criteria are exceeded.

It is not practicable at this stage in the assessment to inspect all properties within the assessment area in order to establish the number of households within each building. Consequently, the assessment counts each floor of properties as individual ‘receivers’. In order to inform the detailed design assessment, discussion is provided to identify the total number of buildings which qualify for consideration of additional noise mitigation on the basis of at least one triggered floor.

8.2 Summary of receivers for consideration of additional noise mitigation

Reasonable and feasible noise mitigation is considered within the specified assessment areas of the works – refer to the respective areas shown in **Appendix B**.

Predicted noise levels at receivers which are above the NCG controlling criteria do not necessarily result in exceedances of the adopted project criteria. As per the discussion in **Section 4.5**, further criteria are used to decide which of those receivers are eligible for additional noise mitigation measures.

It is noted that The Roads and Maritime noise policy was subject to review in late 2014, during the period that the noise assessment was being undertaken. The cumulative limit when applied to non-residential receivers requires consideration of internal noise criteria. This internal noise criteria needs to be converted to an external noise criteria for the purposes of assessment with external noise level predictions. The RNP recommends a 10 dB factor to convert internal to external noise levels on the basis that facades with windows open typically provide approximately 10 dB attenuation from inside to outside. For non-residential receivers this assumption may be overly conservative as the facade area to window ratios are often larger when compared to residential receivers. For the purposes of this assessment non-residential receivers have been assessed against the Acute definition (part of the cumulative limit definition) in the NMG (refer to **Section 4.3**).

During detailed design the cumulative limit with respect to internal noise levels should be investigated considering less conservative internal to external conversion factors. This investigation may identify a small additional number of non-residential receivers that may be eligible for consideration of treatment. As a result and with consideration of any further design refinements, the noise assessment will be updated accordingly.

The noise assessment considered the proposed physical works and adopted noise catchments as specified by RMS where a change in noise level as a result of the proposal was considered likely. In general, these catchments are immediately adjacent to the works areas. Following development of the opening year and future year noise models both with and without the project (ie Build and No Build), potential additional impacts have been identified outside of the adopted noise catchments. These changes in noise impacts are partly related to the improved operating performance of the motorway, namely, under a smart motorway the average operating speeds may increase in some areas with the potential to increase noise levels. Receivers adjacent to such areas have been identified by RMS as needing to be considered for treatment in accordance with the noise mitigation guide (NMG) during the detailed design.

Areas identified for further investigation include the following:

- NCA01 on the southern side of the motorway adjacent the Burnett Street interchange
- NCA01/03 on the southern side of the motorway adjacent the Coleman Street interchange
- NCA20 at receivers adjacent to the EB on-ramp from Roper Road

No treatment options have currently been explored for these areas; however, they will be investigated as part of the detailed design.

8.3 Selection of noise barriers for optimisation

Further consideration of noise barriers in other locations is not required where eligible receivers are not clustered behind these locations. ‘Clustered’ is noted as being defined as more than three closely spaced receivers which are identified as being eligible for consideration of additional noise mitigation, noting that a two storey residence would be counted as two receivers.

Where an existing barrier is relocated as part of the works, the top of noise wall height of the replacement section of the noise barrier should be consistent with the existing section unless the recommended barrier height is greater.

8.4 Operational noise impacts with recommended noise barriers

The final design of recommended noise barriers is included in the modelling of the Final Build scenarios in order to determine the corresponding receiver noise levels and requirements of the project to consider property treatments.

In all cases, the recommended noise barrier height is subject to further considerations during detailed design such as landscaping, overshadowing, structural footings and community views. Where new noise barriers are recommended, reflected noise at residences on the opposite side of the road is considered unlikely to be discernible above the noise which travels directly to the receiver.

8.5 Architectural property treatments

At some locations where the noise criteria are exceeded as a result of the project, the feasibility and reasonableness considerations discussed previously have concluded that the construction or modification of noise barriers is not feasible, reasonable or cost-effective.

At locations, where residual impacts remain after all feasible and reasonable approaches have been exhausted, noise mitigation in the form of acoustic treatment of existing individual dwellings is to be considered.

At-property architectural acoustic treatments should aim to achieve internal noise levels in habitable rooms 10 dB below the external noise level criteria. In some cases this will be limited by the existing construction and condition of the residence.

Building element treatments are more effective when they are applied to masonry structures than lightly clad timber frame structures. Caution should be exercised before providing treatments for buildings in a poor state of repair, as they will be less effective and may not provide any appreciable noise reduction benefit.

The acoustic treatments provided by Roads and Maritime are typically limited to:

- Fresh air ventilation systems that meet the Building Code of Australia requirements with the windows and doors closed (in certain circumstances air conditioning that includes fresh air intake may also be considered, particularly where adverse climate conditions prevail).
- Upgraded windows and glazing and solid core doors on the exposed facades of the substantial structures only (eg masonry or insulated weather board cladding with sealed underfloor). These techniques would be unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls.
- Upgrading window or door seals and appropriately treating sub-floor ventilation.
- The sealing of wall vents.
- The sealing of the underfloor below the bearers.
- The sealing of eaves.

Where facade treatment is undertaken, there is no guarantee that remedial works will achieve any specific noise levels.

Where multi-level residential buildings are apparent, Roads and Maritime policy is to only consider architectural treatment options at the ground and first floor levels.

The recommended residual noise impact mitigation package for all habitable rooms of eligible locations is as follows:

Architectural treatment of exceeding dwellings <10 dB over NCG target

- Where external noise levels are less than 10 dB above the NCG criteria, acceptable internal noise levels may be achieved with windows closed on exposed facades.
- A light framed building with single glazed (closed) windows with sealed wall vents will typically provide an external to internal noise reduction of 20 dB. Where the NCG internal criteria in habitable rooms can only be achieved with windows and vents closed, then mechanical ventilation should be provided (subject to individual consultation with dwelling owners) to ensure sufficient airflow inside the dwelling, so as to meet the requirements of the Building Code of Australia.

Architectural treatment of exceeding dwellings >=10 dB over NCG target

- Where the external levels are 10 dB or higher than the NCG criteria, then upgraded windows, doors and/or seals (depending on individual assessment and generally only suitable for masonry type buildings) is necessary, in addition to the above.

8.6 Discussion of property treatments

For individual residential receivers Roads and Maritime does not consider it reasonable to consider noise mitigation above the ground and first floor.

Where residential receivers are identified exceeding the NCG criteria as multi-storey apartment buildings, a further feasible and reasonable review of architectural treatments at multi-storey apartments should be completed during the detailed design.

8.7 Sensitivity analysis

A sensitivity analysis of the operational road traffic noise assessment and noise modelling methodology has been undertaken.

The likely change in the predicted number of receivers that are considered eligible for consideration of property treatment has been determined by applying a correction factor to the noise model predictions in 0.5 dB increments.

The sensitivity of the total number of property treatments to the noise model accuracy is presented for each interchange area in the following sections.

8.8 Maximum noise levels

A maximum noise level assessment has been conducted in accordance with the procedure *Preparing an Operational Noise and Vibration Assessment* (Roads and Maritime, 2011).

It is noted that the RNP and ENMM both state that whilst a maximum noise level assessment is required to be undertaken for new and upgraded road infrastructure projects, it should only be used as a tool to help prioritise and rank mitigation strategies, and should not be applied as a decisive criterion in itself.

The objective of the maximum noise level assessment is to determine whether maximum noise levels are likely to increase or decrease as a result of the project.

Maximum noise level events were measured as part of the ambient noise study (refer to **Section 3**).

The maximum noise level assessment includes an evaluation of the number and distribution of night-time passby events in accordance with the ENMM. A maximum noise level event is defined within the ENMM as being any pass by where:

- The maximum noise level of the event is greater than 65 dBA, and
- The L_{AFmax} – $L_{Aeq(1hour)}$ is greater than or equal to 15 dB.

It should be noted that strategies are currently being implemented to reduce road traffic noise across the state's road network which may reduce the number of maximum noise levels events over the longer term.

These strategies include local council requirements to include noise mitigation in new dwellings, metropolitan plans to increase the use of public transport, state wide plans for upgrades of major transport routes, and national initiatives to reduce heavy vehicle engine brake noise and road freight haulage.

In addition, state wide strategies for sharing freight with rail modes are expected to result in reduced noise from heavy vehicle freight on roads in many areas and a corresponding reduction in high noise level events from road traffic.

9 BURNETT STREET INTERCHANGE

9.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 13**, **Table 14** and **Figure 3** respectively.

Table 13 Burnett Street interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Burnett.EB.ON	Residential	All	1	2	2	4	1	1	2	4
	Other Sensitive	All	0	0	0	0	0	0	0	0

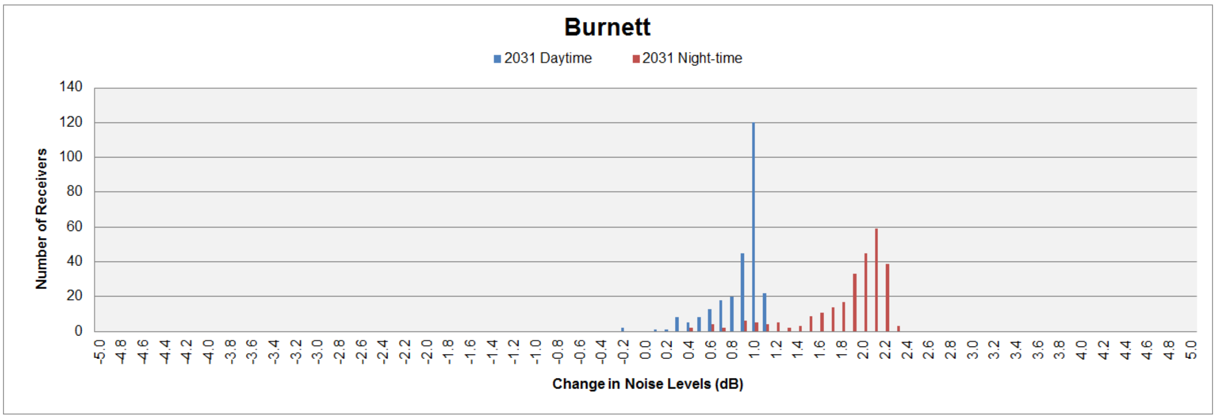
Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 14 Burnett Street interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Burnett.EB.ON	Residential	All	9	9	12	20	9	10	13	24
	Other Sensitive	All	21	6	21	6	21	6	21	6

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 3 Burnett Street interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 13**, **Table 14** and **Figure 3** indicates the following:

- Four residential receivers in the assessment area are predicted to have 'acute' noise levels in the controlling 2031 night-time Build scenario. This is an increase from one receiver in the No Build case. No other sensitive receivers are predicted to have 'acute' noise levels.

- Up to 24 residential receivers in the assessment area are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is an increase from 10 receivers in the No Build case. Up to 21 other sensitive receivers are predicted to have noise levels above NCG goals in the daytime 2031 Build scenario.
- Within this assessment area, the project is predicted to result in a less than 2.0 dB change in noise levels at the majority of receivers (165 of 271 receivers). The maximum predicted increase due to the project in this assessment area is +2.3 dB (during the controlling 2031 night-time scenario). This is primarily due to the conservative inclusion of the congestion factor in the No Build scenario only (refer to **Section 5.7**) and the increase in traffic on the main carriageway.

9.2 Summary of receivers for consideration of additional noise mitigation

Table 15 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 15 Burnett Street interchange - number of receivers considered for additional noise mitigation (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Burnett.EB.ON	Residential	2	17	17	2	18	18
	Other	0	5	5	0	5	5

Note: Additional areas at this interchange have been identified for further investigation at detailed design - refer to **Section 8.2.**

The information presented in **Table 15** indicates that the 2031 scenario results in the highest number of receivers being identified as being eligible for consideration of additional noise mitigation.

A total of 17 residential and five other sensitive receivers in the 2021 scenario are considered eligible while the 2031 scenario results in 18 residential and five other sensitive eligible receivers.

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix E1**. Also shown in this appendix map are the indicative locations of receivers identified by RMS for further investigation at detailed design as discussed in **Section 8.2**.

9.3 Selection of noise barriers for optimisation

The noise barrier optimisation process is based on guidance in the NMG. Information on the noise barrier optimisation process used in this assessment is detailed in **Appendix E2**.

The results of the optimisation are detailed in **Table 16** and illustrated in **Figure 4**.

Table 16 Burnett Street interchange noise barrier optimisation – recommended project noise barriers

Barrier Reference[1]	Barrier Length (m)	Barrier Height (m)					Comments
		Existing [1]	Maximum Barrier Height	Initial Design Height	Final Design Height	Recommended Design Height [2]	
NW.Burnett.EB.ON.02	112	-	3.0	1.5	3.0	3.0	Height as per final design height.
NW.Burnett.EB.ON.03	124	2.1	8.0	4.0	5.5	4.5	The design height is 5.5 m however; this does not provide the required 10 dBA of noise reduction for a barrier greater than 5 m. Therefore a recommended design height is 4.5 m (minimum between initial barrier height and 5 m high wall).

Note 1: Existing height is the height of the existing or the replaced existing noise barrier (ie maintaining the same top of noise barrier height as the existing barrier)

Note 2: Recommended height is subject to further considerations during detailed design such as construction limitations, overshadowing, urban design and community preference.

Figure 4 Burnett Street interchange - recommended noise barrier

9.4 Operational noise impacts with recommended noise barriers

The final design of the recommended noise barriers as shown in **Table 16** and **Figure 4** has been included in the modelling of the Final Build scenarios.

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix E3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix E4**.

The predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are shown in **Table 17** and **Table 18** respectively.

Table 17 Burnett Street interchange – 'acute' receivers with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Burnett.EB.ON	Residential	All	1	2	1	2	1	1	1	1
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 18 Burnett Street interchange – receivers over the NCG controlling criteria with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Burnett.EB.ON	Residential	All	9	9	4	7	9	10	4	9
	Other Sensitive	All	21	6	21	6	21	6	21	6

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

With the recommended noise barriers included, the noise predictions summarised in **Table 17** and **Table 18** indicate the following:

- No change is predicted to the number of 'acute' receivers between the No Build and Final Build scenarios in the controlling 2031 scenario.
- A marginal reduction in receivers over the NCG criteria for the Final Build compared to the No Build scenario is predicted.

9.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 19**.

Table 19 Burnett Street interchange – receivers eligible for consideration of property treatment (as per NMG)

Assessment Area	Receiver Type	2021 Final Build			2031 Final Build		
		Day	Night	Combined	Day	Night	Combined
Burnett.EB.ON	Residential	2	5	5	2	5	5
	Other	0	5	5	0	5	5

Table 20 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix E5**.

Table 20 Burnett Street interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	59/63	PITT STREET	PARRAMATTA	314362	6255351	Other (Place of Worship)	1-hour	50	50	60	57	60	57
2	1	59/63	PITT STREET	PARRAMATTA	314379	6255351	Other (Place of Worship)	1-hour	50	50	57	55	58	55
3	1	59/63	PITT STREET	PARRAMATTA	314384	6255372	Other (Place of Worship)	1-hour	50	50	58	55	58	55
4	1	59/63	PITT STREET	PARRAMATTA	314369	6255376	Other (Place of Worship)	1-hour	50	50	55	53	56	53
5	1	59/63	PITT STREET	PARRAMATTA	314361	6255366	Other (Place of Worship)	1-hour	50	50	59	56	60	57
6	1	222	RAILWAY STREET	PARRAMATTA	313887	6255539	Residential	Period	60	55	64	60	63	59
7	2	222	RAILWAY STREET	PARRAMATTA	313887	6255539	Residential	Period	60	55	65	61	65	61
8	2	75	PITT STREET	PARRAMATTA	314363	6255289	Residential	Period	60	55	62	58	62	58
9	2	9	AUBURN STREET	PARRAMATTA	314295	6255332	Residential	Period	60	55	60	56	60	56
10	2	11	AUBURN STREET	PARRAMATTA	314282	6255339	Residential	Period	60	55	59	56	60	56

Note 1: Refers to the applicable assessment period for that receiver type.

9.6 Discussion of required treatments

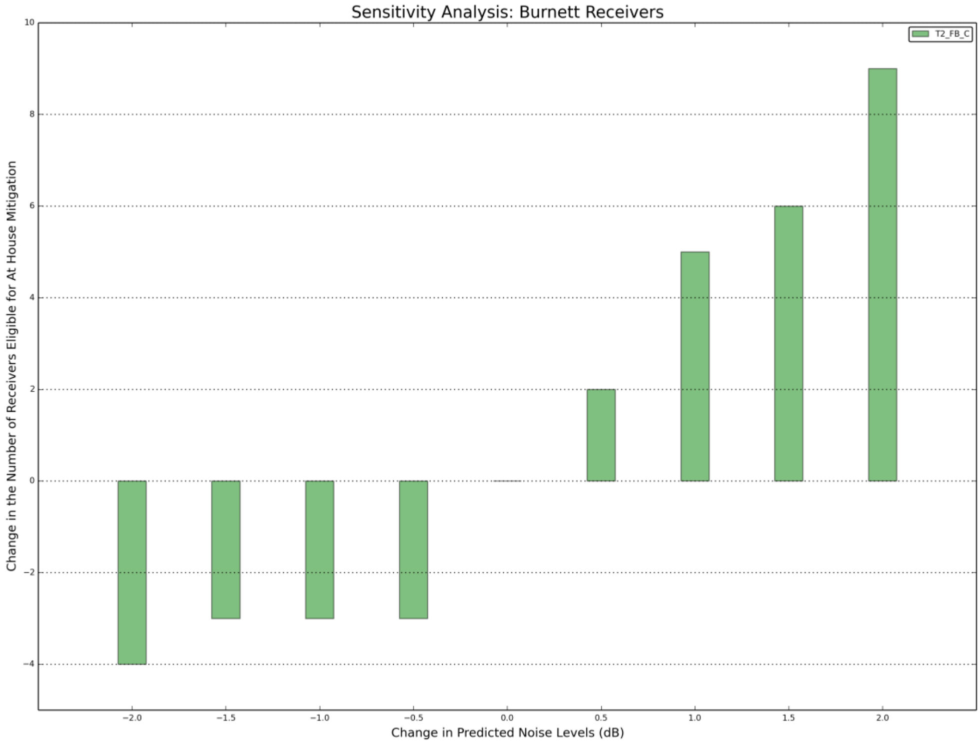
Further to the inclusion of the optimised project noise barriers a total of ten receivers are predicted to be eligible for consideration of property treatment as part of the project. This number comprises:

- Five residential receivers (four individual buildings)
- Five other sensitive receivers (four individual buildings at Street Level Christian Community Inc.)

9.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 5**.

Figure 5 Burnett Street interchange – prediction sensitivity analysis



Reference to the above indicates that an additional five receivers would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of three receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

9.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix E6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 21**.

Table 21 Burnett Street Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A4.1	13/02/13-27/02/13	58	68-86	73
A4.2	13/02/13-27/02/13	16	71-80	75

From the results presented within **Table 21**, it can be seen that average maximum noise level events typically range from 68 dBA to 86 dBA at the monitoring locations in this locality.

Review of the proposed works at this interchange area indicates that an increase in maximum noise level of potential events may be apparent at the following locations:

- Receivers located along Auburn Street, immediately north of the east-bound on-ramp. An increase in the maximum noise level of potential events of up to 5 dB may result from changes to on-ramp design and adjacent topography.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may observe decreases in overall night-time heavy vehicle volumes:

- Receivers to the north of east-bound on-ramp of around 48 vehicles (-65%) in 2031
- Receivers to the south of west-bound off-ramp of around 35 vehicles (-24%) in 2031

10 COLEMAN STREET INTERCHANGE

10.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 22**, **Table 23** and **Figure 6** respectively.

Table 22 Coleman Street interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Coleman.EB.ON	Residential	All	8	5	11	14	6	8	14	18
	Other Sensitive	All	3	3	2	4	2	3	3	4

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

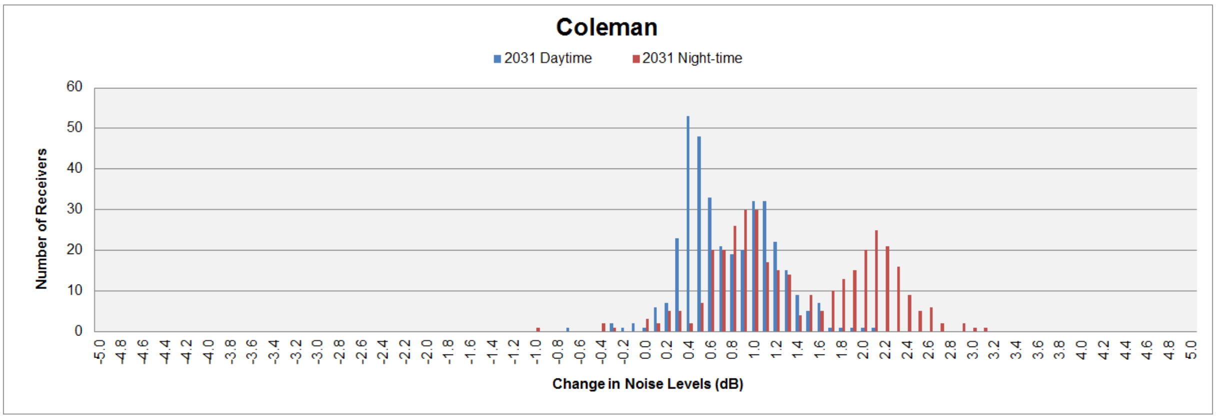
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 23 Coleman Street interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Coleman.EB.ON	Residential	All	34	36	52	65	37	45	54	71
	Other Sensitive	All	8	5	8	5	8	5	8	5

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 6 Coleman Street interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 22**, **Table 23** and **Figure 6** indicates the following:

- Up to 18 residential receivers and four other sensitive receivers in the assessment area are predicted to have 'acute' noise levels in the controlling 2031 night-time Build scenario. This is an increase from eight residential and three other sensitive receivers in the corresponding No Build case.

- Up to 71 residential receivers in the assessment area are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is an increase from 45 receivers in the No Build case. Up to eight other sensitive receivers are predicted to have noise levels above NCG goals in the daytime 2031 Build scenario
- Within this assessment area, the project is predicted to result in a change in noise levels of less than 2.0 dB at the majority of receivers (288 of 370 receivers). The maximum predicted change in this assessment area is +3.1 dB (during the controlling 2031 night-time scenario). This is primarily due to the conservative inclusion of the congestion factor in the No Build scenario only (refer to **Section 5.7**), and the increase in traffic on the main carriageway.

10.2 Summary of receivers for consideration of additional noise mitigation

Table 24 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 24 Coleman Street interchange - number of receivers considered for additional noise mitigation (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Coleman.EB.ON	Residential	8	53	54	11	58	58
	Other	3	4	4	4	4	4

Note: Additional areas at this interchange have been identified for further investigation at detailed design - refer to **Section 8.2.**

The information presented in **Table 24** indicates that the 2031 scenario results in the highest number of receivers being identified as being eligible for consideration of additional noise mitigation.

A total of 54 residential receivers and four other sensitive receivers in the 2021 scenario are considered eligible while the 2031 scenario results in 58 residential receivers and four other sensitive receivers.

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix F1**. Also shown in this appendix map are the indicative locations of receivers identified by RMS for further investigation at detailed design as discussed in **Section 8.2**.

10.3 Selection of noise barriers for optimisation

The noise barrier optimisation process is based on guidance in the NMG. Information on the noise barrier optimisation process used in this assessment is detailed in **Appendix F2**.

The results of the optimisation are detailed in **Table 25** and illustrated in **Figure 7**.

Table 25 Coleman Street interchange noise barrier optimisation – recommended project noise barriers

Barrier Reference[1]	Barrier Length (m)	Barrier Height (m)					Comments
		Existing[1]	Maximum Barrier Height	Initial Design Height	Final Design Height	Recommended Design Height [2]	
NW.Coleman.EB.ON.01	290	2.1	8.0	4.0	6.0	6.0	Height as per final design height.

Note 1: Existing height is the height of the existing or the replaced existing noise barrier (ie maintaining the same top of noise barrier height as the existing barrier)

Note 2: Recommended height is subject to further considerations during detailed design such as construction limitations, overshadowing, urban design and community preference.

Figure 7 Coleman Street interchange - recommended noise barrier

10.4 Operational noise impacts with recommended noise barriers

The final design of the recommended noise barriers as shown in **Table 25** and **Figure 7** has been included in the modelling of the Final Build scenarios.

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix F3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix F4**.

The predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are shown in **Table 26** and **Table 27** respectively.

Table 26 Coleman Street interchange – 'acute' receivers with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Coleman.EB.ON	Residential	All	8	5	7	5	6	8	6	6
	Other Sensitive	All	3	3	2	3	2	3	3	3

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 27 Coleman Street interchange – receivers over the NCG controlling criteria with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Coleman.EB.ON	Residential	All	34	36	15	18	37	45	13	22
	Other Sensitive	All	8	5	8	5	8	5	8	5

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

With the recommended noise barriers included, the noise predictions summarised in **Table 26** and **Table 27** indicate the following:

- A reduction of two residential 'acute' properties is predicted as a result of the project, including the benefit from the recommended noise barriers.
- A notable reduction in receivers over the NCG criteria for the Final Build compared to the No Build scenario is predicted.
- The project (including the recommended noise barriers) is generally predicted to reduce the overall noise impact at adjacent receivers in this assessment area.

10.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 28**.

Table 28 Coleman Street interchange - receivers eligible for consideration of property treatment (as per NMG)

Assessment Area	Receiver Type	2021 Final Build			2031 Final Build		
		Day	Night	Combined	Day	Night	Combined
Coleman.EB.ON	Residential	4	8	9	3	12	12
	Other	3	4	4	4	4	4

Table 29 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix F5**.

Table 29 Coleman Street interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	2	9	MARGARET STREET	MAYS HILL	313842	6255706	Residential	Period	60	55	61	57	61	57
2	2	6	BELINDA PLACE	MAYS HILL	313574	6255923	Residential	Period	60	55	59	55	59	56
3	2	10	BELINDA PLACE	MAYS HILL	313568	6255896	Residential	Period	60	55	59	56	60	56
4	2	12	BELINDA PLACE	MAYS HILL	313565	6255881	Residential	Period	60	55	59	55	60	56
5	1	2-8	BRIDGE ROAD	WESTMEAD	313093	6256349	Other (Place of Worship)	1-hour	50	50	69	67	70	67
6	1	217	GREAT WESTERN HIGHWAY	MAYS HILL	313437	6255979	Other (Place of Worship)	1-hour	50	50	67	65	67	66
7	1	217	GREAT WESTERN HIGHWAY	MAYS HILL	313429	6255939	Other (Place of Worship)	1-hour	50	50	79	77	80	77
8	1	217	GREAT WESTERN HIGHWAY	MAYS HILL	313381	6255995	Other (Place of Worship)	1-hour	50	50	76	74	77	74
9	1	246	GREAT WESTERN HIGHWAY	WENTWORTHVILLE	313034	6256349	Residential	Period	60	55	65	63	67	62
10	1	Lot 1	GREAT WESTERN HIGHWAY	SOUTH WENTWORTHVILLE	313046	6256239	Residential	Period	60	55	72	69	73	69
11	1	235	GREAT WESTERN HIGHWAY	SOUTH WENTWORTHVILLE	313132	6256232	Residential	Period	60	55	68	63	68	64
12	2	235	GREAT WESTERN HIGHWAY	SOUTH WENTWORTHVILLE	313132	6256232	Residential	Period	60	55	70	66	70	66
13	2	199	GREAT WESTERN HIGHWAY	MAYS HILL	313515	6255992	Residential	Period	60	55	65	62	66	63
14	1	1	BELINDA PLACE	MAYS HILL	313512	6255951	Residential	Period	60	55	60	56	60	56
15	2	1	BELINDA PLACE	MAYS HILL	313535	6255947	Residential	Period	60	55	60	56	60	57
16	1	9	BELINDA PLACE	MAYS HILL	313496	6255901	Residential	Period	60	55	59	56	60	56

Note 1: Refers to the applicable assessment period for that receiver type.

10.6 Discussion of required treatments

Further to the inclusion of the optimised project noise barriers a total of 16 receivers are predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

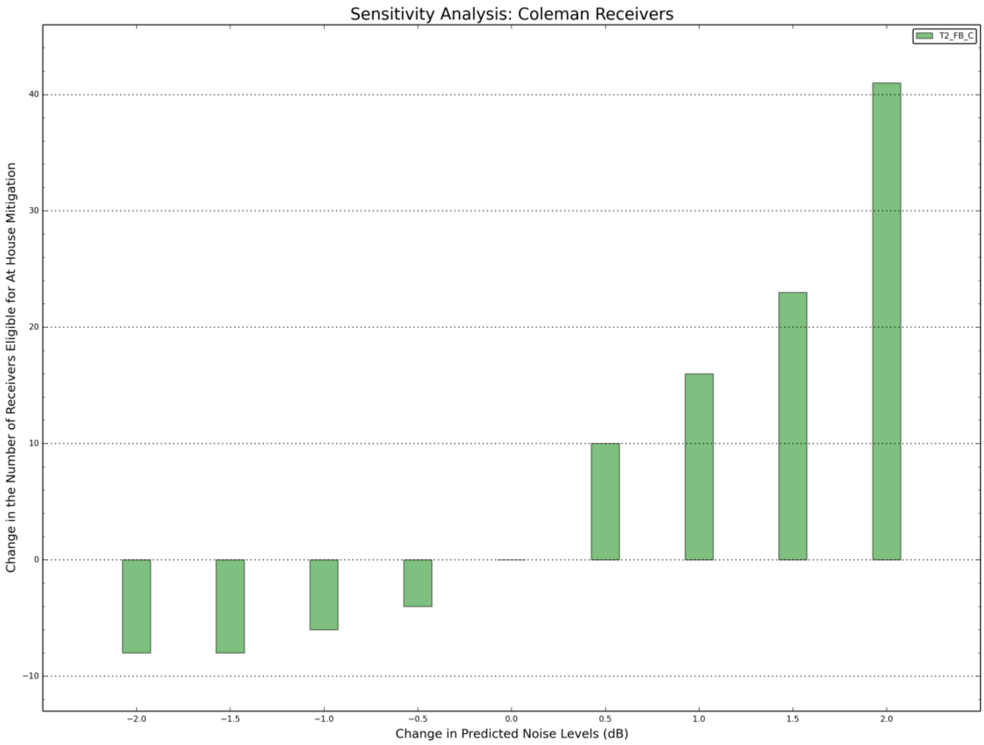
- 12 residential receivers (12 individual buildings)
- Four other sensitive receivers (part of the Place of Worship) (three individual buildings at the Sydney Murugan Temple and one individual building at Essington Christian Academy)

In this locality, noise from traffic on the adjacent Great Western Highway is significant and contributes to the overall road traffic noise at the majority of the receivers.

10.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 8**.

Figure 8 Coleman Street interchange – prediction sensitivity analysis



Reference to the above indicates that an additional 16 receivers would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of six receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

10.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix F6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 30**.

Table 30 Coleman Street Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A5.1	13/02/13-27/02/13	32	69-80	73
A5.2	13/02/13-27/02/13	122	68-88	74

From the results presented within **Table 30**, it can be seen that average maximum noise level events typically range from 68 dBA to 88 dBA at the monitoring locations in this locality.

No significant increases in the magnitude of maximum noise events at residential receivers is predicted at this interchange area on the basis that all design noise barriers across the project area are either proposed to remain at the existing height, to be increased in height or for a new noise barrier to be installed, and do not significantly increase the angle of view to the adjacent receivers.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may observe decreases in overall night-time heavy vehicle volumes:

- Receivers to the north of east-bound on-ramp of around 265 vehicles (-75%) in 2031

11 CUMBERLAND HIGHWAY INTERCHANGE

11.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria the change in noise levels (Build minus No Build) are shown in **Table 31**, **Table 32** and **Figure 9** respectively.

Table 31 Cumberland Highway interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Cumberland.EB.ON	Residential	All	5	7	9	17	6	10	12	21
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.ON	Residential	All	6	8	9	23	6	9	9	26
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.OFF	Residential	All	4	11	5	15	3	15	6	16
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.EB.OFF	Residential	All	6	7	7	13	7	8	7	13
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

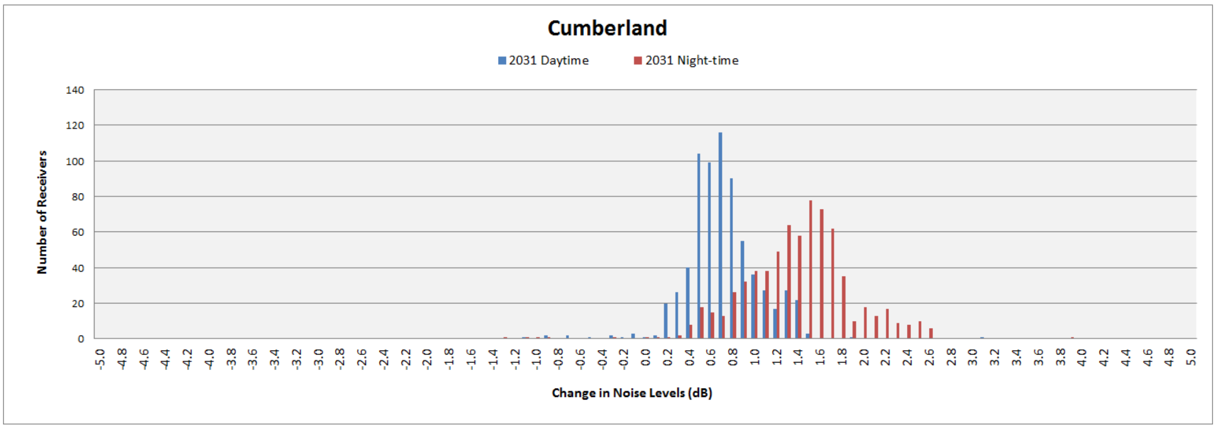
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 32 Cumberland Highway interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Cumberland.EB.ON	Residential	All	31	35	34	44	32	36	35	46
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.ON	Residential	All	52	80	80	118	60	84	84	125
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.OFF	Residential	All	17	32	22	58	21	38	28	65
	Other Sensitive	All	1	1	1	1	1	1	1	1
Cumberland.EB.OFF	Residential	All	31	34	34	34	32	34	34	34
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 9 Cumberland Highway interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 31**, **Table 32** and **Figure 9** indicates the following:

- A total of 76 residential receivers in the assessment areas are predicted to have 'acute' noise levels in the controlling 2031 night-time Build scenario. This is an increase from 44 receivers compared to the No Build case. No other sensitive receivers are predicted to have 'acute' noise levels.
- 270 residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is an increase from 192 receivers in the No Build case. One other sensitive receiver is predicted to have noise levels above NCG goals in the daytime 2031 Build scenario
- Within this assessment area, the project is predicted to result in no greater than 2.0 dB increase in noise levels at the majority of receivers (645 of 709 receivers) in the controlling 2031 night-time period. The maximum predicted change in this assessment area is +3.9 dB (during the controlling 2031 night-time scenario). This is primarily due to the conservative inclusion of the congestion factor in the No Build scenario only (refer to **Section 5.7**) and the increase in traffic on the main carriageways and ramps. The movement of the eastbound on-ramp closer to the receivers immediately adjacent to the north also contributes to the overall increase.

11.2 Summary of receivers for consideration of additional noise mitigation

Table 33 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 33 Cumberland Highway interchange - number of receivers considered for additional noise mitigation (as per NMG)

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Cumberland.EB.ON	Residential	8	30	30	11	21	21
	Other	0	0	0	0	0	0
Cumberland.WB.ON	Residential	9	28	28	9	31	31
	Other	0	0	0	0	0	0
Cumberland.WB.OFF	Residential	5	32	32	6	31	31
	Other	0	0	0	0	0	0

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Cumberland.EB.OFF	Residential	7	13	13	7	13	13
	Other	0	0	0	0	0	0

The information presented in **Table 33** indicates that the 2031 scenario results in a reduction in the number of receivers being identified as being eligible for consideration of additional noise mitigation. These receivers are all residential.

A total of 103 receivers (all residential) in the 2021 scenario are considered eligible while the 2031 scenario results in 96 eligible receivers (again all residential).

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix G1**.

11.3 Selection of noise barriers for optimisation

The noise barrier optimisation process is based on guidance in the NMG. Information on the noise barrier optimisation process used in this assessment is detailed in **Appendix G2**.

The results of the optimisation are detailed in **Table 34** and illustrated in **Figure 10**.

Table 34 Cumberland Highway interchange noise barrier optimisation – recommended project noise barriers

Barrier Reference[1]	Barrier Length (m)	Barrier Height (m)					Comments
		Existing[1]	Maximum Barrier Height	Initial Design Height	Final Design Height	Recommended Design Height [2]	
NW.Cumberland.WB.OFF.01	420	0 to 2.4	8.0	8.0	8.0	0	No benefit provided by barrier.
NW.Cumberland.WB.OFF.02	83	2.0	8.0	8.0	8.0	0	No benefit provided by barrier.
NW.Cumberland.WB.OFF.03	367	2.0	7.0	3.0	4.0	4.0	Height as per final design height.
NW.Cumberland.WB.ON.01	307	0.0	6.0	4.5	4.5	4.5	Height as per final design height.
NW.Cumberland.WB.ON.02	558	3.5	8.0	7.5	7.5	6.0	Under the REF assessment a 6 m barrier has been adopted as the feasibility (wind loading, structural loading, etc.) of a 7.5m to 8m high barrier will be investigated during detailed design.
NW.Cumberland.WB.ON.03	256	0.0	8.0	4.5	4.5	4.5	Height as per final design height.
NW.Cumberland.EB.OFF.01	392	0.0	8.0	6.5	6.5	5.0	The design height is 6.5 m however; this does not provide the required 10 dBA of noise reduction for a barrier greater than 5 m. Therefore a recommended design height is 5 m.
NW.Cumberland.EB.ON.01	355	2.4	8.0	6.0	6.0	6.0	Height as per final design height.

Note 1: Existing height is the height of the existing or the replaced existing noise barrier (ie maintaining the same top of noise barrier height as the existing barrier)

Note 2: Recommended height is subject to further considerations during detailed design such as construction limitations, overshadowing, urban design and community preference.

Figure 10 Cumberland Highway interchange Part 1 - recommended noise barrier

Figure 11 Cumberland Highway interchange Part 2 - recommended noise barrier

11.4 Operational noise impacts with recommended noise barriers

The final design of the recommended noise barriers as shown in **Table 34** and **Figure 10** has been included in the modelling of the Final Build scenarios.

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix G3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix G4**.

The predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are shown in **Table 35** and **Table 36** respectively.

Table 35 Cumberland Highway interchange – 'acute' receivers with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Cumberland.EB.ON	Residential	All	5	7	0	1	6	10	0	2
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.ON	Residential	All	6	8	2	2	6	9	2	2
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.OFF	Residential	All	4	11	4	13	3	15	4	12
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.EB.OFF	Residential	All	6	7	2	2	7	8	2	2
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 36 Cumberland Highway interchange – receivers over the NCG controlling criteria with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Cumberland.EB.ON	Residential	All	31	35	13	18	32	36	15	20
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.ON	Residential	All	52	80	8	41	60	84	9	44
	Other Sensitive	All	0	0	0	0	0	0	0	0
Cumberland.WB.OFF	Residential	All	17	32	17	42	21	38	21	45
	Other Sensitive	All	1	1	1	1	1	1	1	1
Cumberland.EB.OFF	Residential	All	31	34	9	16	32	34	10	16
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

With the recommended noise barriers included, the noise predictions summarised in **Table 35** and **Table 36** indicate the following:

- In the controlling 2031 night-time scenario, a significant overall reduction of 24 residential ‘acute’ properties is predicted as a result of the project at this interchange, including the benefit from the recommended noise barriers.
- Fewer receivers are predicted with noise levels above the NCG noise goal in the Final Build scenario compared to the No Build scenario in both 2021 and 2031. In the controlling 2031 night-time scenario, the number of residential receivers above NCG controlling criteria is predicted to reduce by 67 receivers as a result of the project (including recommended noise barriers)

11.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 37**.

Table 37 Cumberland Highway interchange - receivers eligible for consideration of property treatment (as per NMG)

Assessment Area	Receiver Type	2021 Final Build			2031 Final Build		
		Day	Night	Combined	Day	Night	Combined
Cumberland.EB.ON	Residential	7	12	12	10	13	13
	Other	0	0	0	0	0	0
Cumberland.WB.ON	Residential	7	19	19	7	22	22
	Other	0	0	0	0	0	0
Cumberland.WB.OFF	Residential	5	17	17	5	16	16
	Other	0	0	0	0	0	0
Cumberland.EB.OFF	Residential	3	13	13	3	13	13
	Other	0	0	0	0	0	0

Table 38 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix G5**.

Table 38 Cumberland Highway interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	25	BERITH ROAD	GREYSTANES	311009	6256449	Residential	Period	60	55	60	57	60	57
2	1	1	GREGORY STREET	GREYSTANES	310979	6256445	Residential	Period	60	55	60	57	60	57
3	1	3	GREGORY STREET	GREYSTANES	310959	6256447	Residential	Period	60	55	60	57	60	57
4	1	5	GREGORY STREET	GREYSTANES	310943	6256452	Residential	Period	60	55	60	57	61	57
5	1	7	GREGORY STREET	GREYSTANES	310930	6256452	Residential	Period	60	55	60	57	60	57
6	1	9	GREGORY STREET	GREYSTANES	310911	6256456	Residential	Period	60	55	60	56	60	56
7	2	9	GREGORY STREET	GREYSTANES	310911	6256456	Residential	Period	60	55	62	59	62	59
8	1	11	GREGORY STREET	GREYSTANES	310898	6256460	Residential	Period	60	55	61	58	61	58
9	1	13	GREGORY STREET	GREYSTANES	310881	6256463	Residential	Period	60	55	61	58	61	58
10	1	17	GREGORY STREET	GREYSTANES	310852	6256467	Residential	Period	60	55	59	56	59	56
11	1	19	GREGORY STREET	GREYSTANES	310838	6256470	Residential	Period	60	55	60	57	60	57
12	1	21	GREGORY STREET	GREYSTANES	310820	6256477	Residential	Period	60	55	60	57	60	57
13	2	21	GREGORY STREET	GREYSTANES	310820	6256477	Residential	Period	60	55	63	59	63	59
14	1	23	GREGORY STREET	GREYSTANES	310803	6256483	Residential	Period	60	55	60	56	60	56
15	2	55	GREGORY STREET	GREYSTANES	310562	6256558	Residential	Period	60	55	60	57	60	57
16	1	20	ETTALONG ROAD	GREYSTANES	310502	6256580	Residential	Period	60	55	61	58	61	58
17	2	24	GREGORY STREET	GREYSTANES	310750	6256461	Residential	Period	60	55	59	56	59	56
18	2	17	WATTLE STREET	GREYSTANES	310794	6256447	Residential	Period	60	55	60	57	60	57
19	2	31	BERITH ROAD	GREYSTANES	310995	6256386	Residential	Period	60	55	60	57	60	57
20	1	20	ETTALONG ROAD	GREYSTANES	310469	6256591	Residential	Period	60	55	67	63	68	64
21	2	20	ETTALONG ROAD	GREYSTANES	310469	6256591	Residential	Period	60	55	69	65	69	66
22	2	168	CENTENARY ROAD	SOUTH WENTWORTHVILLE	312025	6256156	Residential	Period	60	55	64	59	65	59

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
23	2	8	BORONIA STREET	SOUTH WENTWORTHVILLE	311958	6256163	Residential	Period	60	55	60	57	61	57
24	2	6	BORONIA STREET	SOUTH WENTWORTHVILLE	311961	6256182	Residential	Period	60	55	65	60	66	60
25	1	86	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311652	6256213	Residential	Period	60	55	65	60	66	60
26	2	86	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311652	6256213	Residential	Period	60	55	67	62	68	63
27	1	84	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311664	6256216	Residential	Period	60	55	65	60	66	61
28	1	82	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311677	6256225	Residential	Period	60	55	66	61	66	61
29	1	80	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311692	6256222	Residential	Period	60	55	65	60	66	61
30	1	78	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311705	6256230	Residential	Period	60	55	66	61	67	62
31	1	76	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311720	6256232	Residential	Period	60	55	67	62	67	62
32	1	74	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311731	6256231	Residential	Period	60	55	66	61	67	62
33	1	72	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311742	6256233	Residential	Period	60	55	67	62	67	62
34	2	5	BORONIA STREET	SOUTH WENTWORTHVILLE	311891	6256201	Residential	Period	60	55	66	60	66	61
35	2	2	CHELMSFORD ROAD	SOUTH WENTWORTHVILLE	311822	6256218	Residential	Period	60	55	69	63	69	63
36	1	37	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311621	6256263	Residential	Period	60	55	66	62	66	62

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
37	1	10	RICHMOND STREET	SOUTH WENTWORTHVILLE	312357	6256217	Residential	Period	60	55	60	57	60	57
38	2	12	RICHMOND STREET	SOUTH WENTWORTHVILLE	312351	6256198	Residential	Period	60	55	61	58	61	58
39	2	6	YVONNE STREET	GREYSTANES	311358	6256256	Residential	Period	60	55	60	56	60	56
40	2	151	CENTENARY ROAD	SOUTH WENTWORTHVILLE	312081	6256155	Residential	Period	60	55	66	60	66	61
41	1	36-42	CROSBY STREET	GREYSTANES	310743	6256640	Residential	Period	60	55	65	61	65	61
42	2	36-42	CROSBY STREET	GREYSTANES	310743	6256640	Residential	Period	60	55	69	65	69	65
43	1	9	BERITH ROAD	GREYSTANES	311022	6256559	Residential	Period	60	55	61	57	61	57
44	2	9	BERITH ROAD	GREYSTANES	311022	6256559	Residential	Period	60	55	62	59	62	59
45	2	8	CROSBY STREET	GREYSTANES	310969	6256589	Residential	Period	60	55	60	57	60	57
46	2	12	CROSBY STREET	GREYSTANES	310939	6256591	Residential	Period	60	55	60	56	60	57
47	2	16	CROSBY STREET	GREYSTANES	310911	6256598	Residential	Period	60	55	60	56	60	56
48	2	14	CROSBY STREET	GREYSTANES	310924	6256599	Residential	Period	60	55	59	56	59	56
49	2	467	GREAT WESTERN HIGHWAY	GREYSTANES	310868	6256655	Residential	Period	60	55	60	57	60	57
50	2	467	GREAT WESTERN HIGHWAY	GREYSTANES	310895	6256647	Residential	Period	60	55	60	57	61	57
51	2	5	CROSBY STREET	GREYSTANES	311002	6256623	Residential	Period	60	55	61	58	61	58
52	2	9	CROSBY STREET	GREYSTANES	310971	6256634	Residential	Period	60	55	61	57	61	57
53	1	12	BERITH ROAD	GREYSTANES	311071	6256552	Residential	Period	60	55	61	58	62	58
54	1	9	FLORENCE STREET	SOUTH WENTWORTHVILLE	311986	6256377	Residential	Period	60	55	60	56	61	57
55	2	9	FLORENCE STREET	SOUTH WENTWORTHVILLE	311986	6256377	Residential	Period	60	55	62	58	63	58

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
56	2	5	FLORENCE STREET	SOUTH WENTWORTHVILLE	311966	6256341	Residential	Period	60	55	62	58	62	58
57	2	7	FLORENCE STREET	SOUTH WENTWORTHVILLE	311972	6256351	Residential	Period	60	55	62	58	62	58
58	2	3	FLORENCE STREET	SOUTH WENTWORTHVILLE	311952	6256324	Residential	Period	60	55	61	57	61	58
59	2	1	FLORENCE STREET	SOUTH WENTWORTHVILLE	311944	6256309	Residential	Period	60	55	61	57	61	58
60	1	21	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	312008	6256323	Residential	Period	60	55	61	57	61	57
61	2	21	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	312008	6256323	Residential	Period	60	55	63	59	63	60
62	1	19	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	312025	6256326	Residential	Period	60	55	67	62	68	62
63	2	6	BARFIL CRESCENT	SOUTH WENTWORTHVILLE	311881	6256379	Residential	Period	60	55	61	57	61	57
64	2	14	FLORENCE STREET	SOUTH WENTWORTHVILLE	311928	6256377	Residential	Period	60	55	61	57	61	58
65	1	4	BARFIL CRESCENT	SOUTH WENTWORTHVILLE	311851	6256349	Residential	Period	60	55	59	55	59	56
66	2	3	BARFIL CRESCENT	SOUTH WENTWORTHVILLE	311830	6256351	Residential	Period	60	55	62	58	62	59
67	1	23	OLD PROSPECT ROAD	SOUTH WENTWORTHVILLE	311992	6256323	Residential	Period	60	55	60	56	60	57

Note 1: Refers to the applicable assessment period for that receiver type.

11.6 Discussion of required treatments

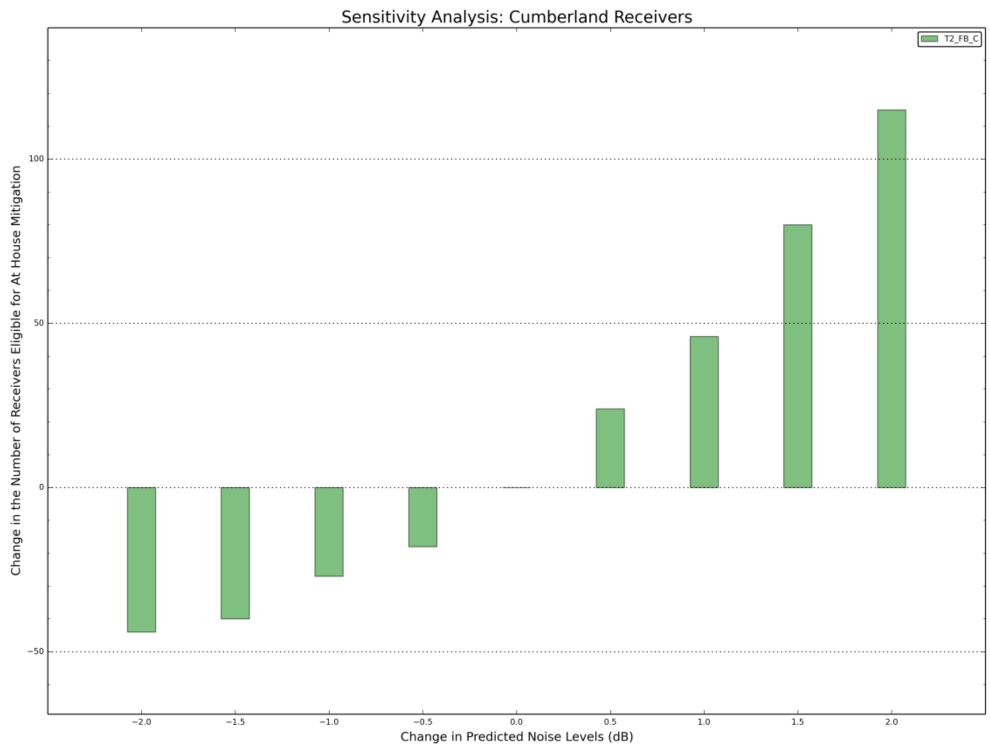
Further to the inclusion of the optimised project noise barriers a total of 67 receivers are predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

- 67 residential receivers (59 individual buildings)

11.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 12**.

Figure 12 Cumberland Highway interchange – prediction sensitivity analysis



Reference to the above indicates that an additional 46 receivers would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of 27 receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

11.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix G6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 39**.

Table 39 Cumberland Highway Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A6.1	1/03/13-12/03/13	56	65-77	69
A6.2	1/03/13-12/03/13	93	66-79	71

From the results presented in **Table 39**, it can be seen that average maximum noise level events typically range from 65 dBA to 79 dBA at the monitoring locations in this locality.

No significant increases in the magnitude of maximum noise events at residential receivers is predicted at this interchange area on the basis that all design noise barriers and mounds across the project area are either proposed to remain at the existing height, to be increased in height or for a new noise barrier to be installed, and do not significantly increase the angle of view to the adjacent receivers.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may observe changes in overall night-time heavy vehicle volumes:

- Receivers to the south of west-bound off-ramp may observe increases in overall night-time heavy vehicle volumes of up to 67 vehicles (+39%), and 39 vehicles (+19%) in years 2021 and 2031 respectively
- Receivers to the south of west-bound on-ramp may observe decreases in overall night-time heavy vehicle volumes of up to 5 vehicles (-4%), and 40 vehicles (-37%) in years 2021 and 2031 respectively
- Receivers to the north of east-bound off-ramp may observe increases in overall night-time heavy vehicle volumes of up to 34 vehicles (+25%)
- Receivers to the north of east-bound on-ramp may observe increases in overall night-time heavy vehicle volumes of up to 159 vehicles (+137%), and 92 vehicles (+26%) in years 2021 and 2031 respectively

12 PROSPECT HIGHWAY INTERCHANGE

12.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 40**, **Table 41**, and **Figure 13** respectively.

Table 40 Prospect Highway interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Prospect.EB.ON	Residential	All	2	2	2	2	2	2	2	2
	Other Sensitive	All	0	1	1	1	1	1	1	1
Prospect.WB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

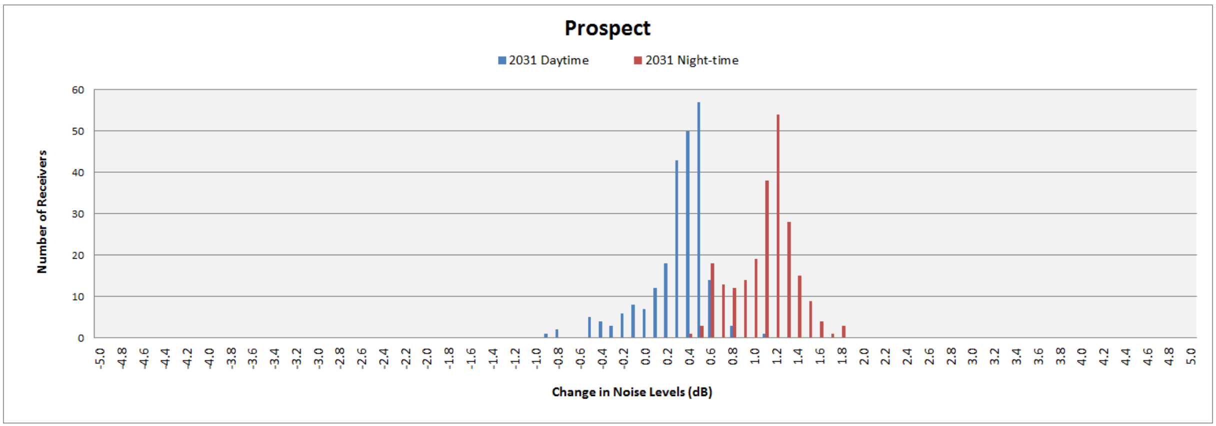
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 41 Prospect Highway interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Prospect.EB.ON	Residential	All	2	2	2	2	2	2	2	2
	Other Sensitive	All	1	1	1	1	1	1	1	1
Prospect.WB.ON	Residential	All	1	1	1	3	1	1	1	3
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 13 Prospect Highway interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 40**, **Table 41**, **Table 14**and **Figure 13** indicates the following:

- A total of two residential receivers in the assessment areas are predicted to have ‘acute’ noise levels in the controlling 2031 night-time Build scenario. There is no change compared to the No Build case. One other sensitive receiver is predicted to have ‘acute’ noise levels.
- Five residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is an increase from three residential receivers in the No Build case. One other sensitive receiver is predicted to have noise levels above the NCG goals in the daytime 2031 Build scenario
- Within this assessment area, the project is predicted to result in an increase of less than 2.0 dB in noise levels at all receivers. The maximum predicted change in this assessment area is +1.8 dB (during the controlling 2031 night-time scenario). This is primarily due to the conservative inclusion of the congestion factor in the No Build scenario only (refer to **Section 5.7**) and the increase in traffic on the main carriageways and ramps. The eastbound on ramp moving closer to adjacent receivers also contributes to the increase.

12.2 Summary of receivers for consideration of additional noise mitigation

Table 42 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 42 Prospect Highway interchange - number of receivers considered for additional noise mitigation (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Prospect.EB.ON	Residential	2	2	2	2	2	2
	Other	1	1	1	1	1	1
Prospect.WB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

The information presented in **Table 42** indicates that all scenarios result in the same number of receivers being identified as being eligible for consideration of additional noise mitigation.

A total of two residential receivers and one other sensitive receiver are considered eligible.

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix H1**.

12.3 Selection of noise barriers for optimisation

There are not more than three closely grouped receivers requiring noise mitigation. Therefore, there is no requirement for noise barriers in this interchange area.

12.4 Operational noise impacts with recommended noise barriers

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix H3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix H4**.

As no change has been recommended to the existing noise barriers in this area, the predicted number of ‘acute’ receivers and receivers with noise levels over the NCG controlling criteria are consistent with those shown in **Table 40** and **Table 41** respectively.

12.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 43**.

Table 43 Prospect Highway interchange - receivers eligible for consideration of property treatment (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Prospect.EB.ON	Residential	2	2	2	2	2	2
	Other	1	1	1	1	1	1
Prospect.WB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

Table 44 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix H5**.

Table 44 Prospect Highway interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	Lot 222	PONDS ROAD	PROSPECT	307163	6257617	Other (Place of Worship)	1-hour	50	50	70	67	70	67
12	1	23	TARLINGTON PLACE	PROSPECT	307758	6257465	Residential	Period	60	55	66	62	66	62
13	2	23	TARLINGTON PLACE	PROSPECT	307758	6257465	Residential	Period	60	55	69	65	69	65

Note 1: Refers to the applicable assessment period for that receiver type, when P = period (ie 15-hour and 9-hour) and H = one hour.

12.6 Discussion of required treatments

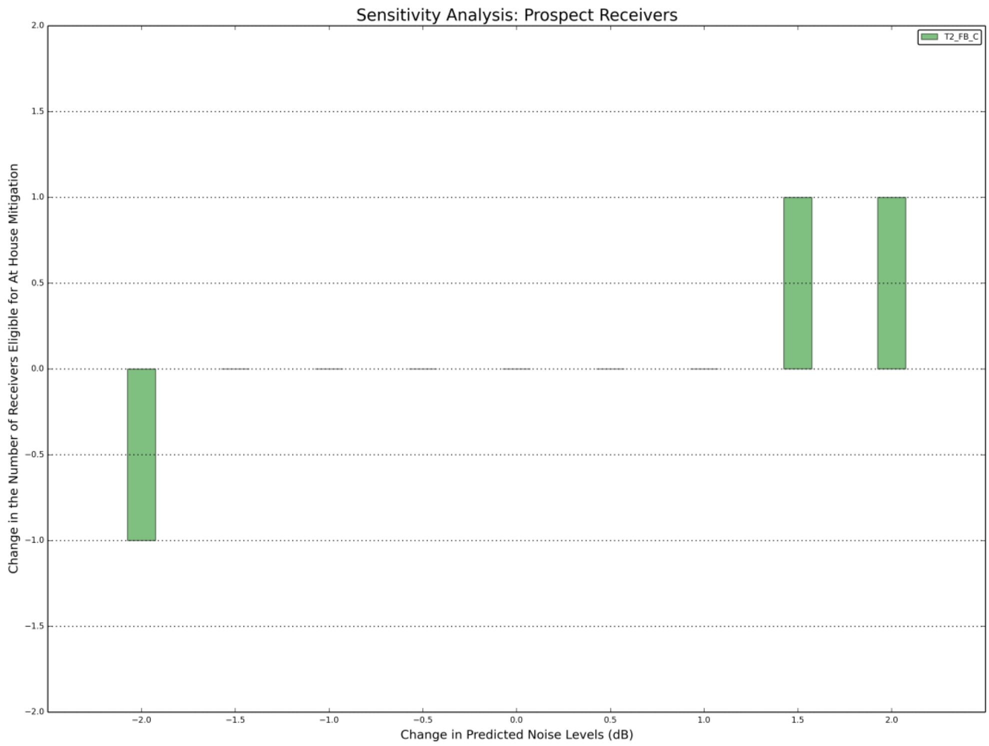
A total of three receivers are predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

- two residential receivers (two individual buildings)
- One other sensitive receiver (Place of Worship) (one individual building at the cemetery)

12.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 14**.

Figure 14 Prospect Highway interchange – prediction sensitivity analysis



Reference to the above indicates that no additional receivers would be eligible for consideration of property treatment if a +1 dB or -1dB correction were to be applied to the noise model predictions.

12.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix H6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 45**.

Table 45 Prospect Highway Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A7.1	1/03/13-12/03/13	291	72-88	79
A7.2	1/03/13-12/03/13	134	65-76	68

From the results presented within **Table 45**, it can be seen that average maximum noise level events typically range from 65 dBA to 88 dBA at the monitoring locations in this locality.

No significant increases in the magnitude of maximum noise events is predicted at this interchange area on the basis that all design noise barriers across the project area are either proposed to remain at the existing height, to be increased in height or for a new noise barrier to be installed, and do not significantly increase the angle of view to the adjacent receivers.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may observe increases in overall night-time heavy vehicle volumes:

- Receivers to the south of west-bound off-ramp of around 67 vehicles (+39%), and 39 vehicles (+19%) in years 2021 and 2031 respectively
- Receivers to the south of west-bound on-ramp of around 274 vehicles (+221%), and 297 vehicles (+278%) in years 2021 and 2031 respectively

13 RESERVOIR ROAD INTERCHANGE

13.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 46**, **Table 47** and **Figure 15** respectively.

Table 46 Reservoir Road interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Reservoir.EB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Reservoir.WB.ON	Residential	All	0	1	1	2	0	1	2	2
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

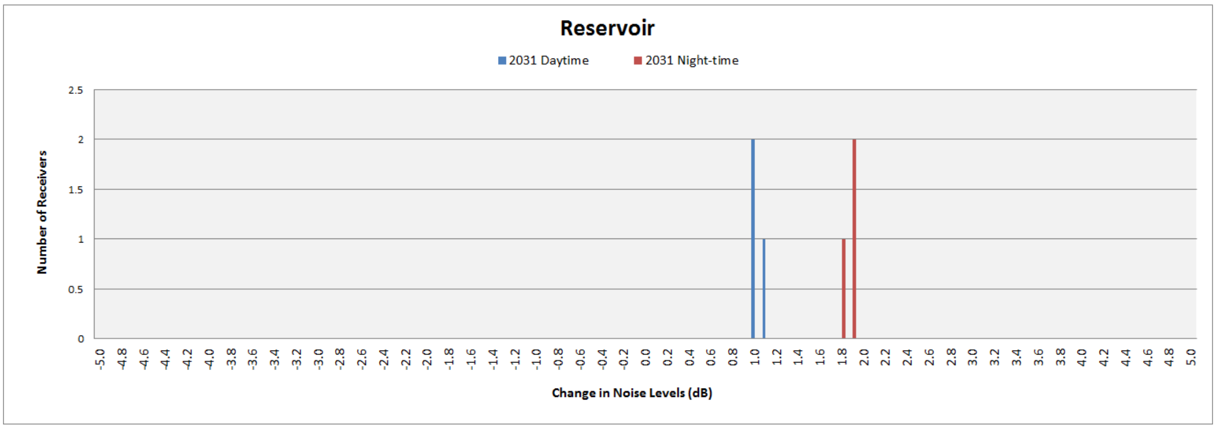
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 47 Reservoir Road interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Reservoir.EB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Reservoir.WB.ON	Residential	All	3	3	3	3	3	3	3	3
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 15 Reservoir Road interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 46**, **Table 47** and **Figure 15** indicates the following:

- A total of two residential receivers in the assessment areas are predicted to have ‘acute’ noise levels in the controlling 2031 night-time Build scenario. This is an increase from one receiver compared to the No Build case. No other sensitive receivers are predicted to have ‘acute’ noise levels.
- Three residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is no change compared to the No Build case. No other sensitive receivers are predicted to have noise levels above NCG goals.
- Within this assessment area, the project is predicted to result in a less than 2.0 dB increase in noise levels at all receivers. The maximum predicted change in this assessment area is +2.7 dB (during the controlling 2031 night-time scenario). This is primarily due to the conservative inclusion of the congestion factor in the No Build scenario only (refer to **Section 5.7**) and the increase in traffic on the main carriageways and ramps. The eastbound on ramp moving closer to adjacent receivers also contributes to the increase.

13.2 Summary of receivers for consideration of additional noise mitigation

Table 48 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 48 Reservoir Road interchange - number of receivers considered for additional noise mitigation (as per NMG)

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Reservoir.EB.ON	Residential	0	0	0	0	0	0
	Other Sensitive	0	0	0	0	0	0
Reservoir.WB.ON	Residential	1	3	3	2	3	3
	Other Sensitive	0	0	0	0	0	0

The information presented in **Table 48** indicates that the 2031 scenario results in the highest number of receivers being identified as being eligible for consideration of additional noise mitigation. These receivers are all residential.

A total of three receivers (all residential) in the 2021 scenario are considered eligible while the 2031 scenario also results in three eligible receivers (again all residential).

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix I1**.

13.3 Selection of noise barriers for optimisation

As discussed in **Section 13.2**, there are not more than three closely grouped receivers requiring noise mitigation. Therefore, there is no requirement for noise barriers at this interchange area.

13.4 Operational noise impacts with recommended noise barriers

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix I3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix I4**.

As no change has been recommended to the existing noise barriers in this area, the predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are consistent with those shown in **Table 46** and **Table 47** respectively.

13.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 49**.

Table 49 Reservoir Road interchange - receivers eligible for consideration of property treatment (as per NMG)

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Reservoir.EB.ON	Residential	0	0	0	0	0	0
	Other Sensitive	0	0	0	0	0	0
Reservoir.WB.ON	Residential	1	3	3	2	3	3
	Other Sensitive	0	0	0	0	0	0

Table 50 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix I5**.

Table 50 Reservoir Road interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	151B	YALLOCK PLACE	PROSPECT	305691	6257494	Residential	Period	60	55	62	59	63	59
2	2	151B	YALLOCK PLACE	PROSPECT	305691	6257494	Residential	Period	60	55	65	62	66	62
3	1	151B	YALLOCK PLACE	PROSPECT	305655	6257505	Residential	Period	60	55	64	61	65	61

Note 1: Refers to the applicable assessment period for that receiver type.

13.6 Discussion of required treatments

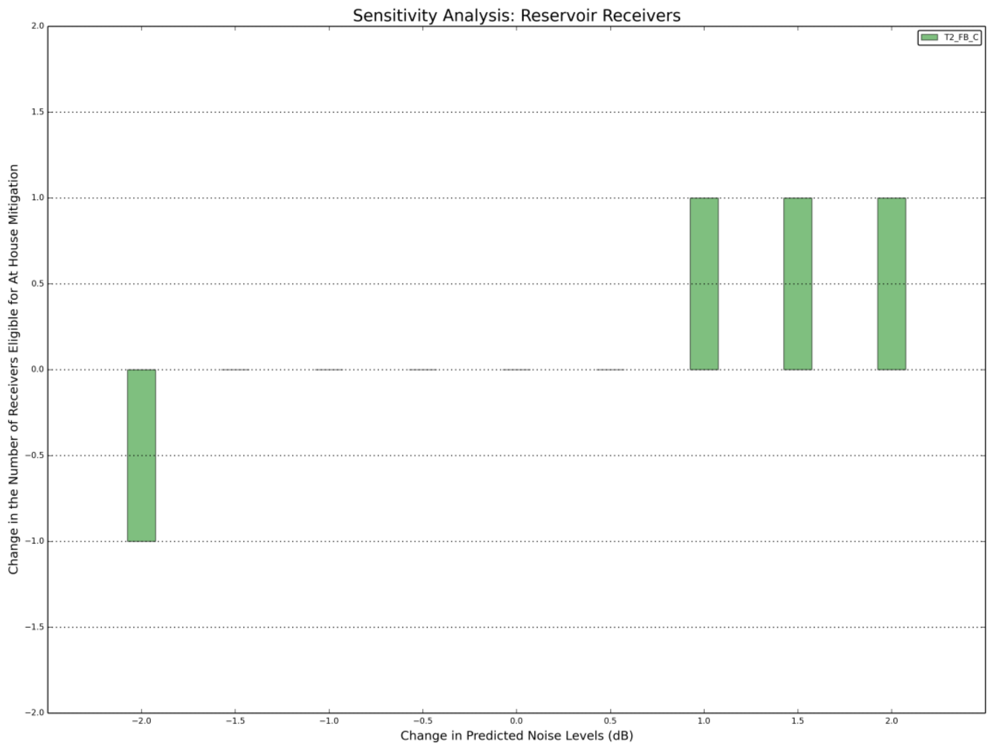
A total of three receivers are predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

- Three residential receivers (two individual buildings)

13.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 16**.

Figure 16 Reservoir Road interchange – prediction sensitivity analysis



Reference to the above indicates that an additional one receiver would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of 0 receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

13.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix I6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 51**.

Table 51 Reservoir Road Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A8.1	1/03/13-12/03/13	31	65-76	70
A8.2	1/03/13-12/03/13	251	69-90	76

From the results presented within **Table 51**, it can be seen that average maximum noise level events typically range from 65 dBA to 90 dBA at the monitoring locations in this locality.

No significant increases in the magnitude of maximum noise events is predicted at this interchange area on the basis that all design noise barriers across the project area are either proposed to remain at the existing height, to be increased in height or for a new noise barrier to be installed, and do not significantly increase the angle of view to the adjacent receivers.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), no significant change in heavy vehicle movements have been identified within this interchange area.

14 ROPER ROAD AND WALL GROVE ROAD/M7 INTERCHANGES INCLUDING THE IN-BETWEEN ADD LANES TO THE M4 MOTORWAY

14.1 Operational noise assessment with existing noise barriers

The predicted number of ‘acute’ receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 52**, **Table 53** and **Figure 17** respectively.

Table 52 Roper Road to M7 (including add-lanes) – ‘acute’ receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Roper2M7.WIDENING	Residential	All	34	51	22	28	42	65	22	29
	Other Sensitive	All	0	1	0	1	0	1	0	1
Roper.EB.ON	Residential	All	21	34	19	27	22	35	19	27
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

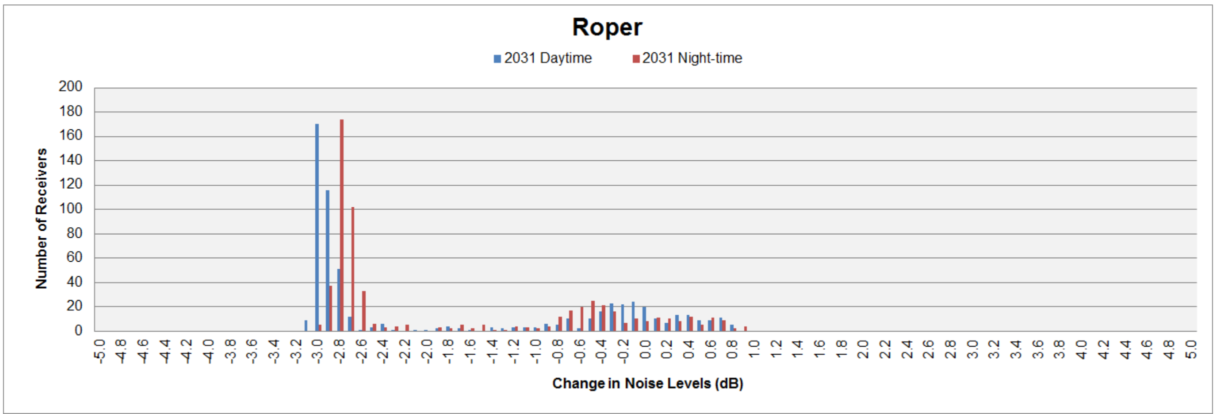
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as ‘acute’ under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 53 Roper Road to M7 (including add-lanes) – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Roper2M7.WIDENING	Residential	All	184	283	62	105	237	304	63	109
	Other Sensitive	All	2	1	2	1	2	1	2	1
Roper.EB.ON	Residential	All	61	96	60	90	62	101	62	93
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 17 Roper Road to M7 (including add-lanes) – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 52**, **Table 53** and **Figure 17** indicates the following:

- A total of 56 residential receivers in the assessment areas are predicted to have ‘acute’ noise levels in the controlling 2031 night-time Build scenario. This is a decrease from 100 receivers in the No Build case. One other sensitive receiver is predicted to have ‘acute’ noise levels.
- 202 residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is a decrease from 405 receivers in the No Build case. Two other sensitive receivers are predicted to have noise levels above NCG goals in the daytime 2031 Build scenario
- Within this assessment area, the project is predicted to result in a general reduction in noise levels at the majority of receivers due to the re-sheeting of the carriageway in the widened section of the M4 Motorway. The maximum predicted change in this assessment area is +0.9 dB (during the controlling 2031 night-time scenario).

14.2 Summary of receivers for consideration of additional noise mitigation

Table 54 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 54 Roper Road to M7 (including add-lanes) - number of receivers considered for additional noise mitigation (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Roper2M7.WIDENING	Residential	22	27	27	22	28	28
	Other	0	1	1	0	1	1
Roper.EB.ON	Residential	19	27	27	19	27	27
	Other	0	0	0	0	0	0

Note: Additional areas at this interchange have been identified for further investigation at detailed design - refer to **Section 8.2.**

The information presented in **Table 54** indicates that the 2031 scenario results in the highest number of receivers being identified as being eligible for consideration of additional noise mitigation.

A total of 54 residential receivers and one other sensitive receiver in the 2021 scenario are considered eligible while the 2031 scenario results in 55 residential receivers and one other sensitive receiver.

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix J1**. Also shown in this appendix map are the indicative locations of receivers identified by RMS for further investigation at detailed design as discussed in **Section 8.2**.

14.3 Selection of noise barriers for optimisation

The noise barrier optimisation process is based on guidance in NMG. Information on the noise barrier optimisation process used in this assessment is detailed in **Appendix J2**.

The results of the optimisation are detailed in **Table 55** and illustrated in **Figure 18**.

Table 55 Roper Road to M7 (including add-lanes) noise barrier optimisation – recommended project noise barriers

Barrier Reference[1]	Barrier Length (m)	Barrier Height (m)					Comments
		Existing[1]	Maximum Barrier Height	Initial Design Height	Final Design Height	Recommended Design Height [2]	
NW.Roper2M7.WIDENING.01	590	0.0	8.0	7.5	7.5	5	The design height is 7.5 m however; this does not provide the required 10 dBA of noise reduction for a barrier greater than 5 m. Therefore a recommended design height is 5.0 m
NW.Roper.EB.ON.01	611	2.3	8.0	7.0	7.0	6	Under the REF assessment a 6 m barrier has been adopted as the feasibility (wind loading, structural loading, etc.) of a 7.5m to 8m high barrier will be investigated during detailed design.

Note 1: Existing height is the height of the existing or the replaced existing noise barrier (ie maintaining the same top of noise barrier height as the existing barrier)

Note 2: Recommended height is subject to further considerations during detailed design such as construction limitations, overshadowing, urban design and community preference.

Figure 18 Roper Road to M7 (including add-lanes) - recommended noise barrier

Figure 19 Roper Road - recommended noise barrier

14.4 Operational noise impacts with recommended noise barriers

The final design of the recommended noise barriers as shown in **Table 55** and **Figure 18** has been included in the modelling of the Final Build scenarios.

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix J3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix J4**.

The predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are shown in **Table 56** and **Table 57** respectively.

Table 56 Roper Road to M7 (including add-lanes) – 'acute' receivers with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Roper2M7.WIDENING	Residential	All	34	51	0	5	42	65	0	6
	Other Sensitive	All	0	1	0	1	0	1	0	1
Roper.EB.ON	Residential	All	21	34	2	3	22	35	2	3
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 57 Roper Road to M7 (including add-lanes) – receivers over the NCG controlling criteria with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Roper2M7.WIDENING	Residential	All	184	283	50	91	237	304	52	93
	Other Sensitive	All	2	1	2	1	2	1	2	1
Roper.EB.ON	Residential	All	61	96	13	29	62	101	15	32
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

With the recommended noise barriers included, the noise predictions summarised in **Table 56** and **Table 57** indicate the following:

- In the controlling 2031 night-time scenario, a significant overall reduction of 91 residential 'acute' properties is predicted as a result of the project at this interchange, including the benefit from the recommended noise barriers.
- Fewer receivers are predicted with noise levels above the NCG noise goal in the Final Build scenario compared to the No Build scenario in both 2021 and 2031. In the controlling 2031 night-time scenario, the number of receivers above NCG controlling criteria is predicted to reduce by 280 residential receivers as a result of the project (including recommended noise barriers)
- At this interchange area, the project (including the recommended noise barriers) is generally predicted to reduce noise levels at the majority of adjacent receivers.

14.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 58**.

Table 58 Roper Road to M7 (including add-lanes) - receivers eligible for consideration of property treatment (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Roper2M7.WIDENING	Residential	17	26	26	17	27	27
	Other	0	1	1	0	1	1
Roper.EB.ON	Residential	9	20	20	9	20	20
	Other	0	0	0	0	0	0

Table 59 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix J5**.

Table 59 Roper Road to M7 (including add-lanes) - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	28	WALLGROVE ROAD	MINCHINBURY	300392	6258665	Other (Place of Worship)	1-hour	50	50	69	66	69	67
2	1	27	FARRINGTON STREET	MINCHINBURY	300169	6258676	Residential	Period	60	55	62	58	62	59
3	1	29	FARRINGTON STREET	MINCHINBURY	300159	6258662	Residential	Period	60	55	62	58	62	59
4	2	29	FARRINGTON STREET	MINCHINBURY	300159	6258662	Residential	Period	60	55	63	60	64	60
5	1	31	FARRINGTON STREET	MINCHINBURY	300142	6258654	Residential	Period	60	55	62	59	63	59
6	1	33	FARRINGTON STREET	MINCHINBURY	300122	6258657	Residential	Period	60	55	61	57	62	58
7	1	35	FARRINGTON STREET	MINCHINBURY	300106	6258664	Residential	Period	60	55	61	57	62	58
8	1	37	FARRINGTON STREET	MINCHINBURY	300090	6258670	Residential	Period	60	55	61	57	62	58
9	1	39	FARRINGTON STREET	MINCHINBURY	300074	6258675	Residential	Period	60	55	62	58	62	59
10	1	41	FARRINGTON STREET	MINCHINBURY	300054	6258680	Residential	Period	60	55	62	59	62	59
11	1	43	FARRINGTON STREET	MINCHINBURY	300034	6258686	Residential	Period	60	55	62	59	62	59
12	1	45	FARRINGTON STREET	MINCHINBURY	300014	6258695	Residential	Period	60	55	62	58	62	58
13	2	45	FARRINGTON STREET	MINCHINBURY	300014	6258695	Residential	Period	60	55	64	60	64	60
14	1	47	FARRINGTON STREET	MINCHINBURY	299994	6258702	Residential	Period	60	55	60	56	60	56
15	2	47	FARRINGTON STREET	MINCHINBURY	299994	6258702	Residential	Period	60	55	62	58	62	58
16	1	16	TIRAGE PLACE	MINCHINBURY	299958	6258710	Residential	Period	60	55	60	56	60	57
17	1	14	TIRAGE PLACE	MINCHINBURY	299931	6258718	Residential	Period	60	55	60	57	60	57
18	1	12	TIRAGE PLACE	MINCHINBURY	299919	6258729	Residential	Period	60	55	60	57	60	57
19	1	5	ESPALIER PLACE	MINCHINBURY	299879	6258742	Residential	Period	60	55	61	57	61	57
20	1	18	AGRAFE PLACE	MINCHINBURY	299801	6258769	Residential	Period	60	55	61	57	61	57
21	1	16	AGRAFE PLACE	MINCHINBURY	299783	6258774	Residential	Period	60	55	61	57	61	57
22	1	20	AGRAFE PLACE	MINCHINBURY	299819	6258762	Residential	Period	60	55	61	58	61	58

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
23	1	3	ESPALIER PLACE	MINCHINBURY	299896	6258734	Residential	Period	60	55	61	57	61	57
24	1	14	AGRAFE PLACE	MINCHINBURY	299768	6258785	Residential	Period	60	55	60	57	60	57
25	2	13	RUTHERGLEN PLACE	MINCHINBURY	299335	6258894	Residential	Period	60	55	63	60	63	60
26	2	20	RUTHERGLEN PLACE	MINCHINBURY	299272	6258920	Residential	Period	60	55	64	60	64	60
27	2	8	BERGIN PLACE	MINCHINBURY	299128	6258936	Residential	Period	60	55	63	59	63	60
28	2	7	TOD PLACE	MINCHINBURY	298663	6258981	Residential	Period	60	55	64	61	64	61
29	1	7	MARTIN GROVE	COLYTON	296339	6259044	Residential	Period	60	55	59	56	60	56
30	1	8	MARTIN GROVE	COLYTON	296330	6259031	Residential	Period	60	55	60	56	60	56
31	1	9	MARTIN GROVE	COLYTON	296318	6259024	Residential	Period	60	55	62	58	62	58
32	1	10	MARTIN GROVE	COLYTON	296301	6259029	Residential	Period	60	55	63	59	63	59
33	1	11	MARTIN GROVE	COLYTON	296286	6259034	Residential	Period	60	55	64	60	64	60
34	1	12	MARTIN GROVE	COLYTON	296271	6259039	Residential	Period	60	55	65	61	65	61
35	1	4-8	ROPER ROAD	COLYTON	297015	6259040	Residential	Period	60	55	67	62	67	63
36	2	6	HARWELL PLACE	COLYTON	296556	6258994	Residential	Period	60	55	61	57	61	57
37	1	7	HARWELL PLACE	COLYTON	296550	6258978	Residential	Period	60	55	60	56	60	56
38	1	8	HARWELL PLACE	COLYTON	296529	6258983	Residential	Period	60	55	60	56	60	56
39	1	9	HARWELL PLACE	COLYTON	296513	6258985	Residential	Period	60	55	60	56	60	56
40	2	9	HARWELL PLACE	COLYTON	296513	6258985	Residential	Period	60	55	62	58	62	58
41	1	10	HARWELL PLACE	COLYTON	296491	6258993	Residential	Period	60	55	60	56	60	56
42	2	10	HARWELL PLACE	COLYTON	296491	6258993	Residential	Period	60	55	62	58	62	58
43	1	11	HARWELL PLACE	COLYTON	296476	6258988	Residential	Period	60	55	60	56	60	56
44	2	11	HARWELL PLACE	COLYTON	296476	6258988	Residential	Period	60	55	62	58	62	58
45	1	12	HARWELL PLACE	COLYTON	296458	6258996	Residential	Period	60	55	60	56	60	56
46	2	14	HARWELL PLACE	COLYTON	296486	6259039	Residential	Period	60	55	60	56	60	56

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
47	1	5	SWALES PLACE	COLYTON	296765	6258972	Residential	Period	60	55	60	56	60	56
48	1	6	SWALES PLACE	COLYTON	296750	6258967	Residential	Period	60	55	60	56	60	56

Note 1: Refers to the applicable assessment period for that receiver type.

14.6 Discussion of required treatments

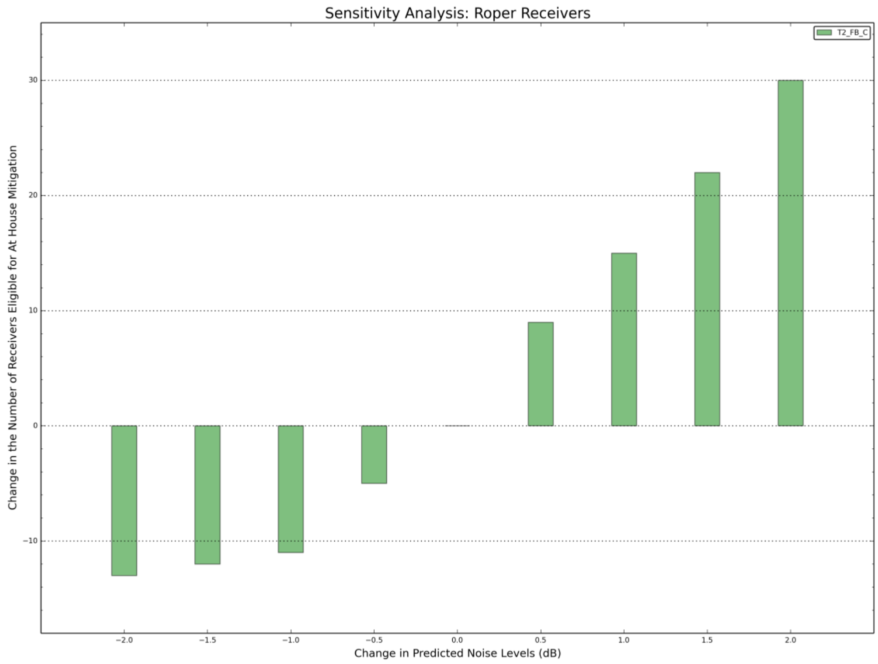
Further to the inclusion of the optimised project noise barriers a total of 48 receivers are predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

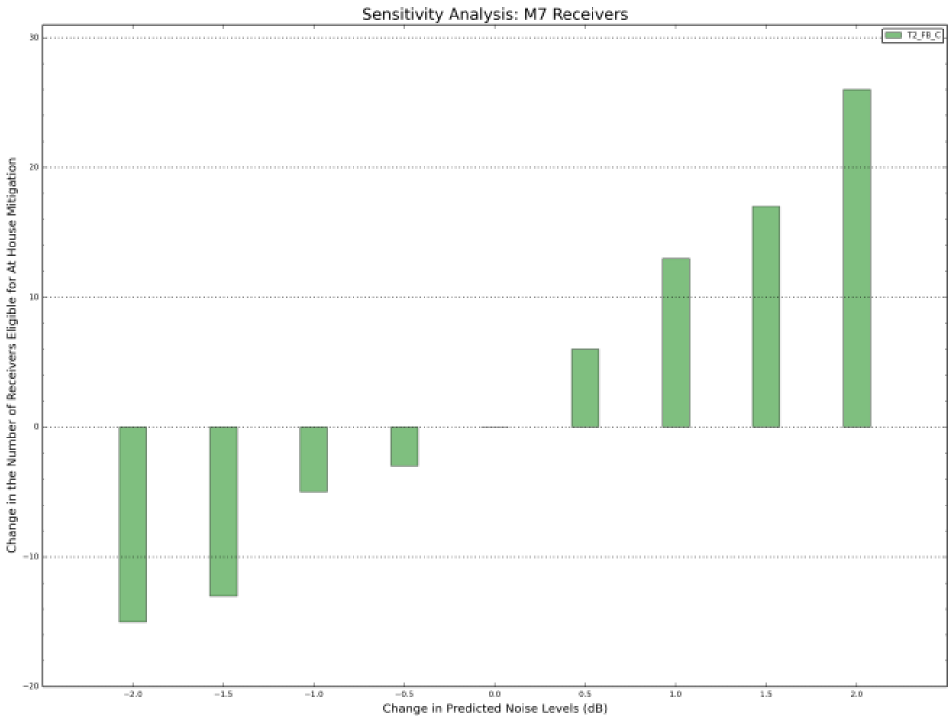
- 47 residential receivers (41 individual buildings)
- One other sensitive receiver (Place of Worship) (one individual building at the cemetery)

14.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 20**

Figure 20 Roper Road to M7 (including add-lanes) – prediction sensitivity analysis





Reference to the above indicates that an additional 28 receivers would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of 16 receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

14.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix J6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 60**.

Table 60 Roper Road to M7 (including add-lanes) – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A9.2	1/03/13-12/03/13	16	67-75	68
A9.3	1/03/13-12/03/13	48	66-85	75
A9.5	1/03/13-12/03/13	57	65-87	72
A9.6	1/03/13-12/03/13	12	66-74	70

From the results presented within **Table 60**, it can be seen that average maximum noise level events typically range from 66 dBA to 85 dBA at the monitoring locations in the vicinity of the M7 interchange, and from 65 dBA to 87 dBA at the monitoring locations in the vicinity of the Roper Road interchange.

No significant increases in the magnitude of maximum noise events is predicted at these interchange areas on the basis that all design noise barriers across the project area are either proposed to remain at the existing height, to be increased in height or for a new noise barrier to be installed, and do not significantly increase the angle of view to the adjacent receivers.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may observe decreases in overall night-time heavy vehicle volumes:

- Receivers to the south of west-bound off-ramp of around 99 vehicles (-32%) in 2021
- Receivers to the north of east-bound on-ramp of around 43 vehicles (-39%) in 2031

15 MAMRE ROAD INTERCHANGE

15.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 61**, **Table 62** and **Figure 21** respectively.

Table 61 Mamre Road interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Mamre.EB.ON	Residential	All	4	14	11	24	5	14	11	24
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mamre.WB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mamre.EB.OFF	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

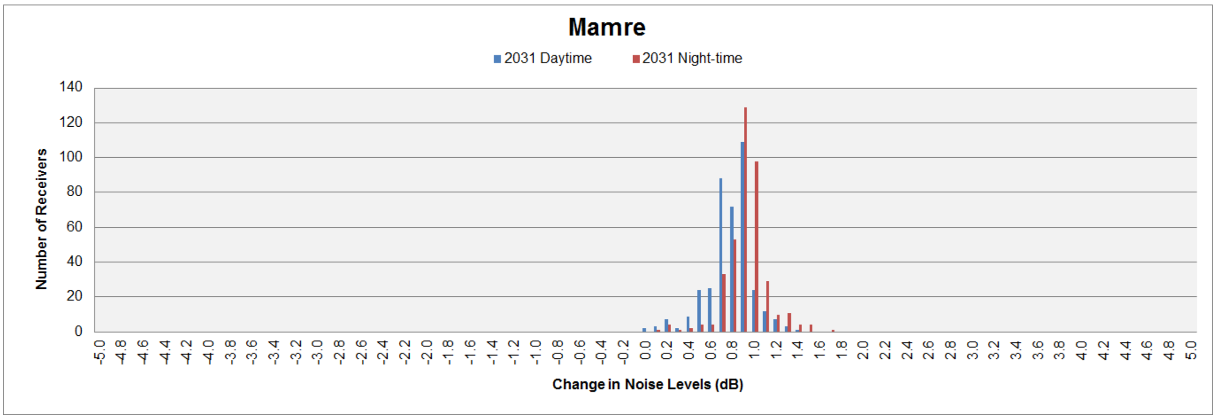
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 62 Mamre Road interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Mamre.EB.ON	Residential	All	40	60	60	95	40	64	62	96
	Other Sensitive	All	0	0	1	0	0	0	1	0
Mamre.WB.ON	Residential	All	4	7	6	11	4	8	5	12
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mamre.EB.OFF	Residential	All	3	11	8	24	4	12	9	30
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 21 Mamre Road interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 61**, **Table 62** and **Figure 21** indicates the following:

- A total of 24 residential receivers in the assessment areas are predicted to have 'acute' noise levels in the controlling 2031 night-time Build scenario. This is an increase from 14 receivers in the No Build case. No other sensitive receivers are predicted to have 'acute' noise levels.
- 138 residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is an increase from 84 receivers in the No Build case. One other sensitive receiver is predicted to have noise levels above NCG goals.
- Within this assessment area, the project is predicted to result in a less than 2.0 dB increase in noise levels at all receivers. The maximum predicted change in this assessment area is +1.7 dB (during the controlling 2031 night-time scenario).

15.2 Summary of receivers for consideration of additional noise mitigation

Table 63 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 63 Mamre Road interchange - number of receivers considered for additional noise mitigation (as per NMG)

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Mamre.EB.ON	Residential	11	24	24	11	24	24
	Other	0	0	0	0	0	0
Mamre.WB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Mamre.EB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

The information presented in **Table 63** indicates that the 2031 scenario results in the highest number of receivers being identified as being eligible for consideration of additional noise mitigation. These receivers are all residential.

A total of 24 receivers (all residential) in the 2021 scenario are considered eligible while the 2031 scenario also results in 24 eligible receivers (again all residential).

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix K1**.

15.3 Selection of noise barriers for optimisation

The noise barrier optimisation process is based on guidance in the NMG. Information on the noise barrier optimisation process used in this assessment is detailed in **Appendix K2**.

The results of the optimisation are detailed in **Table 64** and illustrated in **Figure 22**.

Table 64 Mamre Road interchange noise barrier optimisation – recommended project noise barriers

Barrier Reference[1]	Barrier Length (m)	Barrier Height (m)					Comments
		Existing[1]	Maximum Barrier Height	Initial Design Height	Final Design Height	Recommended Design Height [2]	
NW.Mamre.EB.ON.01	359	4.5	8.0	8.0	8.0	-	No benefit provided by barrier. Rebuild to existing RL when relocating barrier.
NW.Mamre.EB.ON.02	272	2	8.0	8.0	8.0	6.0	Under the REF assessment a 6 m barrier has been adopted as the feasibility (wind loading, structural loading, etc.) of an 8 m high barrier will be investigated during detailed design.

Note 1: Existing height is the height of the existing or the replaced existing noise barrier (ie maintaining the same top of noise barrier height as the existing barrier)

Note 2: Recommended height is subject to further considerations during detailed design such as construction limitations, overshadowing, urban design and community preference.

Figure 22 Mamre Road interchange - recommended noise barrier

15.4 Operational noise impacts with recommended noise barriers

The final design of the recommended noise barriers as shown in **Table 64** and **Figure 22** has been included in the modelling of the Final Build scenarios.

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix K3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix K4**.

The predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are shown in **Table 65** and **Table 66** respectively.

Table 65 Mamre Road interchange – 'acute' receivers with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Mamre.EB.ON	Residential	All	4	14	1	4	5	14	1	4
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mamre.WB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mamre.EB.OFF	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 66 Mamre Road interchange – receivers over the NCG noise goal with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Mamre.EB.ON	Residential	All	40	60	41	60	40	64	45	60
	Other Sensitive	All	0	0	1	0	0	0	1	0
Mamre.WB.ON	Residential	All	4	7	6	11	4	8	5	12
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mamre.EB.OFF	Residential	All	3	11	7	24	4	12	9	30
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

With the recommended noise barriers included, the noise predictions summarised in **Table 65** and **Table 66** indicate the following:

- In the controlling 2031 night-time scenario, a significant overall reduction of 10 residential 'acute' properties is predicted as a result of the project at this interchange, including the benefit from the recommended noise barriers.
- More receivers are however predicted with noise levels above the NCG noise goal in the Final Build scenario compared to the No Build scenario in both 2021 and 2031. In the controlling 2031 night-time scenario, the number of receivers above NCG controlling criteria is predicted to increase by 18 receivers as a result of the project (including recommended noise barriers). This is due to increases in the traffic volumes on the main carriageway.

15.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 67**.

Table 67 Mamre Road interchange - receivers eligible for consideration of property treatment (as per NMG)

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Mamre.EB.ON	Residential	11	24	24	11	24	24
	Other	0	0	0	0	0	0
Mamre.WB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Mamre.EB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

Table 68 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix K5**.

Table 68 Mamre Road interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	48	CAINES CRESCENT	ST MARYS	294661	6259435	Residential	Period	60	55	63	59	63	59
2	1	46	CAINES CRESCENT	ST MARYS	294632	6259442	Residential	Period	60	55	62	58	62	58
3	1	44	CAINES CRESCENT	ST MARYS	294617	6259449	Residential	Period	60	55	62	58	62	58
4	2	44	CAINES CRESCENT	ST MARYS	294617	6259449	Residential	Period	60	55	64	60	64	60
5	1	42	CAINES CRESCENT	ST MARYS	294596	6259453	Residential	Period	60	55	61	57	61	57
6	1	40	CAINES CRESCENT	ST MARYS	294578	6259456	Residential	Period	60	55	61	57	61	57
7	2	40	CAINES CRESCENT	ST MARYS	294578	6259456	Residential	Period	60	55	63	59	63	59
8	1	38	CAINES CRESCENT	ST MARYS	294561	6259465	Residential	Period	60	55	61	57	61	57
9	1	36	CAINES CRESCENT	ST MARYS	294548	6259470	Residential	Period	60	55	61	57	61	57
10	1	34	CAINES CRESCENT	ST MARYS	294524	6259471	Residential	Period	60	55	61	57	61	57
11	1	32	CAINES CRESCENT	ST MARYS	294509	6259477	Residential	Period	60	55	61	57	61	57
12	1	30	CAINES CRESCENT	ST MARYS	294491	6259479	Residential	Period	60	55	61	57	61	57
13	1	28	CAINES CRESCENT	ST MARYS	294470	6259481	Residential	Period	60	55	61	57	61	57
14	1	26	CAINES CRESCENT	ST MARYS	294450	6259490	Residential	Period	60	55	60	57	61	57
15	1	24	CAINES CRESCENT	ST MARYS	294433	6259498	Residential	Period	60	55	61	57	61	57
16	1	22	CAINES CRESCENT	ST MARYS	294414	6259501	Residential	Period	60	55	61	58	61	58
17	1	20	CAINES CRESCENT	ST MARYS	294396	6259507	Residential	Period	60	55	62	58	62	58
18	1	18	CAINES CRESCENT	ST MARYS	294377	6259511	Residential	Period	60	55	62	58	62	58
19	2	18	CAINES CRESCENT	ST MARYS	294377	6259511	Residential	Period	60	55	63	60	63	60
20	1	16	CAINES CRESCENT	ST MARYS	294359	6259514	Residential	Period	60	55	62	58	62	58
21	1	27	CAINES CRESCENT	ST MARYS	294267	6259521	Residential	Period	60	55	62	59	63	59
22	1	25	CAINES CRESCENT	ST MARYS	294231	6259527	Residential	Period	60	55	63	59	63	59
23	2	25	CAINES CRESCENT	ST MARYS	294231	6259527	Residential	Period	60	55	65	61	65	61

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
24	2	23	CAINES CRESCENT	ST MARYS	294229	6259548	Residential	Period	60	55	63	60	64	60

Note 1: Refers to the applicable assessment period for that receiver type.

15.6 Discussion of required treatments

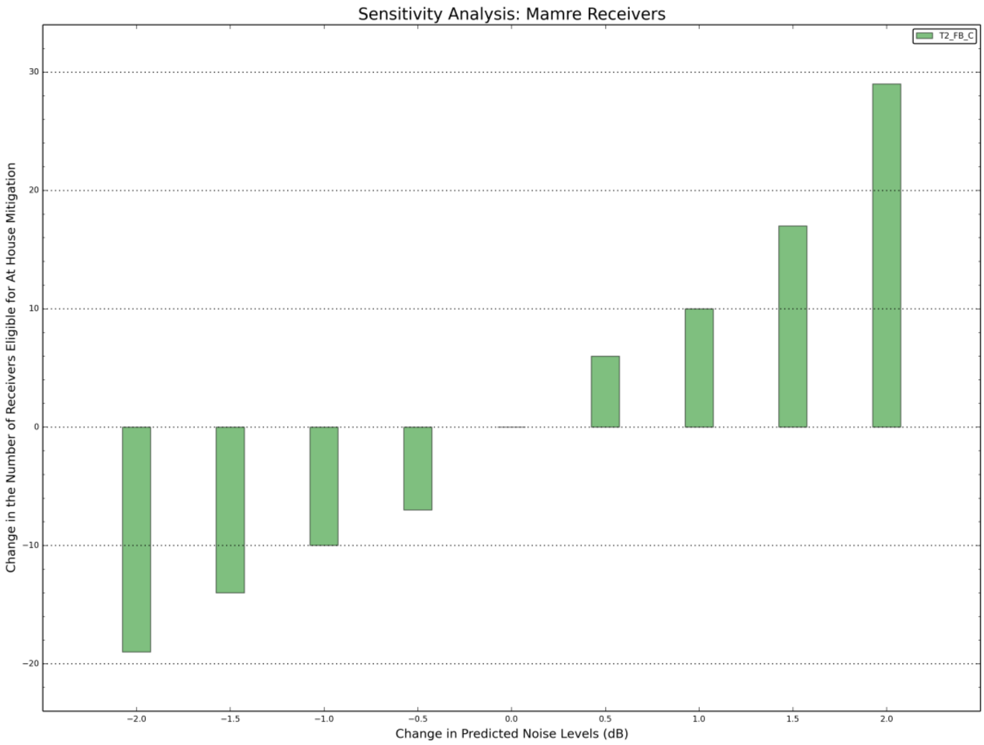
Further to the inclusion of the optimised project noise barriers a total of 24 receivers are predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

- 24 residential receivers (20 individual buildings)

15.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 23**.

Figure 23 Mamre Road interchange – prediction sensitivity analysis



Reference to the above indicates that an additional 10 receivers would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of 10 receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

15.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix K6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 69**.

Table 69 Mamre Road Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A10.1	14/03/13-27/03/13	54	65-82	71
A10.2	14/03/13-27/03/13	91	65-77	68

From the results presented within **Table 69**, it can be seen that average maximum noise level events typically range from 65 dBA to 82 dBA at the monitoring locations in this locality.

No significant increases in the magnitude of maximum noise events is predicted at these interchange areas on the basis that all design noise barriers across the project area are either proposed to remain at the existing height, to be increased in height or for a new noise barrier to be installed, and do not significantly increase the angle of view to the adjacent receivers.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may observe changes in overall night-time heavy vehicle volumes:

- Receivers to the south of west-bound off-ramp may observe increases in overall night-time heavy vehicle volumes of up to 10 vehicles (+20%), and 9 vehicles (+23%) in years 2021 and 2031 respectively
- Receivers to the north of east-bound on-ramp may observe increases in overall night-time heavy vehicle volumes of up to 12 vehicles (+18%), and may observe decrease in overall night-time heavy vehicle volumes of up to 13 vehicles (-28%) in years 2021 and 2031 respectively

16 NORTHERN ROAD INTERCHANGE

16.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 70**, **Table 71** and **Figure 24** respectively.

Table 70 Northern Road interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Northern.EB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	2	0	2	0	2	0	2	0
Northern.WB.OFF	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Northern.EB.OFF	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Northern.WB.ON	Residential	All	1	0	2	1	2	1	2	1
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

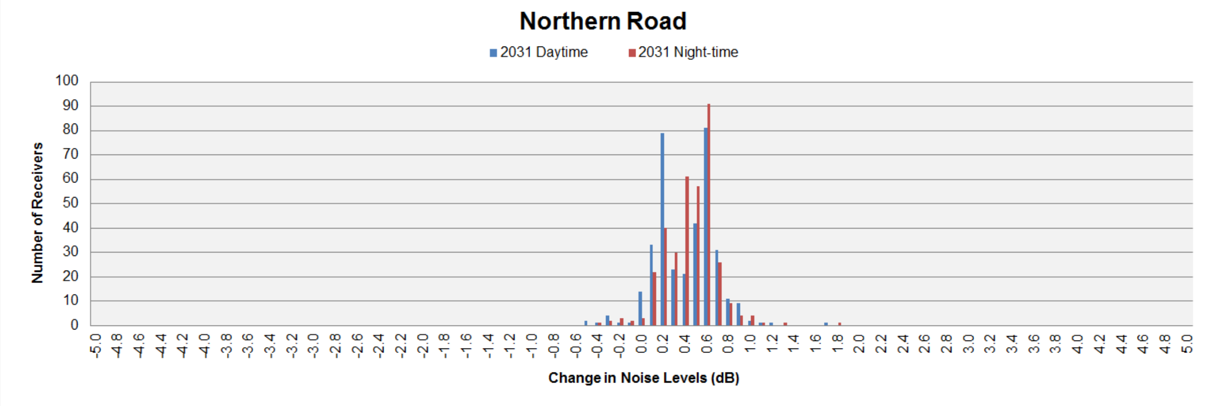
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 71 Northern Road interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Northern.EB.ON	Residential	All	2	2	2	3	2	3	2	3
	Other Sensitive	All	15	0	15	0	15	0	15	0
Northern.WB.OFF	Residential	All	2	3	3	5	2	4	4	5
	Other Sensitive	All	0	0	0	0	0	0	0	0
Northern.EB.OFF	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Northern.WB.ON	Residential	All	5	6	7	9	6	7	11	11
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 24 Northern Road interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 70**, **Table 71** and **Figure 24** indicates the following:

- A total of one residential receiver in the assessment areas is predicted to have 'acute' noise levels in the controlling 2031 night-time Build scenario. There is no change compared to the No Build case. Two other sensitive receivers are predicted to have 'acute' noise levels.
- 19 residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is an increase from 14 receivers in the No Build case. Fifteen other sensitive receivers are predicted to have noise levels above NCG goals in the daytime 2031 Build scenario.
- Within this assessment area, the project is predicted to result in a less than 2.0 dB change in noise levels at all receivers. The maximum predicted change in this assessment area is +1.8 dB (during the controlling 2031 night-time scenario).

16.2 Summary of receivers for consideration of additional noise mitigation

Table 72 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 72 Northern Road interchange - number of receivers considered for additional noise mitigation (as per NMG)

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Northern.EB.ON	Residential	0	0	0	0	0	0
	Other	2	0	2	2	0	2
Northern.WB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Northern.EB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Northern.WB.ON	Residential	2	1	2	2	1	2
	Other	0	0	0	0	0	0

The information presented in **Table 72** indicates that the 2031 scenario results in the same number of receivers being identified as being eligible for consideration of additional noise mitigation as 2021.

A total of two residential receivers and two other sensitive receivers in the 2021 scenario are considered eligible while the 2031 scenario also results in two residential receivers and two other sensitive receivers.

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix L1**.

16.3 Selection of noise barriers for optimisation

There are not more than three closely grouped receivers requiring noise mitigation. Therefore, there is no requirement for noise barriers in this interchange area.

16.4 Operational noise impacts with recommended noise barriers

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix L3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix L4**.

As no change has been recommended to the existing noise barriers in this area, the predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are consistent with those shown in **Table 70** and **Table 71** respectively.

16.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 73**.

Table 73 Northern Road interchange - receivers eligible for consideration of property treatment (as per NMG)

NCA	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Northern.EB.ON	Residential	0	0	0	0	0	0
	Other	2	0	2	2	0	2
Northern.WB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Northern.EB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Northern.WB.ON	Residential	2	1	2	2	1	2
	Other	0	0	0	0	0	0

Table 74 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix L5**.

Table 74 Northern Road interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	1	SIMEON ROAD	ORCHARD HILLS	287917	6259258	Other (Educational)	1-hour	50	n/a	72	-	72	-
2	1	1	SIMEON ROAD	ORCHARD HILLS	287935	6259257	Other (Educational)	1-hour	50	n/a	72	-	72	-
3	1	1	SOUTH STREET	GLENMORE PARK	286586	6259345	Residential	Period	60	55	66	60	66	61
4	1	1917-1919	THE NORTHERN ROAD	GLENMORE PARK	287234	6259188	Residential	Period	60	55	65	59	65	59

Note 1: Refers to the applicable assessment period for that receiver type.

16.6 Discussion of required treatments

A total of four receivers are predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

- two residential receivers (two individual buildings)
- two other sensitive receivers (two individual buildings at the educational facility)

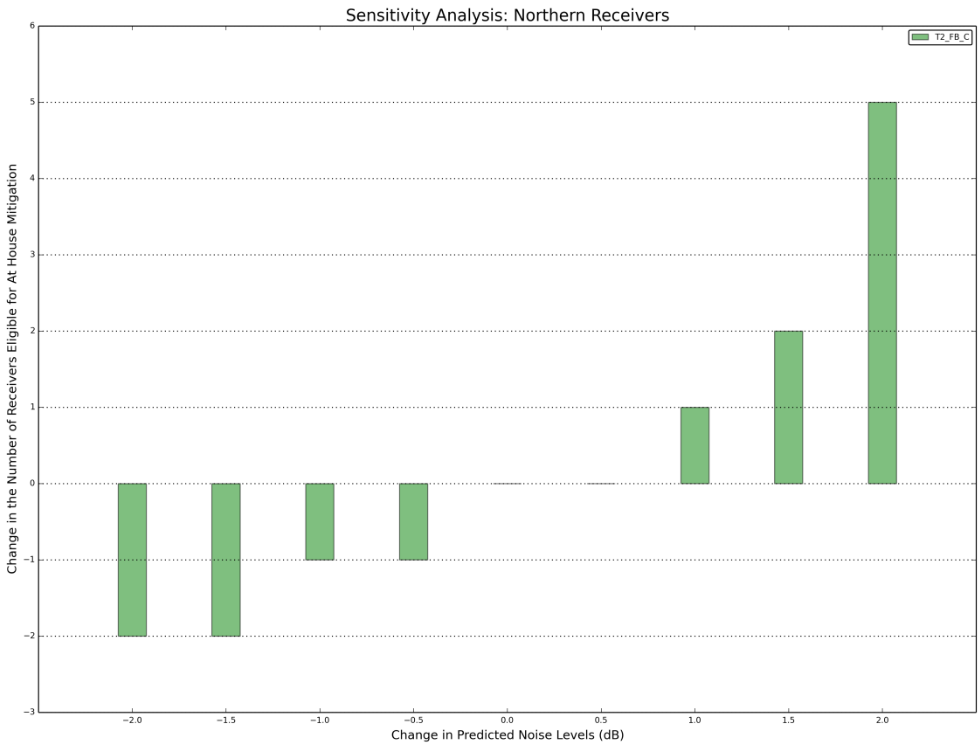
The educational facility is eligible for consideration of additional mitigation on the basis of 'acute' $L_{Aeq(15hour)}$ noise levels, however the $L_{Aeq(1hour)}$ NCG noise goal applies to the school and would be the target in order to eliminate property treatment – refer to **Section 4.5**.

As this school appears fairly new, it is likely that their design would have considered road traffic noise intrusion. Scope for reasonable measures for improvements via further architectural treatments may therefore be limited. A reduction to below the NCG criteria from a noise barrier would be considered unlikely across all school buildings; however, a noticeable noise benefit from a noise barrier may be achieved at some locations, including the outdoor areas adjacent to the M4 motorway. Further analysis of potential treatments at the school should involve a process of consultation with the affected receivers.

16.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 25**.

Figure 25 Northern Road interchange – prediction sensitivity analysis



Reference to the above indicates that an additional one receiver would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of one receiver would be apparent if 1 dB was to be subtracted from the noise model predictions.

16.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix L6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 75**.

Table 75 Northern Road Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A11.2	14/03/13-27/03/13	97	65-76	67
A11.3	14/03/13-27/03/13	91	65-83	68

From the results presented within **Table 75**, it can be seen that average maximum noise level events typically range from 65 dBA to 83 dBA at the monitoring locations in this locality.

Review of the proposed works at this interchange area indicates that an increase in maximum noise level of potential events may be apparent at the following locations:

- Receivers located along South Street, immediately south of the west-bound on-ramp. An increase in the maximum noise level of potential events of up to 4 dB may result from changes to on-ramp design and adjacent topography.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may observe decreases in overall night-time heavy vehicle volumes:

- Receivers to the south of west-bound on-ramp may observe decreases in overall night-time heavy vehicle volumes of up to 12 vehicles (-33%), and 2 vehicles (-10%) in years 2021 and 2031 respectively
- Receivers to the south of west-bound off-ramp may observe decreases in overall night-time heavy vehicle volumes of up to 4 vehicles (-17%) in 2021
- Receivers to the north of east-bound off-ramp may observe decreases in overall night-time heavy vehicle volumes of up to 2 vehicles (-8%) in 2031

17 MULGOA ROAD INTERCHANGE

17.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 76**, **Table 77** and **Figure 26** respectively.

Table 76 Mulgoa Road interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Mulgoa.EB.ON	Residential	All	1	2	2	4	2	2	2	4
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mulgoa.WB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mulgoa.WB.OFF	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

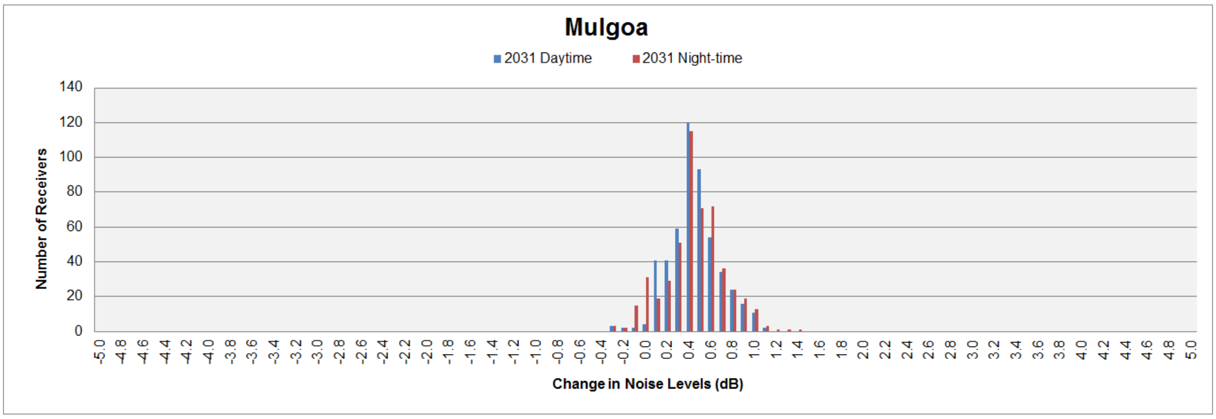
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 77 Mulgoa Road interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Mulgoa.EB.ON	Residential	All	12	14	12	14	12	14	14	14
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mulgoa.WB.ON	Residential	All	1	0	1	0	2	1	2	3
	Other Sensitive	All	2	0	2	0	2	0	2	0
Mulgoa.WB.OFF	Residential	All	1	1	3	1	1	2	3	2
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 26 Mulgoa Road interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 76**, **Table 77** and **Figure 26** indicates the following:

- A total of four residential receivers in the assessment areas are predicted to have 'acute' noise levels in the controlling 2031 night-time Build scenario. This is a decrease from two receivers in the No Build case. No other sensitive receivers are predicted to have 'acute' noise levels.
- 19 residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is an increase from 17 receivers in the No Build case. Two other sensitive receivers are predicted to have noise levels above NCG goals in the daytime 2031 Build scenario
- Within this assessment area, the project is predicted to result in a less than 2.0 dB increase in noise levels at all receivers. The maximum predicted change in this assessment area is +1.4 dB (during the controlling 2031 night-time scenario).

17.2 Summary of receivers for consideration of additional noise mitigation

Table 78 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 78 Mulgoa Road interchange - number of receivers considered for additional noise mitigation (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Mulgoa.EB.ON	Residential	2	4	4	2	4	4
	Other	0	0	0	0	0	0
Mulgoa.WB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Mulgoa.WB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

The information presented in **Table 78** indicates that the 2031 scenario results in the same number of receivers being identified as being eligible for consideration of additional noise mitigation as 2021.

A total of four residential receivers in the 2021 scenario are considered eligible while the 2031 also scenario results in four residential receivers.

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix M1**.

17.3 Selection of noise barriers for optimisation

The noise barrier optimisation process is based on guidance in the RMS document Noise Mitigation Guideline . Information on the noise barrier optimisation process used in this assessment is detailed in **Appendix M2**.

The results of the optimisation are detailed in **Table 79** and illustrated in **Figure 27**.

Table 79 Mulgoa Road interchange noise barrier optimisation – recommended project noise barriers

Barrier Reference[1]	Barrier Length (m)	Barrier Height (m)					Comments
		Existing[1]	Maximum Barrier Height	Initial Design Height	Final Design Height	Recommended Design Height [2]	
NW.Mulgoa.EB.ON.01		0.0	8.0	4.0	4.0	4.0	Height as per final design height.

Note 1: Existing height is the height of the existing or the replaced existing noise barrier (ie maintaining the same top of noise barrier height as the existing barrier)

Note 2: Recommended height is subject to further considerations during detailed design such as construction limitations, overshadowing, urban design and community preference.

Figure 27 Mulgoa Road interchange - recommended noise barrier

17.4 Operational noise impacts with recommended noise barriers

The final design of the recommended noise barriers as shown in **Table 79** and **Figure 27** has been included in the modelling of the Final Build scenarios.

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix M3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix M4**.

The predicted number of 'acute' receivers and receivers with noise levels over the NCG controlling criteria are shown in **Table 80** and **Table 81** respectively.

Table 80 Mulgoa Road interchange – 'acute' receivers with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Mulgoa.EB.ON	Residential	All	1	2	1	1	2	2	1	1
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mulgoa.WB.ON	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mulgoa.WB.OFF	Residential	All	0	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 81 Mulgoa Road interchange – receivers over the NCG controlling criteria with recommended noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Final Build		2031 No Build		2031 Final Build	
			Day	Night	Day	Night	Day	Night	Day	Night
Mulgoa.EB.ON	Residential	All	12	14	6	8	12	14	6	9
	Other Sensitive	All	0	0	0	0	0	0	0	0
Mulgoa.WB.ON	Residential	All	1	0	1	0	2	1	2	3
	Other Sensitive	All	2	0	2	0	2	0	2	0
Mulgoa.WB.OFF	Residential	All	1	1	3	1	1	2	3	2
	Other Sensitive	All	0	0	0	0	0	0	0	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

With the recommended noise barriers included, the noise predictions summarised in **Table 80** and **Table 81** indicate the following:

- In the controlling 2031 night-time scenario, there is a marginal decrease of one residential 'acute' property as a result of the project at this interchange, including the benefit from the recommended noise barriers.
- There is also a marginal decrease in the number of receivers predicted with noise levels above the NCG noise goal in the Final Build scenario compared to the No Build scenario in both 2021 and 2031.

- At this interchange, the project (including the recommended noise barriers) is generally predicted to have negligible adverse impact at the majority of adjacent receivers.

17.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 82**.

Table 82 Mulgoa Road interchange - receivers eligible for consideration of property treatment (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Mulgoa.EB.ON	Residential	1	1	1	1	1	1
	Other	0	0	0	0	0	0
Mulgoa.WB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0
Mulgoa.WB.OFF	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

Table 83 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix M5**.

Table 83 Mulgoa Road interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
1	1	33	HATCHINSON CRESCENT	JAMISONTOWN	284385	6260629	Residential	Period	60	55	69	65	69	66

Note 1: Refers to the applicable assessment period for that receiver type.

17.6 Discussion of required treatments

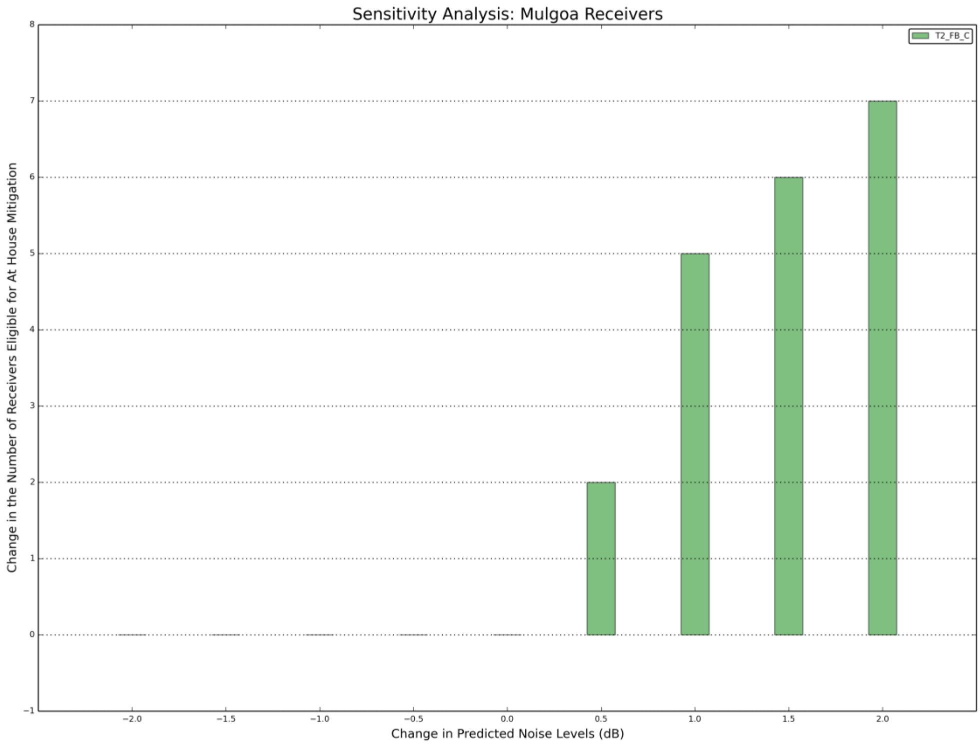
Further to the inclusion of the optimised project noise barriers a total of one receiver is predicted to be eligible for consideration of property treatment as part of the project according to the criteria nominated in **Section 4.5**. This number comprises:

- one residential receiver (one individual building)

17.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 28**

Figure 28 Mulgoa Road interchange – prediction sensitivity analysis



Reference to the above indicates that an additional five receivers would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of zero receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

17.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix M6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 84**.

Table 84 Mulgoa Road Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A12.1	14/03/13-27/03/13	447	65-86	71
A12.2	14/03/13-27/03/13	219	65-76	67

From the results presented within **Table 84**, it can be seen that average maximum noise level events typically range from 65 dBA to 86 dBA at the monitoring locations in this locality.

Review of the proposed works at this interchange area indicates that an increase in maximum noise level of potential events may be apparent at the following locations:

- Some receivers on Hatchinson Crescent, immediately adjacent the east-bound on-ramp lane extension at the eastern end of the existing noise barrier. Maximum noise level of potential events may increase at up to two receivers due to changes in the noise propagation path resulting from the extended ramp alignment.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may be subject to increases in overall night-time heavy vehicle volumes:

- Receivers to the south of the west-bound on-ramp of around 50 (+313%) for 2031
- Receivers to the north of the east-bound on-ramp of around 77 vehicles for year 2021, and 70 vehicles for year 2031 (+48% and +43% respectively)

18 RUSSELL STREET INTERCHANGE

18.1 Operational noise assessment with existing noise barriers

The predicted number of 'acute' receivers, receivers with noise levels over the NCG controlling criteria and the change in noise levels (Build minus No Build) are shown in **Table 85**, **Table 86** and **Figure 29** respectively.

Table 85 Russell Street interchange – 'acute' receivers with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Russell.EB.ON	Residential	All	1	0	0	0	0	0	0	0
	Other Sensitive	All	0	0	0	0	0	0	0	0

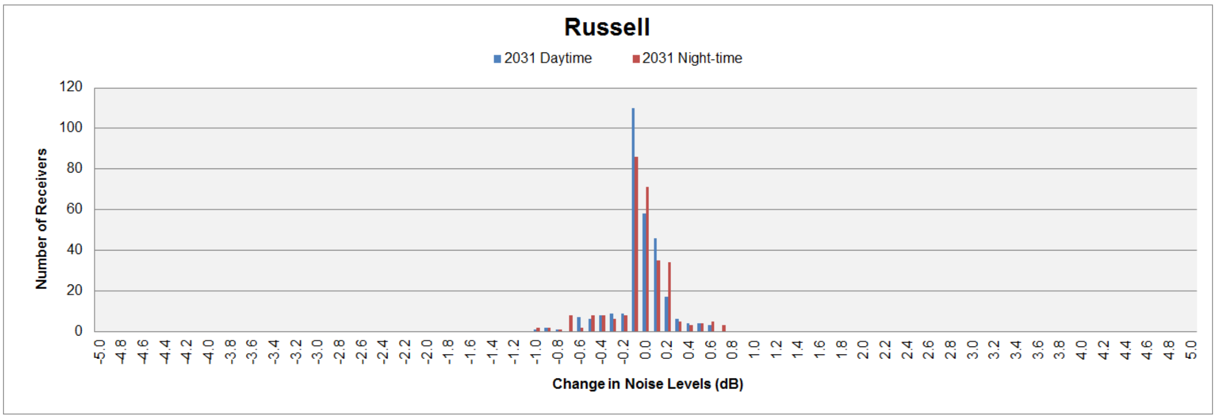
Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.
Note 2: Sensitive receivers (residences, schools, places of worship or health care centres) are considered as 'acute' under the NMG for LAeq(15hour) daytime road traffic noise levels of 65 dBA and above, or for LAeq(9hour) night-time road traffic noise levels of 60 dBA and above.

Table 86 Russell Street interchange – receivers over the NCG controlling criteria with existing noise barriers

Assessment Area	Receiver Type	Floor	2021 No Build		2021 Build		2031 No Build		2031 Build	
			Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]	Day[1]	Night[1]
Russell.EB.ON	Residential	All	10	11	11	12	11	16	11	15
	Other Sensitive	All	5	0	3	0	5	0	4	0

Note 1: Counts do not include receivers where noise levels are dominated by non-project existing roads.

Figure 29 Russell Street interchange – change in noise levels (Build minus No Build) with existing noise barriers



The information presented in **Table 85**, **Table 86** and **Figure 29** indicates the following:

- There are no 'acute' residential receivers in the assessment areas in the controlling 2031 night-time Build or No Build scenario. No other sensitive receivers are predicted to have 'acute' noise levels.

- 15 residential receivers in the assessment areas are predicted to have noise levels above NCG goals in the controlling night-time 2031 Build scenario. This is a decrease from 16 receivers in the No Build case. Four other sensitive receivers are predicted to have noise levels above NCG goals in the daytime 2031 Build scenario
- Within this assessment area, the project is predicted to result in a less than 2.0 dB increase in noise levels at all receivers. The maximum predicted change in this assessment area is +0.7 dB (during the controlling 2031 night-time scenario).

18.2 Summary of receivers for consideration of additional noise mitigation

Table 87 shows the number of receivers which have been identified for consideration of additional noise mitigation.

Table 87 Russell Street interchange - number of receivers considered for additional noise mitigation (as per NMG)

Assessment Area	Receiver Type	2021 Baseline Build			2031 Baseline Build		
		Day	Night	Combined	Day	Night	Combined
Russell.EB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

The information presented in **Table 87** indicates that no receivers in either the 2021 or 2031 scenarios are considered eligible for treatment.

The locations of the receivers eligible for consideration of additional noise mitigation are shown graphically in **Appendix N1**.

18.3 Selection of noise barriers for optimisation

There are not more than three closely grouped receivers requiring noise mitigation. Therefore, there is no requirement for noise barriers in this interchange area.

18.4 Operational noise impacts with recommended noise barriers

Predicted noise level maps showing individual noise levels at all residential receiver buildings for the Final Build scenarios are provided in **Appendix N3**. The full NCG assessment table for receivers predicted above the baseline NCG criteria (any scenario) at this interchange is provided in **Appendix N4**.

As no change has been recommended to the existing noise barriers in this area, the predicted number of ‘acute’ receivers and receivers with noise levels over the NCG controlling criteria are consistent with those shown in **Table 85**and **Table 86** respectively.

18.5 Summary of receivers eligible for property treatment

With reference to the criteria for additional mitigation (refer to **Section 4.5**), the number of receivers which have been identified as eligible for consideration of property treatments in the Final Build scenario are shown in **Table 88**.

Table 88 Russell Street interchange - receivers eligible for consideration of property treatment (as per NMG)

Assessment Area	Receiver Type	2021 Final Build			2031 Final Build		
		Day	Night	Combined	Day	Night	Combined
Russell.EB.ON	Residential	0	0	0	0	0	0
	Other	0	0	0	0	0	0

Table 89 provides a detailed list of the sensitive receivers that are eligible for additional property treatments as part of the project. The locations of the receivers eligible for consideration of property treatment are shown in the maps in **Appendix N5**.

Table 89 Russell Street interchange - summary of impacts at receivers qualifying for consideration of property treatment

Count	Receiver Details							Period[1]	NCG Criteria		Final Design Noise Level at Most Affected Facade (dBA)[2]			
	Address (approximate within 50 metres)				Centroid Co-ordinate		Type				2021		2031	
	Floor	Street No.	Street	Suburb	Easting	Northing			Day	Night	Day	Night	Day	Night
nil	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: Refers to the applicable assessment period for that receiver type.

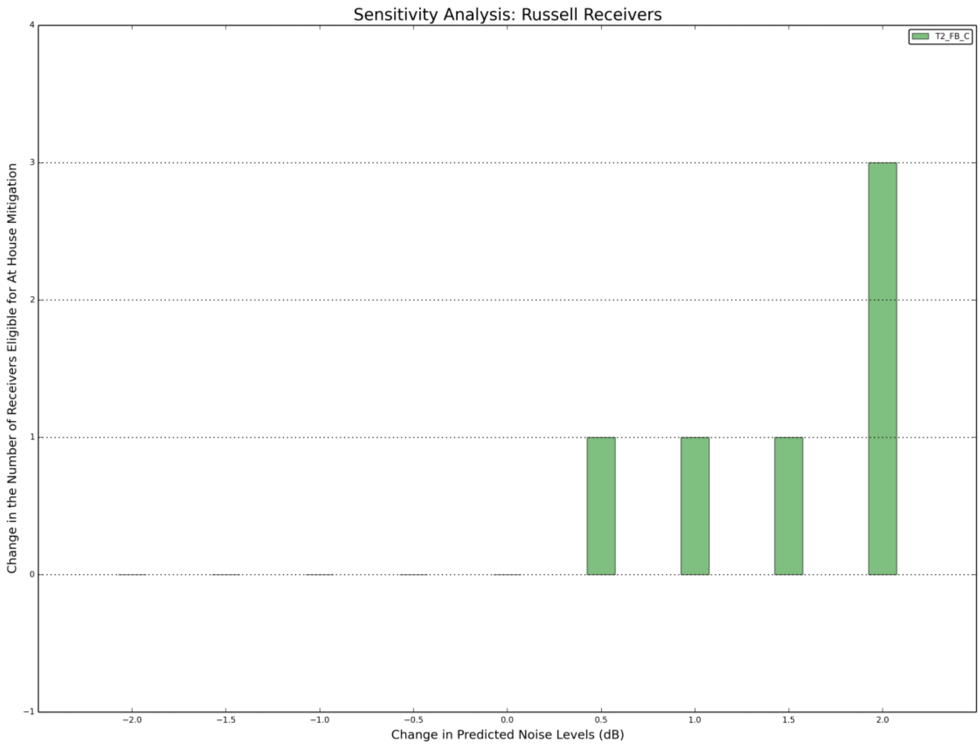
18.6 Discussion of required treatments

No receivers are predicted to be eligible for consideration of property treatment as part of the project.

18.7 Sensitivity analysis

The sensitivity of the total number of property treatments to the modelling predictions is shown in **Figure 30**

Figure 30 Russell Street interchange – prediction sensitivity analysis



Reference to the above indicates that an additional one receiver would be eligible for consideration of property treatment if a +1 dB correction were to be added to the noise model predictions. A reduction of zero receivers would be apparent if 1 dB was to be subtracted from the noise model predictions.

18.8 Maximum noise level assessment

The representative results of the maximum noise level assessments are provided in **Appendix N6** and include the maximum noise level range for the passby events. A summary of the maximum noise level assessments at this interchange is presented in **Table 90**.

Table 90 Russell Street Interchange – measured maximum noise level events

Monitoring Location	Monitoring Dates	Total Night-time Events within the Monitoring Period	Measured Maximum Noise Level (dBA)	
			Range	Average
A13.1	14/03/13-27/03/13	302	65-87	68
A13.2	14/03/13-27/03/13	41	65-73	67
A13.3	14/03/13-27/03/13	134	65-81	70

From the results presented within **Table 90**, it can be seen that average maximum noise level events typically range from 65 dBA to 87 dBA at the monitoring locations in this locality.

Review of the proposed works at this interchange area indicates that an increase in maximum noise level of potential events may be apparent at the following locations:

- One receiver on Tattersall Place, immediately adjacent the east-bound on-ramp lane extension. Maximum noise level of potential events may increase at one receiver due to changes in the noise propagation path resulting from the extended ramp alignment.

The number of maximum noise events at adjacent receivers would be generally expected to vary in line with the changes in traffic volumes. With reference to the traffic forecasts for the No Build and Build scenarios (refer to **Appendix D**), receivers adjacent to the following roads may be subject to increases in overall night-time heavy vehicle volumes:

- East-bound on-ramp traffic volumes are predicted to increase an additional 11 vehicles for year 2021, and 16 vehicles for year 2031 (+11% and +15% respectively)
- East-bound off-ramp traffic volumes are predicted to increase an additional 9 vehicles for year 2021, and 9 vehicles for year 2031 (+13% and +14% respectively)

19 DISCUSSION OF TRAFFIC CONGESTION IMPACT

19.1 Overview

The assessment has conservatively assumed that no congestion in the Build case would be apparent (refer to **Section 5.7**). The effect of congestion is generally to reduce noise levels due to slower vehicle speeds and a degree of acoustic shielding provided by closely spaced vehicles on the carriageways. By including the congestion factors in the No-Build scenarios only, the effect is therefore to generate an increase in road traffic noise between the No Build to the Build scenarios.

While the project is anticipated to reduce congestion, it may not be possible to eliminate congestion along all sections of the carriageway. This section presents a summary of the anticipated differences in noise impacts should congestion not be reduced as part of this project in order to inform the later design stages.

19.2 Comparison non-congested build vs congested all

The following comparison identifies the relative difference between two congestion scenarios when considering houses that are identified as being eligible for treatment. The two scenarios are described in **Table 91**.

Table 91 Congestion scenario descriptions

Item	Congestion Scenario	Traffic Assessed	Congestion Correction Applied
A	Non-Congested Build (the assessment scenario)	2021 No-Build 2031 No-Build	YES
		2021 Build 2031 Build	NO
B	Congested All	2021 No-Build 2031 No-Build	YES
		2021 Build 2031 Build	YES

As per **Section 5.7** the congestion corrections are greatest towards the Eastern end of the project. The largest correction is evident between Burnett and Cumberland interchanges with the next largest corrections evident between Cumberland and the M7 interchange. This indicates that the greatest changes between the congestion scenarios should be visible towards the East end of the project area where the corrections are the largest.

Table 92 below summarises the overall difference in the number of receivers eligible for consideration of at house mitigation between the two congestions scenarios (A and B) during the 2021 (at opening) and 2031 (opening + 10 yr) time periods.

Table 92 Summary of difference in the number of receivers eligible for consideration of at house mitigation between the congestion models.

Interchange Area	Receiver Type	Difference in the number of receivers eligible for consideration of At-Property Mitigation 2021 A minus B	 2031 A minus B
Burnett.EB.ON	Residential	16	17
Coleman.EB.ON	Residential	48	49
Cumberland.EB.OFF	Residential	6	4
Cumberland.EB.ON	Residential	22	12
Cumberland.WB.OFF	Residential	20	16
Cumberland.WB.ON	Residential	16	19
Prospect.EB.ON	Residential	0	3
Prospect.WB.ON	Residential	0	0
Reservoir.EB.ON	Residential	0	0
Reservoir.WB.ON	Residential	1	1
Roper.EB.ON	Residential	1	0
Roper2M7.WIDENING	Residential	1	2
Mamre.EB.OFF	Residential	0	0
Mamre.EB.ON	Residential	5	3
Mamre.WB.ON	Residential	0	0
Northern.EB.OFF	Residential	0	0
Northern.EB.ON	Residential	0	0
Northern.WB.OFF	Residential	0	0
Northern.WB.ON	Residential	1	0
Mulgoa.EB.ON	Residential	0	0
Mulgoa.WB.OFF	Residential	0	0
Mulgoa.WB.ON	Residential	0	0
Russell.EB.ON	Residential	0	0
Total	**Residential**	**137**	**126**

The results align with the anticipated outcomes: the majority of the differences are localised to the areas of the project with the largest congestion factors ie the interchange areas to the east of the project between Burnett and the M7 interchanges. West of the M7 interchange the congestion factors were negligible so the differences between the models is very small or nil.

Overall the non-congested Build scenario (A) has a greater impact than the Congested All scenario (B). The overall worst case difference is illustrated in the 2021 timeframe where a total 137 additional receivers are considered eligible for treatment in scenario A compared to scenario B.

The noise modelling undertaken for this assessment used the non-congested Build scenario and represents a conservative assessment as it represents the worst case in terms of noise generated by the project.

19.3 Recommendations for further analysis at detailed design

Where congestion remains apparent when the project is operational, levels would be expected to be lower than for non-congested flow and predicted increases (especially east of Cumberland) would be reduced. Consequently, should detailed design considerations indicate that congestion may remain with the project, the assessment should be revisited incorporating corresponding congestion factors in the Build scenarios.

It is noted that The Roads and Maritime noise policy was subject to review in late 2014, during the period that the noise assessment was being undertaken. The cumulative limit when applied to non-residential receivers requires consideration of internal noise criteria. This internal noise criteria needs to be converted to an external noise criteria for the purposes of assessment with external noise level predictions. The RNP recommends a 10 dB factor to convert internal to external noise levels on the basis that facades with windows open typically provide approximately 10 dB attenuation from inside to outside. For non-residential receivers this assumption may be overly conservative as the facade area to window ratios are often larger when compared to residential receivers. For the purposes of this assessment non-residential receivers have been assessed against the Acute definition (part of the cumulative limit definition) in the NMG (refer to **Section 4.3**).

During detailed design the cumulative limit with respect to internal noise levels should be investigated considering less conservative internal to external conversion factors. This investigation may identify a small additional number of non-residential receivers that may be eligible for consideration of treatment. As a result and with consideration of any further design refinements, the noise assessment will be updated accordingly.

The noise assessment considered the proposed physical works and adopted noise catchments as specified by RMS where a change in noise level as a result of the proposal was considered likely. In general, these catchments are immediately adjacent to the works areas. Following development of the opening year and future year noise models both with and without the project (ie Build and No Build), potential additional impacts have been identified outside of the adopted noise catchments. These changes in noise impacts are partly related to the improved operating performance of the motorway, namely, under a smart motorway the average operating speeds may increase in some areas with the potential to increase noise levels. Receivers adjacent to such areas have been identified by RMS as needing to be considered for treatment in accordance with the noise mitigation guide (NMG) during the detailed design.

Areas identified for further investigation include the following:

- NCA01 on the southern side of the motorway adjacent the Burnett Street interchange
- NCA01/03 on the southern side of the motorway adjacent the Coleman Street interchange
- NCA20 at receivers adjacent to the EB on-ramp from Roper Road

No treatment options have currently been explored for these areas; however, they will be investigated as part of the detailed design.

20 ASSESSMENT OF CONSTRUCTION NOISE – ON SITE WORKS

20.1 Overview

People are usually more tolerant to noise and vibration during the construction phase of proposals than during normal operation. This response results from recognition that the construction emissions are of a temporary nature – especially if the most noise-intensive construction impacts occur during the less sensitive daytime period. For these reasons, acceptable noise and vibration levels are normally higher during construction than during operations.

Construction often requires the use of heavy machinery which can generate high noise and vibration levels at nearby buildings and receivers. For some equipment, there is limited opportunity to mitigate the noise and vibration levels in a cost-effective manner and hence the potential impacts should be minimised by using feasible and reasonable management techniques.

At any particular location, the potential impacts can vary greatly depending on factors such as the relative proximity of sensitive receivers, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken and the character of the noise or vibration emissions.

The following section details the assessment of potential airborne noise impacts associated with the construction of the proposal. Construction noise goals have been determined based on the relevant government guidelines and industry standards. Potential noise levels have been predicted at sensitive receivers for expected activities and where levels are above the goals, feasible and reasonable impact mitigation measures are considered.

20.2 Proposed Construction Activities

20.2.1 Proposed Works

This report provides an assessment of the potential noise and vibration impacts associated with the activities likely to be required to construct the proposal. These activities involve conventional road construction equipment such as rock breakers, concreting equipment, earth moving equipment, paving plant and cranes. Further information on the specific items of plant considered in the assessment is presented in **Section 20.5**.

The location of all site compound proposed as part of the project are shown in the maps in **Appendix P**.

20.2.2 Construction Hours

Where possible, works would be completed during the standard day time construction hours of Monday to Friday 7.00 am to 6.00 pm and Saturdays 8.00 am to 1.00 pm. However, the nature of the project means evening and night work would also be required, particularly where safety considerations require lane closures to undertake the work.

Out of Hours Works (OOHWs) are included in the assessment for all proposed works at all locations in order to inform the scheduling of construction activity and management of noise during the detailed design phase. It is anticipated that the finalised requirements for OOHWs would be determined at a later design stage. It is understood that any OOHW would be subject to a separate approval on a case-by-case basis and would likely require approval under the project's Environmental Protection Licence (EPL).

20.3 Construction Noise Metrics

The three primary noise metrics used to describe construction noise emissions in the modelling and assessments are:

$L_{A1(1minute)}$ The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the L_{Amax} or maximum noise level

$L_{Aeq(15minute)}$ The 'energy average noise level' evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.

L_{A90} The 'background noise level' in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15minute)}$ construction noise management levels are based on the L_{A90} background noise levels.

The subscript 'A' indicates that the noise levels are filtered to match normal hearing characteristics (A-weighted).

20.4 Noise Management Levels for Construction Activity

The ICNG requires proposal specific Noise Management Levels (NMLs) to be established for noise affected receivers. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

Having investigated all feasible and reasonable work practices, if construction noise levels are still predicted to exceed the NMLs then the potential noise impacts would be managed via site specific construction noise management plans, to be prepared in the detailed design phase.

20.4.1 Residential Receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at residential receivers along the alignment applying the measured $L_{A90(15minute)}$ background noise levels, as described in **Table 93**.

Table 93 Determination of NMLs for Residential Receivers

Time of Day	NML LAeq(15minute)	How to Apply
Standard hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. • 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. • 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 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. 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: • 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. • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	RBL + 5 dBA	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practise have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1 Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy.

Adopting the measured background noise levels in **Table 6** the NMLs derived for the proposal are detailed in **Table 94**.

Table 94 Residential Receiver NMLs for Construction

NCA-receiver type	Logger ID	Receiver Type	Standard Const (RBL +10dBA)	Out of Hours (RBL +5dBA)			Sleep Disturbance Screening (RBL+15)
			Daytime Period	Daytime Period	Evening Period	Night-time Period	
Burnett Street Interchange							
NCA01.RES	A4.2	Residential	67	62	62	56	66
NCA02.RES	A4.1	Residential	63	58	58	53	63
Coleman Street Interchange							
NCA03.RES	A5.1	Residential	64	59	59	51	61
NCA04.RES	A5.2	Residential	66	61	60	52	62

NCA-receiver type	Logger ID	Receiver Type	Standard Const (RBL +10dBA)	Out of Hours (RBL +5dBA)			Sleep Disturbance Screening (RBL+15)
			Daytime Period	Daytime Period	Evening Period	Night-time Period	
Cumberland Highway Interchange							
NCA05.RES	A6.2	Residential	64	59	57	51	61
NCA06.RES	A6.1	Residential	63	58	56	51	61
Prospect Highway Interchange							
NCA07.RES	A7.2	Residential	62	57	56	51	61
NCA08.RES	A7.1	Residential	64	59	57	51	61
Reservoir Road Interchange							
NCA09.RES	A8.1	Residential	62	57	57	53	63
NCA10.RES	A8.2	Residential	66	61	58	52	62
Roper to M7 Interchanges							
NCA11.RES	A9.2	Residential	60	55	54	53	63
NCA12.RES	A9.2	Residential	60	55	54	53	63
NCA14.RES	A9.3	Residential	61	56	61	54	64
NCA16.RES	A9.4	Residential	62	57	60	58	68
NCA19.RES	A9.6	Residential	64	59	59	49	59
NCA20.RES	A9.5	Residential	62	57	59	52	62
Mamre Road Interchange							
NCA21.RES	A10.2	Residential	59	54	51	44	54
NCA22.RES	A10.1	Residential	65	60	56	48	58
NCA23.RES	A10.2	Residential	59	54	51	44	54
NCA24.RES	A10.2	Residential	59	54	51	44	54
Northern Road Interchange							
NCA25.RES	A11.1	Residential	68	63	59	48	58
NCA26.RES	A11.4	Residential	66	61	55	47	57
NCA27.RES	A11.3	Residential	61	56	53	44	54
NCA28.RES	A11.2	Residential	55	50	49	41	51
Mulgoa Road Interchange							
NCA29.RES	A11.3	Residential	61	56	53	44	54
NCA30.RES	A12.1	Residential	60	55	51	41	51
NCA31.RES	A12.2	Residential	60	55	51	41	51
Russel Street Interchange							
NCA33.RES	A13.1	Residential	61	56	52	39	49
NCA34.RES	A13.3	Residential	58	53	53	49	59

Where construction would be undertaken during the night-time period the potential for sleep disturbance should be assessed. The current approach to identifying potential sleep disturbance impacts is to set a screening criterion 15 dB above the RBL during the night-time period (10.00 pm to 7.00 am).

The term ‘screening criterion’ indicates a noise level that is intended as a guide to identify the likelihood of sleep disturbance. It is not a firm criteria to be met, however where the criterion is met sleep disturbance is not likely. When the screening criterion is not met, a more detailed analysis is required.

The detailed analysis should assess the maximum noise level or $L_{A1(1minute)}$, the extent that the maximum noise level exceeds the background noise level and the number of times any exceedance occurs during the night-time period.

The RNP contains a section on sleep disturbance that includes a summary of current literature; concluding that:

- Maximum internal noise levels below 50 dB to 55 dB are unlikely to cause awakening reactions
- One or two events per night, with maximum internal noise levels of 65 dB to 70 dB, are not likely to affect health and wellbeing significantly.

20.4.2 Other Sensitive Land Uses

The proposal specific $L_{Aeq(15minute)}$ NMLs for other non-residential noise sensitive receivers from the ICNG are provided in **Table 95**.

Table 95 Noise Management Levels for Other Sensitive Receivers

Land Use	NML $L_{Aeq(15minute)}$ (Applied when the property is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dB
Hospital wards and operating theatres	Internal noise level 45 dB
Places of Worship	Internal noise level 45 dB
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. reading, meditation)	External noise level 60 dB
Community centres	Depends on the intended use of the centre. Refer to the recommended ‘maximum’ internal levels in AS 2107 for specific uses.

For sensitive receivers such as schools and places of worship, the NMLs presented in **Table 95** are based on internal noise levels. For the purpose of this assessment, it is conservatively assumed that all schools and places of worship have open-able windows. On the basis that external noise levels are typically 10 dB higher than internal noise levels when windows are open, an external $L_{Aeq(15minute)}$ NML of 55 dB has been adopted.

Other noise-sensitive businesses require separate proposal specific noise goals and it is suggested in the ICNG that the internal construction noise levels at these premises are to be referenced to the ‘maximum’ internal levels presented in AS 2107 Acoustics – *Recommended design sound levels and reverberation times for building interiors*. The ICNG and AS2107 do not provide specific guideline noise levels for childcare centres. Childcare centres generally have internal play areas and sleep areas. For internal play areas an internal NML of $L_{Aeq(15minute)}$ 55 dB has been adopted and for sleeping areas, an internal NML of $L_{Aeq(15minute)}$ 40 dB (when in use) has been adopted.

On the assumption that windows and doors of childcare centres may be opened, an external NML of $L_{Aeq(15minute)}$ 65 dB for play areas has been applied at the facade and would also be applicable to external play areas. For sleeping areas on the assumption that windows are open, the external NML is $L_{Aeq(15minute)}$ 50 dB.

20.4.3 Commercial and Industrial Premises

For commercial premises, including offices, retail outlets and small commercial premises an external NML of $L_{Aeq(15minute)}$ 70 dB has been adopted. An external NML of $L_{Aeq(15minute)}$ 75 dB has been adopted for industrial premises. In both land uses, the external noise levels should be assessed at the most affected occupied point on the premises.

20.4.4 Construction Traffic Noise

When trucks and other vehicles are operating within the boundaries of the various construction sites, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements would be regarded as ‘additional road traffic’ rather than as part of the construction site. Construction traffic noise impacts on public roads are assessed in **Section 21**.

20.5 Overview of Construction Noise Modelling

To quantify noise levels from the construction activities a noise prediction model using the CONCAWE algorithms was developed using SoundPLAN Version 7.1 noise propagation software. The concept designs of the proposal, local terrain, receiver buildings and structures have been digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding environment.

Maximum sound power levels for the typical operation of construction equipment applied in the modelling are listed in **Table 96**. To assess construction noise levels against the NMLs, the maximum noise levels have been converted to equivalent $L_{Aeq(15minute)}$ noise emissions. Based on SLR’s experience on large construction proposals suitable adjustments of between 2 dB to 5 dB have been applied to convert the L_{Amax} noise levels in to L_{Aeq} noise levels for assessment with the NMLs.

Table 96 Sound Power Levels for Construction Equipment

Scenario Name	Activity (ie Equipment Split)	Equipment (realistic worst-case)	Operating minutes in 15-min period	No of items in same location	Sound Power Level (dBA)		
					Maximum L_{Aeq}		L_{Amax}
					Item	Activity	Activity
Main Corridor / Ramp Works	Site Clearing and Bulk Earthworks	Chainsaw	5.0	1	108	114	124
		Bobcat	15.0	1	104		
		Jackhammer*	5.0	1	108		
		Excavator (Breaker)*	3.0	1	116		
		Grader	15.0	1	108		
		Truck (10 tonne)	15.0	1	98		
		Concrete Saw*	10.0	1	103		
		Excavator (20 tonne)	15.0	1	99		
		Hydromulching Equipment	15.0	1	97		

Scenario Name	Activity (ie Equipment Split)	Equipment (realistic worst-case)	Operating minutes in 15-min period	No of items in same location	Sound Power Level (dBA)		
					Maximum LAeq		LAmax
					Item	Activity	Activity
Main Corridor / Ramp Works	Excavation and Installation of Drainage	Excavator (15 tonne)	15.0	1	96	105	114
		Tipper Truck	15.0	1	97		
		Plate compactor	5.0	1	108		
Main Corridor / Ramp Works	Pavement Works Including Laying Concrete and Asphaltic Surfaces	Excavator (Breaker)*	3.0	1	116	117	124
		Truck (10 tonne)	15.0	1	98		
		Excavator (20 tonne)	15.0	1	99		
		Concrete Saw*	10.0	1	103		
		Concrete Truck / Agitator	7.5	1	106		
		Concrete Pump	7.5	1	106		
		Smooth Drum Roller*	15.0	1	109		
		Vibratory Roller (~10 - 12 tonne)*	15.0	1	109		
		Asphalt Milling Machine*	15.0	1	111		
		Paving Machine	15.0	1	104		
Main Corridor / Ramp Works	Slope Stability and Retaining Wall Works	Dozer	15.0	1	110	112	118
		Back Hoe (7.5 tonne JCB)	15.0	1	102		
		Grout Mixer & Pump	15.0	1	97		
		Excavator (Diamond Rock Saw)*	7.5	1	106		
		Elevated Working Platform	15.0	1	97		
Main Corridor / Ramp Works	Installation of Street Lighting, ITS Infrastructure, and Linemarking	Grinder 4"*	7.5	1	98	107	111
		Hand Tools	15.0	1	94		
		Mobile Crane (50 tonne)	15.0	1	100		
		Concrete Saw*	10.0	1	103		
		Generator	15.0	1	101		
		Line Marking Plant	15.0	1	98		
		Elevated Working Platform	15.0	1	97		
Main Corridor / Ramp Works	Landscaping	Truck (10 tonne)	15.0	1	98	105	110
		Bobcat	15.0	1	104		
		Hand Tools	15.0	1	94		
Site Compounds	Preparation and Establishment of Site Compounds	Truck (HIAB)	15.0	1	98	105	108
		Franna Crane	15.0	1	99		
		Generator	15.0	1	101		
		Hand Tools	15.0	1	94		
Site Compounds	Material Processing	Mobile Jaw Crusher (50 tonne)*	15.0	1	120	120	128

Scenario Name	Activity (ie Equipment Split)	Equipment (realistic worst-case)	Operating minutes in 15-min period	No of items in same location	Sound Power Level (dBA)		
					Maximum LAeq		LAmax
					Item	Activity	Activity
Site Compounds	Typical operation of site compound	Excavator (20 tonne)	15.0	1	99	106	111
		Front End Loader (L120)	15.0	1	104		
		Truck (12-15 tonne)	5.0	1	103		
Noise Wall Removal	Noise Wall Removal	Excavator (20 tonne)	15.0	1	99	106	113
		Jackhammer*	5.0	1	108		
		Mobile Crane (25 tonne)	15.0	1	99		
Noise Wall Removal	Re-install Noise Walls	Piling Rig (Vibratory)*	7.5	1	116	114	121
		Excavator (20 tonne)	15.0	1	99		
		Truck (HIAB)	15.0	1	98		
		Mobile Crane (25 tonne)	15.0	1	99		
		Bogies	15.0	1	97		
New Bridge/Bridge Modifications	New Bridge/Bridge Modifications	Excavator (Breaker)*	3.0	1	116	113	124
		Piling Rig (Bored)*	7.5	1	108		
		Excavator (20 tonne)	15.0	1	99		
		Tower Crane	15.0	1	100		
		Concrete Truck / Agitator	7.5	1	106		
		Concrete Pump	7.5	1	106		
		Compressor	15.0	1	95		
		Smooth Drum Roller*	7.5	1	109		

Note 1: In accordance with the EPA ICNG for activities identified as particularly annoying (such as jackhammering, rock breaking and power saw operation), a 5 dB ‘penalty’ is added to the source sound power level when predicting noise using the quantitative method.

Consistent with the requirements of the ICNG, and to inform the scheduling of construction activity and management of noise during the detailed design phase, the construction noise impacts are based on a worst-case assessment. The ICNG recommends that the realistic worst-case or conservative noise levels from the source should be predicted for assessment locations representing the most noise-exposed residences or other sensitive land uses. For each receiver area the noise levels are predicted at the most noise-exposed location, which would usually be the closest receiver.

For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted at the most-exposed receiver as the noise levels presented in this report are based on a realistic worst-case assessment.

Furthermore, other receivers within each receiver area would generally experience lower noise levels compared to the most noise-exposed location as construction work is undertaken at greater separation distance from receivers. To provide an indication of the likely reduction in construction noise levels, the following can be assumed:

- A doubling of the distance between the source and receiver would provide an approximate 6 dB reduction in noise level. For example the sound pressure levels from most items of plant would decrease by around 6 dB as the distance increases from 15 metres to 30 metres.
- Buildings and other solid structures located between the construction noise source and sensitive receivers would act as barriers and would typically reduce noise levels by up to 15 dB. For example, in a residential area adjoining a construction site the first row of houses would provide an effective shield to the second and subsequent rows with resulting noise levels up to 10 dB lower than would otherwise be experienced in the absence of the first row.

20.6 Noise Assessment at the Nearest Noise Sensitive Receivers

20.6.1 Predicted Construction Noise Levels

In each of the interchange areas, the noise impacts have been quantitatively assessed for several construction activity groups and scenarios. The scenarios considered are described in **Table 96**.

The noise sensitive receivers in each area are identified in **Section 3.2**.

The typical $L_{Aeq(15minute)}$ noise levels at the nearest noise sensitive receivers (at the worst-affected floor level) are provided in **Appendix O** for each of the construction activity groups and are representative of the 'noisiest' construction periods allowing for the simultaneous operation of noise intensive construction plant in proximity to adjacent receivers. In **Appendix O**, the quantitative assessment results are presented as a range with the lower end of the range corresponding to the least noise-intensive scenario in each activity group and the upper end of the range corresponding to the most noise-intensive scenario.

The results of the quantitative noise impact assessment for construction of the proposal are summarised across all activity groups and scenarios in **Table 97**, **Table 98**, **Table 99** and **Table 100** for the proposed Main Corridor, Compounds, Noise Wall Removal and Bridge Modifications works respectively. The range of predicted NML exceedances represents the range of exceedances for different construction scenarios, with some scenarios being considerably more noise intensive than others. For assessment purposes, it has been assumed that all construction activities and scenarios may occur during any time period – daytime, evening or night-time.

Table 97 Summary of Airborne Construction NML Exceedances - Main Corridor / Ramp Works

NCA	RBL			NML				Noise Level – $L_{Aeq(15minute)}$ (dBA) (least noise intensive scenario – most noise intensive scenario)				
								Worst-case Predicted at Nearby Receivers	NML Exceedance			
	Day	Eve	Night	Day	Day OOH	Eve	Night		Day	Day OOH	Eve	Night
Burnett Street Interchange												
NCA01.RES	57	57	51	67	62	62	56	58-69	up to 2	up to 7	up to 7	2 - 13
NCA02.RES	53	53	48	63	58	58	53	70-82	7 - 19	12 - 24	12 - 24	17 - 29
Coleman Street Interchange												
NCA03.RES	54	54	46	64	59	59	51	55-67	up to 3	up to 8	up to 8	4 - 16
NCA04.RES	56	55	47	66	61	60	52	69-81	3 - 15	8 - 20	9 - 21	17 - 29
Cumberland Highway Interchange												
NCA05.RES	52	50	44	62	57	55	49	65-77	3 - 15	8 - 20	10 - 22	16 - 28
NCA06.RES	53	51	46	63	58	56	51	67-79	4 - 16	9 - 21	11 - 23	16 - 28
Prospect Highway Interchange												
NCA07.RES	52	51	46	62	57	56	51	52-64	up to 2	up to 7	up to 8	1 - 13
NCA08.RES	52	50	44	62	57	55	49	51-63	up to 1	up to 6	up to 8	2 - 14

NCA	RBL			NML				Noise Level – LAeq(15minute) (dBA) (least noise intensive scenario – most noise intensive scenario)				
								Worst-case Predicted at Nearby Receivers	NML Exceedance			
	Day	Eve	Night	Day	Day OOH	Eve	Night		Day	Day OOH	Eve	Night
Reservoir Road Interchange												
NCA09.RES	52	52	48	62	57	57	53	48-59	-	up to 2	up to 2	up to 6
NCA10.RES	54	51	45	64	59	56	50	42-53	-	-	-	up to 3
Roper to M7 Interchanges												
NCA11.RES	50	49	48	60	55	54	53	37-48	-	-	-	-
NCA12.RES	50	49	48	60	55	54	53	37-49	-	-	-	-
NCA14.RES	49	54	47	59	54	59	52	56-68	up to 9	2 - 14	up to 9	4 - 16
NCA16.RES	52	55	53	62	57	60	58	52-64	up to 2	up to 7	up to 4	up to 6
NCA19.RES	52	52	42	62	57	57	47	53-65	up to 3	up to 8	up to 8	6 - 18
NCA20.RES	50	52	45	60	55	57	50	59-70	up to 10	4 - 15	2 - 13	9 - 20
Mamre Road Interchange												
NCA21.RES	47	44	37	57	52	49	42	56-68	up to 11	4 - 16	7 - 19	14 - 26
NCA22.RES	55	51	43	65	60	56	48	58-70	up to 5	up to 10	2 - 14	10 - 22
NCA23.RES	47	44	37	57	52	49	42	40-52	-	-	up to 3	up to 10
NCA24.RES	47	44	37	57	52	49	42	40-52	-	-	up to 3	up to 10
Northern Road Interchange												
NCA25.RES	58	54	43	68	63	59	48	58-70	up to 2	up to 7	up to 11	10 - 22
NCA26.RES	56	50	42	66	61	55	47	49-61	-	-	up to 6	2 - 14
NCA27.RES	51	48	39	61	56	53	44	67-78	6 - 17	11 - 22	14 - 25	23 - 34
NCA28.RES	45	44	36	55	50	49	41	61-73	6 - 18	11 - 23	12 - 24	20 - 32
Mulgoa Road Interchange												
NCA29.RES	51	48	39	61	56	53	44	50-62	up to 1	up to 6	up to 9	6 - 18
NCA30.RES	48	44	34	58	53	49	39	65-77	7 - 19	12 - 24	16 - 28	26 - 38
NCA31.RES	50	46	36	60	55	51	41	58-69	up to 9	3 - 14	7 - 18	17 - 28
Russel Street Interchange												
NCA33.RES	49	45	32	59	54	50	37	53-65	up to 6	up to 11	3 - 15	16 - 28
NCA34.RES	48	48	44	58	53	53	49	61-73	3 - 15	8 - 20	8 - 20	12 - 24

Table 98 Summary of Airborne Construction NML Exceedances - Site Compounds

NCA	RBL			NML				Noise Level – LAeq(15minute) (dBA) (least noise intensive scenario – most noise intensive scenario)				
								Worst-case Predicted at Nearby Receivers	NML Exceedance			
	Day	Eve	Night	Day	Day OOH	Eve	Night		Day	Day OOH	Eve	Night
Burnett Street Interchange												
NCA01.RES	57	57	51	67	62	62	56	43-58	-	-	-	up to 2
NCA02.RES	53	53	48	63	58	58	53	75-91	12 - 28	17 - 33	17 - 33	22 - 38
Coleman Street Interchange												
NCA03.RES	54	54	46	64	59	59	51	50-65	up to 1	up to 6	up to 6	up to 14
NCA04.RES	56	55	47	66	61	60	52	70-85	4 - 19	9 - 24	10 - 25	18 - 33

NCA	RBL			NML				Noise Level – LAeq(15minute) (dBA) (least noise intensive scenario – most noise intensive scenario)				
								Worst-case Predicted at Nearby Receivers	NML Exceedance			
	Day	Eve	Night	Day	Day OOH	Eve	Night		Day	Day OOH	Eve	Night
Cumberland Highway Interchange												
NCA05.RES	52	50	44	62	57	55	49	81-97	19 - 35	24 - 40	26 - 42	32 - 48
NCA06.RES	53	51	46	63	58	56	51	87-102	24 - 39	29 - 44	31 - 46	36 - 51
Prospect Highway Interchange												
NCA07.RES	52	51	46	62	57	56	51	45-60	-	up to 3	up to 4	up to 9
NCA08.RES	52	50	44	62	57	55	49	39-54	-	-	-	up to 5
Reservoir Road Interchange												
NCA09.RES	52	52	48	62	57	57	53	37-53	-	-	-	-
NCA10.RES	54	51	45	64	59	56	50	41-56	-	-	-	up to 6
Roper to M7 Interchanges												
NCA11.RES	50	49	48	60	55	54	53	34-49	-	-	-	-
NCA12.RES	50	49	48	60	55	54	53	50-66	up to 6	up to 11	up to 12	up to 13
NCA14.RES	49	54	47	59	54	59	52	up to 45	-	-	-	-
NCA16.RES	52	55	53	62	57	60	58	up to 34	-	-	-	-
NCA19.RES	52	52	42	62	57	57	47	47-62	-	up to 5	up to 5	up to 15
NCA20.RES	50	52	45	60	55	57	50	68-83	8 - 23	13 - 28	11 - 26	18 - 33
Mamre Road Interchange												
NCA21.RES	47	44	37	57	52	49	42	39-54	-	up to 2	up to 5	up to 12
NCA22.RES	55	51	43	65	60	56	48	45-60	-	-	up to 4	up to 12
NCA23.RES	47	44	37	57	52	49	42	32-47	-	-	-	up to 5
NCA24.RES	47	44	37	57	52	49	42	53-68	up to 11	1 - 16	4 - 19	11 - 26
Northern Road Interchange												
NCA25.RES	58	54	43	68	63	59	48	47-63	-	-	up to 4	up to 15
NCA26.RES	56	50	42	66	61	55	47	46-61	-	-	up to 6	up to 14
NCA27.RES	51	48	39	61	56	53	44	72-88	11 - 27	16 - 32	19 - 35	28 - 44
NCA28.RES	45	44	36	55	50	49	41	47-62	up to 7	up to 12	up to 13	6 - 21
Mulgoa Road Interchange												
NCA29.RES	51	48	39	61	56	53	44	73-89	12 - 28	17 - 33	20 - 36	29 - 45
NCA30.RES	48	44	34	58	53	49	39	72-88	14 - 30	19 - 35	23 - 39	33 - 49
NCA31.RES	50	46	36	60	55	51	41	68-84	8 - 24	13 - 29	17 - 33	27 - 43
Russel Street Interchange												
NCA33.RES	49	45	32	59	54	50	37	72-87	13 - 28	18 - 33	22 - 37	35 - 50
NCA34.RES	48	48	44	58	53	53	49	92-107	34 - 49	39 - 54	39 - 54	43 - 58

Table 99 Summary of Airborne Construction NML Exceedances - Noise Wall Removal

NCA	RBL			NML				Noise Level – LAeq(15minute) (dBA) (least noise intensive scenario – most noise intensive scenario)				
								Worst-case Predicted at Nearby Receivers	NML Exceedance			
	Day	Eve	Night	Day	Day OOH	Eve	Night		Day	Day OOH	Eve	Night
Burnett Street Interchange												
NCA01.RES	57	57	51	67	62	62	56	59-67	-	up to 5	up to 5	3 - 11
NCA02.RES	53	53	48	63	58	58	53	74-82	11 - 19	16 - 24	16 - 24	21 - 29
Coleman Street Interchange												
NCA03.RES	54	54	46	64	59	59	51	54-62	-	up to 3	up to 3	3 - 11
NCA04.RES	56	55	47	66	61	60	52	65-72	up to 6	4 - 11	5 - 12	13 - 20
Cumberland Highway Interchange												
NCA05.RES	52	50	44	62	57	55	49	74-82	12 - 20	17 - 25	19 - 27	25 - 33
NCA06.RES	53	51	46	63	58	56	51	71-79	8 - 16	13 - 21	15 - 23	20 - 28
Prospect Highway Interchange												
NCA07.RES	52	51	46	62	57	56	51	<30	-	-	-	-
NCA08.RES	52	50	44	62	57	55	49	<30	-	-	-	-
Reservoir Road Interchange												
NCA09.RES	52	52	48	62	57	57	53	<30	-	-	-	-
NCA10.RES	54	51	45	64	59	56	50	<30	-	-	-	-
Roper to M7 Interchanges												
NCA11.RES	50	49	48	60	55	54	53	<30	-	-	-	-
NCA12.RES	50	49	48	60	55	54	53	<30	-	-	-	-
NCA14.RES	49	54	47	59	54	59	52	<30	-	-	-	-
NCA16.RES	52	55	53	62	57	60	58	<30	-	-	-	-
NCA19.RES	52	52	42	62	57	57	47	<30	-	-	-	-
NCA20.RES	50	52	45	60	55	57	50	<30	-	-	-	-
Mamre Road Interchange												
NCA21.RES	47	44	37	57	52	49	42	52-59	up to 2	up to 7	3 - 10	10 - 17
NCA22.RES	55	51	43	65	60	56	48	65-73	up to 8	5 - 13	9 - 17	17 - 25
NCA23.RES	47	44	37	57	52	49	42	<30	-	-	-	-
NCA24.RES	47	44	37	57	52	49	42	32-40	-	-	-	-
Northern Road Interchange												
NCA25.RES	58	54	43	68	63	59	48	<30	-	-	-	-
NCA26.RES	56	50	42	66	61	55	47	<30	-	-	-	-
NCA27.RES	51	48	39	61	56	53	44	<30	-	-	-	-
NCA28.RES	45	44	36	55	50	49	41	<30	-	-	-	-
Mulgoa Road Interchange												
NCA29.RES	51	48	39	61	56	53	44	49-57	-	up to 1	up to 4	5 - 13
NCA30.RES	48	44	34	58	53	49	39	65-73	7 - 15	12 - 20	16 - 24	26 - 34
NCA31.RES	50	46	36	60	55	51	41	57-65	up to 5	2 - 10	6 - 14	16 - 24
Russel Street Interchange												
NCA33.RES	49	45	32	59	54	50	37	52-60	up to 1	up to 6	2 - 10	15 - 23
NCA34.RES	48	48	44	58	53	53	49	64-72	6 - 14	11 - 19	11 - 19	15 - 23

Table 100 Summary of Airborne Construction NML Exceedances - Bridge Modifications

NCA	RBL			NML				Noise Level – LAeq(15minute) (dBA) (least noise intensive scenario – most noise intensive scenario)				
								Worst-case Predicted at Nearby Receivers	NML Exceedance			
	Day	Eve	Night	Day	Day OOH	Eve	Night		Day	Day OOH	Eve	Night
Burnett Street Interchange												
NCA01.RES	57	57	51	67	62	62	56	<30	-	-	-	-
NCA02.RES	53	53	48	63	58	58	53	<30	-	-	-	-
Coleman Street Interchange												
NCA03.RES	54	54	46	64	59	59	51	<30	-	-	-	-
NCA04.RES	56	55	47	66	61	60	52	<30	-	-	-	-
Cumberland Highway Interchange												
NCA05.RES	52	50	44	62	57	55	49	<30	-	-	-	-
NCA06.RES	53	51	46	63	58	56	51	<30	-	-	-	-
Prospect Highway Interchange												
NCA07.RES	52	51	46	62	57	56	51	<30	-	-	-	-
NCA08.RES	52	50	44	62	57	55	49	31-31	-	-	-	-
Reservoir Road Interchange												
NCA09.RES	52	52	48	62	57	57	53	43-43	-	-	-	-
NCA10.RES	54	51	45	64	59	56	50	41-41	-	-	-	-
Roper to M7 Interchanges												
NCA11.RES	50	49	48	60	55	54	53	<30	-	-	-	-
NCA12.RES	50	49	48	60	55	54	53	<30	-	-	-	-
NCA14.RES	49	54	47	59	54	59	52	<30	-	-	-	-
NCA16.RES	52	55	53	62	57	60	58	<30	-	-	-	-
NCA19.RES	52	52	42	62	57	57	47	<30	-	-	-	-
NCA20.RES	50	52	45	60	55	57	50	<30	-	-	-	-
Mamre Road Interchange												
NCA21.RES	47	44	37	57	52	49	42	<30	-	-	-	-
NCA22.RES	55	51	43	65	60	56	48	<30	-	-	-	-
NCA23.RES	47	44	37	57	52	49	42	<30	-	-	-	-
NCA24.RES	47	44	37	57	52	49	42	<30	-	-	-	-
Northern Road Interchange												
NCA25.RES	58	54	43	68	63	59	48	<30	-	-	-	-
NCA26.RES	56	50	42	66	61	55	47	<30	-	-	-	-
NCA27.RES	51	48	39	61	56	53	44	<30	-	-	-	-
NCA28.RES	45	44	36	55	50	49	41	<30	-	-	-	-
Mulgoa Road Interchange												
NCA29.RES	51	48	39	61	56	53	44	<30	-	-	-	-
NCA30.RES	48	44	34	58	53	49	39	<30	-	-	-	-
NCA31.RES	50	46	36	60	55	51	41	<30	-	-	-	-
Russel Street Interchange												
NCA33.RES	49	45	32	59	54	50	37	<30	-	-	-	-
NCA34.RES	48	48	44	58	53	53	49	<30	-	-	-	-

20.6.2 Discussion of Predicted Construction Noise Impacts - Main Corridor / Ramp Works

Activities associated with Main Corridor / Ramp Works are anticipated to be undertaken over the extent of works at each interchange. For works during standard daytime hours, minor worst-case NML exceedances of less than 10 dB are predicted at most residential receivers where a combination of existing noise walls and offset distance to the works help to mitigate impacts. Predicted worst-case noise impacts are higher in NCA02, NCA04, NCA05, where predicted NML exceedances are greater than 10 dB during standard daytime hours:

- NCA02 near Burnett Street interchange works
- NCA04 near Coleman Street interchange works
- NCA05 and NCA06 near Cumberland Highway interchange works
- NCA20 near Roper Road interchange works
- NCA21 near Mamre Road interchange works
- NCA27 and NCA28 near Northern Road interchange works
- NCA30 near Mulgoa Road interchange works
- NCA34 near Russell Street interchange works

In these locations, elevated receiver positions, close vicinity to the works and/or noise via demolished noise wall sections result in higher noise impacts. Noise mitigation measures, including construction of the design noise walls (for mitigating operational noise impacts) at an early stage in the construction are discussed in **Section 20.8**.

Out of hours works would be expected to result in higher noise impacts than works during standard daytime hours at all locations. Predicted construction noise levels at the most affected residential receivers in each NCA would typically be greater than 10 dB during out of hours works during noise intensive periods where works are located immediately adjacent to these receivers.

Other sensitive receivers are generally predicted to be subject to moderate NML exceedances of up to 15 dB (refer to **Appendix L**), with the exception of the following receivers which have higher predicted noise impacts:

- Place of Worship in NCA04 immediately adjacent to the Coleman Street interchange works (up to 30 dB exceedance of NML)
- Educational Facility in NCA26 near the Northern Road interchange works (up to 23 dB exceedance of NML)
- Childcare Centre in NCA31 near the Mulgoa Road interchange works.

20.6.3 Discussion of Predicted Construction Noise Impacts - Site Compounds

The information presented in **Table 98** indicates that noise impacts due to “Material Processing” results in the highest noise impacts in immediately adjacent receiver areas with typically NML exceedances of greater than 10 dB immediately adjacent to most compound locations. It is noted that material processing is unlikely to occur at every potential compound site and the requirements for this will be determined at a later design stage.

Typical construction compound activity (refer to **Table 96**) is predicted to have a lower impact than the material processing and would be representative of the more common level of impacts day to day while the compound is in use. Typically, these impacts are moderate of around 10 dB however, at some locations, immediately adjacent to the compounds, higher NML exceedances are predicted. Graphical display of the typical operation of the compounds is presented in **Appendix P**.

Impacts from each of these activities are expected to be intermittent but may last for up to the total duration of the construction phase. As the compound works are at fixed locations, it is likely that mitigation measures such as temporary noise walls, in combination with judicious selection of works areas within the site compound would assist in reducing impacts. These are discussed further in **Section 20.8**.

20.6.4 Discussion of Predicted Construction Noise Impacts – Noise Wall Removal

Due to the close vicinity of the noise wall removal works to the receivers, and by eliminating the screening benefit provided by the existing noise walls, high noise impacts are predicted during these works. These high noise impacts are limited to the receiver areas immediately adjacent to the works. Worst-case NML exceedances are typically predicted to be over 15 dB during these works.

20.6.5 Discussion of Predicted Construction Noise Impacts – Bridge Construction

The information presented in **Table 100** indicates that no significant noise impacts are predicted due to bridge construction works which are located in the area of Reservoir road westbound entry ramp.

20.6.6 Sleep Disturbance

Review of the predicted $L_{A1(1minute)}$ noise levels at the nearest noise sensitive receivers provided in **Appendix O** indicate that the sleep disturbance screening criterion is likely to be exceeded when night works are occurring adjacent to residential receivers for the majority of works scenarios. This level of noise is typical for construction works using noise intensive equipment in built up areas.

At this early stage in the approval process, the assessment has included predictions of maximum noise impacts for assessment of potential sleep disturbance; however, it is noted that the ICNG only requires the proposal to consider maximum noise levels where construction works are planned to extend over more than two consecutive nights.

It is anticipated that the finalised requirements for OOHWs would be determined at a later design stage.

20.7 Cumulative Noise Impacts

The prediction of cumulative noise levels from more than one construction scenario operating close to another scenario within the project area is a complex matter given the number of sources and possible locations of a particular combination of construction works.

In practice, it is not always possible to specify the precise location of more than one works for the same 15-minute period and the assessment becomes overly conservative to calculate the cumulative impacts based on all nearby works operating on a worst-case basis at the same time.

Since the works are anticipated to be of a similar nature, the effect of concurrent construction works is likely only to increase the number of 15-minute periods during construction where the predicted worst-case noise impacts are apparent. In practice, the noise levels will vary due to the fact that plant and equipment will move about the worksites and will not all be operating concurrently at the worst-case scenario used in the assessment (ie there are times where equipment is not operating).

In order to manage potential cumulative noise impacts, it is suggested that an exceedance category system be employed in steps of 5 dB as follows:

- NML Exceedance Category 1 : >0 to 5 dB exceedance of NML
- NML Exceedance Category 2 : >5 to 10 dB exceedance of NML
- NML Exceedance Category 3 : >10 to 15 dB exceedance of NML

- NML Exceedance Category 4 : >15 to 20 dB exceedance of NML
- NML Exceedance Category 5 : >20 to 25 dB exceedance of NML
- NML Exceedance Category 5 : >25 dB exceedance of NML

For the subject works and separation distances involved, the following approach can be used to estimate the likely effect of cumulative impacts and to identify scenarios where such impacts may be significant:

- Where the predicted exceedances of the NML at the same receiver for a number of proposed activities fall within different exceedance categories (eg one in 6-10 dB category and one in the 11-20 dB exceedance category) the works corresponding to the higher of the exceedance categories should be considered dominant (without further considering cumulative impacts).
- Where the predicted exceedances of the NML at the same receiver for a number of proposed activities fall within the same exceedance category, the cumulative impact would be likely to increase the predicted level by up to 3 dB for two activities and up to 6 dB for four activities.

20.8 Construction Noise Mitigation

The ICNG describes strategies for construction noise mitigation and control that are applicable to this proposal. The strategies are designed to minimise, to the fullest extent practicable, noise during construction.

20.8.1 Restriction of Construction Hours

Where reasonable and feasible, preference would be given to scheduling construction works within the standard construction hours of:

- Monday to Friday 7.00 am to 6.00 pm.
- Saturday 8.00 am to 1.00 pm.

The nature of the project means evening and night work would also be required. Construction works would be required outside of standard hours where:

- Temporary road closures and other measures are required by the Police and other regulatory authorities for the safe delivery of material/ equipment.
- Works have the potential to disrupt commuter services and road networks.
- Works are required to be completed to maintain health and safety, avoid loss of life or injury and to prevent environmental damage.

Working 24 hours would allow contractors to spread the workload from peak to non-peak periods where there are less traffic impacts. It would allow the works to be less constrained which would reduce the impacts to businesses and residents in that the overall duration of the works would be reduced.

Where works are proposed during the night-time period (10:00 pm to 7:00 am) site specific Construction Noise and Vibration Management Plans (CNVMPs) would be developed in the detailed design phase. The CNVMPs would provide a detailed assessment of potential noise levels and site specific measures to control potential noise impacts and minimise the potential for disturbance at affected receivers. It is understood that any OOHW would be subject to a separate approval on a case-by-case basis and would likely require approval under the project's EPL. A range of feasible and reasonable construction noise mitigation measures is provided in **Section 20.8.3**.

20.8.2 Restriction of Construction Noise Levels

The ICNG acknowledges that due to the nature of construction activities it is inevitable there would be some noise from construction sites. The NMLs identified in this report have been applied to prescribe measures for the control of potential construction noise impacts at sensitive receivers. Where exceedances of the NMLs have been predicted during the daytime (standard construction hours), receivers are considered to be noise affected.

The proponent should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and the contact details for the proposal.

Receivers are considered to be highly noise affected if noise levels from construction exceed 75 dBA L_{Aeq}. This relates to daytime works only. **Table 101** presents a worst-case summary of highly noise affected receivers.

Table 101 Summary of Highly Noise Affected Receivers

Scenario	NCA	Type	Number of worst-case highly noise affected residential receivers[1]
Main Corridor / Ramp Works	NCA02.RES	Residential	4
	NCA04.RES	Residential	2
	NCA05.RES	Residential	2
	NCA06.RES	Residential	4
	NCA27.RES	Residential	1
	NCA30.RES	Residential	2
Site Compounds	NCA02.RES	Residential	2
	NCA04.RES	Residential	1
	NCA05.RES	Residential	12
	NCA06.RES	Residential	13
	NCA20.RES	Residential	4
	NCA27.RES	Residential	1
	NCA29.RES	Residential	7
	NCA30.RES	Residential	11
	NCA31.RES	Residential	7
	NCA33.RES	Residential	3
	NCA34.RES	Residential	19
Noise Wall Removal	NCA02.RES	Residential	5
	NCA05.RES	Residential	8
	NCA06.RES	Residential	3

Note 1: Count is based on the total number of receiver buildings predicted to be subject to worst-case daytime construction noise levels above the highly noise affected level (75 dBA) at any time in the entire construction schedule. This is generally limited to periods when noise intensive activities are located immediately adjacent to residences. It is therefore expected that the number of noise affected receivers on a typical day to day basis would be considerably less than presented in this table.

The information presented in **Table 101** indicates that, due to the close vicinity of the works, worst case construction works may result in daytime noise levels above 75 dBA during noise intensive activities at immediately adjacent residences during the works.

Consequently, site-specific CNVMPs should be developed in the detailed design phase when more information is available on the schedule for the works and the equipment to be used. The proponent and construction contractor(s) should schedule work to provide respite periods from the noisiest activities, and communicate with the impacted residents by clearly explaining the duration and noise level of the works. A potential approach would be to schedule a respite period of one hour for every three hours of continuous construction activity, or scheduling high noise generating works to less sensitive times of 9:00 am to 12:00 pm or 2:00 pm to 5:00 pm.

Where OOHWs are required, these would be predicted to result in significant exceedances of the NMLs (refer to **Section 20.6.1**). The proponent should identify all feasible and reasonable work practices in the CNVMPs to reduce potential noise impacts. Where all feasible and reasonable practices have been applied and noise would be more than 5 dB above the noise affected level, the proponent should negotiate with the community to determine the schedule for the works or provide respite to occupants where sleep disturbance is likely to occur.

20.8.3 Construction Noise Mitigation Measures

Based on the assessment of construction noise impacts in this report a range of noise mitigation measures have been recommended to reduce and control potential construction noise impacts. The construction noise mitigation measures are recommended to, where feasible and reasonable, minimise potential for disturbance at receivers, preserve the acoustic amenity of the surrounding environment and aim to control noise levels within the construction NMLs.

The reasonableness of the identified feasible mitigation measures would be considered during the construction planning and site establishment phases of the proposal, and in the development of CNVMPs. In general, mitigation measures that should be considered are summarised as follows:

- For construction concentrated in a single area, such as at the compounds and bridge sites, temporary acoustic fencing/barriers around the site perimeter should be considered where feasible and reasonable to mitigate off-site noise levels. Noise barriers are effective for receivers at or near ground level and not effective for receivers overlooking the sites.
- Construct the noise barriers proposed to mitigate operational noise impacts of the project at the earliest practicable stage in the construction period in order to provide noise screening to adjacent receivers during the subsequent construction activities.
- Given the potentially high noise levels at residential receivers, adherence to daytime construction hours is recommended for excavation, demolition or rock breaking activities, and for activities concentrated in a single area (ie activities that do not move along the alignment, and do not require out of hours activities for safety reasons or to minimise disruption to road networks).
- Night works should be programmed to minimise the number of consecutive nights work impacting the same receivers.
- When working adjacent to schools, particularly noisy activities should be scheduled outside normal school hours, where possible.
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers would result in reduced noise emissions.
- Equipment which is used intermittently is to be shut down when not in use.
- Where possible, the offset distance between noisy plant items and nearby noise sensitive receivers should be as great as possible.
- Where possible, equipment with directional noise emissions should be oriented away from sensitive receivers.
- Regular compliance checks on the noise emissions of all plant and machinery used for the proposal would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.

- Ongoing noise monitoring during construction at sensitive receivers during critical periods to identify and assist in managing high risk noise events.
- Where possible heavy vehicle movements should be limited to daytime hours.
- Reversing of equipment should be minimised so as to prevent nuisance caused by reversing alarms.
- Loading and unloading should be carried out away from sensitive receivers, where practicable.

20.8.4 Mitigation Summary

A summary of the potential noise benefit from the project noise mitigation measures (refer to **Section 20.8.1**, **Section 20.8.2** and **Section 20.8.3** is presented in **Table 102**.

Table 102 Noise Mitigation Summary

Construction Noise Mitigation Measures	Potential Noise Reduction
Schedule construction works within the standard construction hours	No reduction during standard construction hours Eliminates Out of Hours noise impacts
Schedule a respite period (eg one hour for every three hours of continuous construction activity)	n/a
Schedule high noise generating works to less sensitive times of 9:00 am to 12:00 pm or 2:00 pm to 5:00 pm	n/a
Temporary acoustic fencing/barriers	Typically around 5 to 10 dB
Portable temporary enclosures	Up to around 15 dB
Construct operational noise walls	5-10 dB
Install operational property treatments	n/a
Minimise the number of consecutive nights work impacting the same receivers	n/a
Noisy activities should be scheduled outside normal school hours, where possible	n/a
Avoid the coincidence of noisy plant working simultaneously close together	Up to 3dB for halving the number of similar dominant plant items working together
Shut down equipment when not in use	Negligible reduction in comparison to worst-case predictions, however eliminates noise source during less noise intensive works
Maximise offset distance between noisy plant items and nearby noise sensitive receivers	Approximately 6dB reduction per doubling of offset distance
Regular compliance checks on the noise emissions	n/a
Ongoing noise monitoring during construction	n/a
Where possible heavy vehicle movements should be limited to daytime hours	n/a
Non-tonal reversing alarms	n/a
Loading and unloading should be carried out away from sensitive receivers	Approximately 6dB reduction per doubling of offset distance

20.8.5 Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) would be prepared during the detailed design phase and implemented through all construction activities. A CNVMP would be included in the CEMP to provide the framework and mechanisms for the management and mitigation of all potential noise and vibration impacts from the construction works. The CNVMP would include restrictions on the hours of construction for specific sites and the construction noise levels at sensitive receivers.

This would address each major stage of the construction works and identify the appropriate mitigation and management measures, consistent with the requirements of the ICNG

The objectives of the CNVMP are as follows:

- Assist in ensuring that the noise emissions during the construction works comply with the noise management levels and goals nominated in **Section 20.4**.
- Determine noise and vibration monitoring, reporting and response procedures.
- Describe specific mitigation treatments, management methods and procedures to be implemented to control noise and vibration during construction.
- Describe construction timetabling to minimise noise impacts including time and duration restrictions, respite periods and frequency.
- Describe procedures for notifying residents of construction activities likely to affect their amenity through noise and vibration.
- Define contingency plans to be implemented in the event of non-compliances and/or noise complaints.

21 ASSESSMENT OF CONSTRUCTION NOISE - PUBLIC ROAD NETWORK

This section provides an assessment of the construction related traffic on the public road network. When trucks and other vehicles are operating within the boundaries of the various construction sites, noise levels are assessed as outlined in **Section 19**. When construction related traffic moves onto the public road network, vehicle movements would be regarded as ‘additional road traffic’ rather than as part of the construction site.

21.1 Construction road traffic noise goals

The ICNG does not provide specific guidance in relation to acceptable noise levels associated with construction traffic. For assessment purposes, guidance is taken from the RNP.

One of the objectives of the RNP is to apply relevant permissible noise increase criteria to protect sensitive receivers against excessive decreases in amenity as the result of a proposal. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

On this basis, construction traffic NMLs set at 2 dB above the existing road traffic noise levels during the daytime and night-time periods are considered appropriate to identify the onset of potential noise impacts. Where the road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration would also be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the following road traffic noise criteria in the RNP:

- 60 dBA $L_{Aeq(15hour)}$ day and 55 dBA $L_{Aeq(9hour)}$ night for existing freeway/ arterial/ sub-arterial roads.
- 55 dBA $L_{Aeq(1hour)}$ day and 50 dBA $L_{Aeq(1hour)}$ night for existing local roads.

Sleep Disturbance and Maximum Noise Events

In addition to the current legislative guidance on potential sleep disturbance outlined in **Section 20.4**, the RNP refers to Practice Note 3 of the ENMM for specific impacts from road traffic. The ENMM recommends an evaluation of the number and distribution of night-time passby events where the L_{AFmax} - $L_{Aeq(1hour)}$ difference is greater than 15 dB, and the maximum noise level of that event is greater than 65 dBA.

On the basis of the current guidance, an external sleep disturbance screening criterion of RBL + 15 dB and sleep disturbance NML of L_{Amax} 55 dBA (internal) have been adopted – the latter equates to an external NML of 65 dBA (assuming open windows).

21.2 Construction Traffic Noise Assessment

It is understood that the additional heavy construction vehicle movements on public roads would be predominantly required during daytime hours, although some heavy vehicle movements at night would be required to support night-time construction works (when these are required for safety reasons or to minimise disruption to the road network).

As heavy vehicles currently use the sub-arterial roads, L_{Amax} levels at all adjacent receivers would be comparable with existing heavy vehicles using the sub-arterial roads.

Heavy vehicle movements may be required on a number of local roads with likely significantly lower existing traffic flows than the main arterial roads. Noise impacts are considered likely where construction heavy vehicles are required to access compounds via local roads. It is recommended that the detailed design seeks to minimise the number of truck movements adjacent to sensitive receivers on public local roads by favouring access via existing arterial/sub-arterial roads or existing commercial/industrial areas where practicable. It is anticipated that this process would occur during preparation of the CNVMP.

It is noted that when streets are closed to general traffic during construction (with access retained for emergency vehicles and local access), noise from heavy vehicles would fall within the assessment of general construction noise as described in **Section 19**.

Additional assessment for night-time truck movements on public roads when required would be undertaken at the detailed design stage when the finalised traffic plan is determined.

Consideration should be given to the potential noise impact due to trucks idling near construction sites, and for this reason, it is recommended that any of the planned truck queues be located away from residences.

22 CONSTRUCTION GROUND-BORNE NOISE ASSESSMENT

Ground-borne noise results from the transmission of vibration rather than the direct transmission of noise through the air. Ground-borne (or regenerated) construction noise is usually present on tunnelling projects when vibration from activities such as rockbreaking, road heading, rotary cutting, tunnel boring and rock drilling/sawing can be transmitted through the ground and into the habitable areas of nearby buildings. Ground-borne noise occurs when this vibration in the ground and/or building elements is regenerated as audible noise within areas of occupancy inside the building.

The ICNG defines internal ground-borne noise goals for residential receivers of 40 dBA $L_{Aeq(15minute)}$ during the evening (6:00 pm to 10:00 pm) and 35 dBA $L_{Aeq(15minute)}$ during the night-time (10:00 pm to 7:00 am). The goals are only applicable when ground-borne noise levels are higher than airborne noise levels

The nature of the works (surface works with minimal screening effects) means that ground-borne noise impacts are expected to be negligible. This is because the airborne noise emissions in most circumstances are much higher than the ground-borne noise levels. For this reason ground borne noise is not anticipated to be the controlling factor for these proposed works and therefore further assessment is not warranted.

23 CONSTRUCTION VIBRATION ASSESSMENT

23.1 Vibration Damage Criteria Overview

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

In terms of the most recent relevant vibration damage criteria, British Standard 7385:Part 2-1993 *Evaluation and Measurement for Vibration in Buildings Part 2*[xi] is an internationally accepted standard against which the likelihood of building damage from ground vibration can be assessed. This is the Standard recommended in Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives*[xii] as the vibration guideline values and assessment methods "are applicable to Australian conditions".

Another reference, German Standard DIN 4150:Part 3-1999[xiii] also provides guidelines for evaluating the effects of vibration on structures. For vibration frequencies of less than 10 Hz, the DIN Standard gives a "safe limit" of peak vibration for dwellings of 5 mm/s and for historic buildings (with preservation orders or the like) of 3 mm/s. As opposed to the "minimal risk of cosmetic damage" approach adopted in BS 7385, the "safe limits" given in DIN 4150 are the vibration levels up to which no damage due to vibration effects has been observed. Hence the guideline limits in DIN 4150 are somewhat lower than those in BS 7385.

Although there is a lack of reliable data on the threshold of vibration-induced damage in buildings both in countries where national standards already exist and in the UK, BS7385:Part 2 has been developed from an extensive review of UK data, relevant national and international documents and other published data. The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95 per cent probability of no effect.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extraction or construction excavation), demolition, piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

23.2 Vibration Damage Goals

Australian standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* recommends the frequency dependent vibration guideline values and assessment methods given in British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* as they 'are applicable to Australian conditions'.

The Standard sets guide values for vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk is usually taken as a 95 per cent probability of no effect.

The recommended guideline limits for transient vibration to minimise risk of cosmetic damage to residential and industrial buildings are presented in **Table 103** and graphically in **Figure 31**.

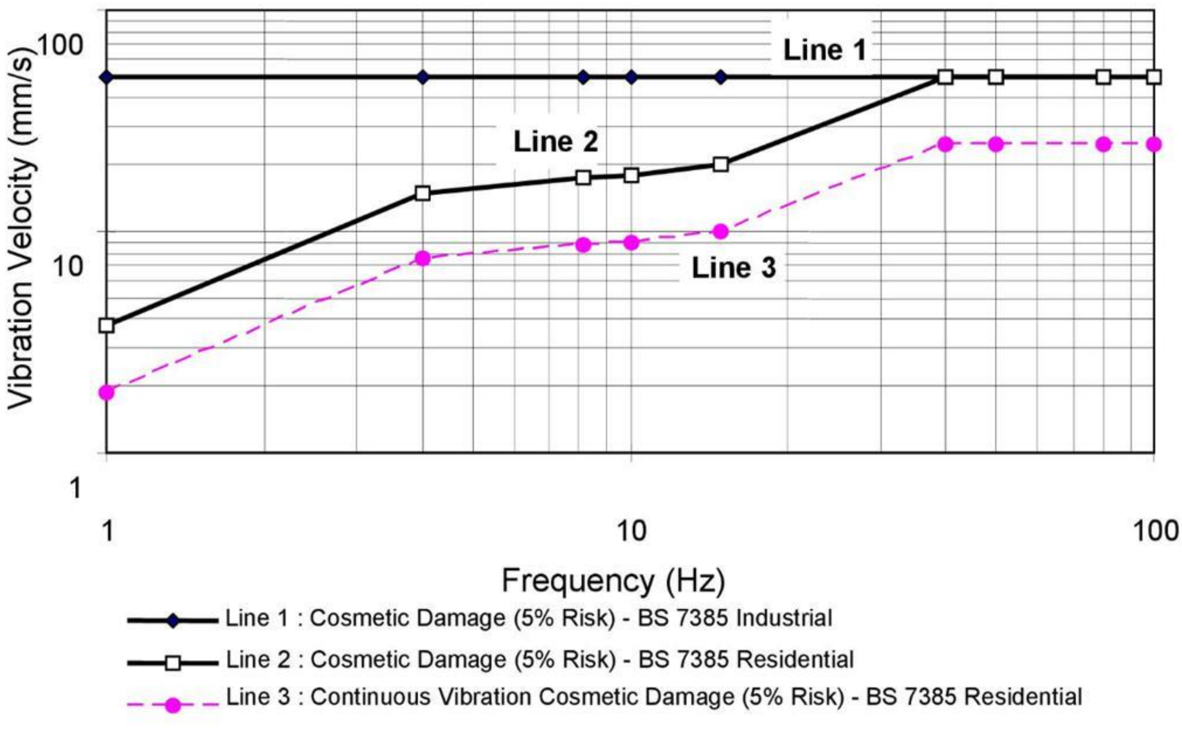
Table 103 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	**15 Hz and Above**
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The guide values in **Table 103** relate predominately to transient vibration which does not give rise to resonant responses in structures and low-rise buildings. In the event continuous vibration gives rise to magnification of vibration by resonance (specific conditions where the structure can readily store and transfer vibration energy), then the guide values in **Table 103** may need to be reduced by up to 50 per cent (**Figure 31**).

Rockbreaking, rock hammering and sheet piling are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50 per cent for these construction activities.

Figure 31 Transient Vibration Guide Values for Cosmetic Damage



For most sources of intermittent vibration during construction, such as rockbreakers, piling rigs, vibratory rollers and excavators, the predominant vibration energy occurs at frequencies usually in the 10 Hz to 100 Hz range. On this basis a vibration damage screening level of 7.5 mm/s has been adopted for the purpose of assessing potential impacts.

In the lower frequency region below 4 Hz the guide values for building types are reduced as a high displacement is associated with relatively low peak component particle velocity. To minimise risk of structural damage a guide value of 3.7 mm/s has been adopted.

It is noteworthy that further to the guide values the Standard advises that:

> *A building of historical value should not (unless it's structurally unsound) be assumed to be more sensitive.*

For this reason, vibration impacts on heritage listed buildings have not been specifically considered.

23.3 Human Comfort Goals for Construction Vibration

For most construction activities that generate perceptible vibration in nearby buildings, the character of the vibration emissions is intermittent. The *Assessing Vibration: A Technical Guideline* nominates preferred and maximum vibration goals for critical areas, residences and other sensitive receivers as shown in **Table 104**. The guideline advises a low probability of adverse comment or disturbance to building occupants would be expected at or below the preferred values.

The applicable human comfort vibration goal for intermittent vibration source is defined in terms of Vibration Dose Values (VDVs) where the permissible vibration level corresponding to the VDV varies according to the duration of exposure.

Table 104 Preferred and Maximum Vibration Dose Values for Intermittent Vibration

Building Type	Preferred Vibration Dose Value ($m/s^{1.75}$)	Maximum Vibration Dose Value ($m/s^{1.75}$)
Critical Working Areas (e.g. hospital operating theatres, precision laboratories)	0.10	0.20
Residential Daytime	0.20	0.40
Residential Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80
Workshops	0.80	1.60

Note: Daytime is 7:00 am to 10:00 pm and night-time is 10:00 pm to 7:00 am

In applying the preferred and maximum VDV the guidelines states that:

> *Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. An example is a construction or excavation project.*

The guideline also advises that:

> *Where all feasible and reasonable measures have been applied to control potential ground vibration levels the maximum values may be used. For values above the maximum value the proponent should negotiate directly with the affected community.*

23.4 Safe Working Distances for Vibration Intensive Plant

The propagation of vibration emitted from a source would be site specific with the level of vibration potentially experienced at a receiver dependent upon the vibration energy generated by the source, the predominant frequencies of vibration, the localised geotechnical conditions and the interaction of structures and features which can dampen vibration.

The recommended safe working distances for construction plant in **Table 105** are referenced from the *Construction Noise Strategy (*Transport for NSW, 2012)[xiv].

Consistent with the British Standard and the Assessing Vibration guideline, the recommendations are for the practical management of potential vibration to minimise the likelihood of cosmetic damage to buildings and disturbance or annoyance in humans. The human comfort safe working distances are conservative, developed with reference to the more stringent objectives for continuous vibration for typical residential building constructions.

Table 105 Recommended Safe Working Distances for Vibration Intensive Plant

Plant Item	Rating/ Description	Safe Working Distance	
		Cosmetic Damage[1]	Human Response[2]
Vibratory Roller	< 50 kN (Typically 1-2 tonnes	5 m	15 m to 20 m
	< 50 kN (Typically 2-4 tonnes	6 m	20 m
	< 50 kN (Typically 4-6 tonnes	12 m	40 m
	< 50 kN (Typically 7-13 tonnes	15 m	100 m
	< 50 kN (Typically 13-18 tonnes	20 m	100 m
	< 50 kN (Typically > 18 tonnes	25 m	100 m
Small Hydraulic Hammer	300 kg – 18 to 34t excavator	2 m	7 m
Medium Hydraulic Hammer	1600 kg – 5 to 12t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg – 12 to 18t excavator	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Note 1: Referenced from British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2*
Note 2: Referenced from EPA's *Assessing Vibration: a technical guideline (*DEC, 2006)

23.5 Estimated Working Distances and Vibration Intensive Plant

The proposed works have been analysed to determine best estimates of the minimum distances receivers and the equipment to be used that is most likely to be vibration intensive, as shown in **Table 106**. This allows for a comparison to the safe working distances listed in **Table 105** when determining the likely vibration impacts of the construction scenarios.

Table 106 Construction Vibration Assessment

Work Scenario	Vibration Intensive Equipment	Interchange Area	Indicative distance to nearest NCA receiver (m)	Closer than safe working distance (any plant item)?	
				Cosmetic Damage	Human Response
Main Corridors / Ramp Work	Vibratory Roller (10-12 tonne) Excavator (Breaker) Plate Compactor Jackhammer	Burnett Street	19	Yes	Yes
		Coleman Street	< 5	Yes	Yes
		Cumberland Highway	6	Yes	Yes
		Prospect Highway	20	Yes	Yes
		Reservoir Road	40	No	Yes
		Roper Road to M7	15	Yes	Yes
		Mamre Road	32	No	Yes
		Northern Road	9	Yes	Yes
		Mulgoa Road	13	Yes	Yes
		Russell Street	32	No	Yes
Site Compounds	n/a[1]	n/a[1]	n/a[1]	n/a	n/a
Noise Barrier Removal	Piling Rig (Vibratory) Jackhammer Excavator (20 tonne)	Burnett Street	22	No	No
		Coleman Street	15	Yes	Yes
		Cumberland Highway	16	Yes	Yes
		Prospect Highway	n/a[2]	n/a	n/a
		Reservoir Road	n/a[2]	n/a	n/a
		Roper Road to M7	n/a[2]	n/a	n/a
		Mamre Road	46	No	No
		Northern Road	n/a[2]	n/a	n/a
		Mulgoa Road	13	Yes	Yes
		Russell Street	32	No	No
Structures – Bridge Construction[3]	Piling Rig (Bored) Excavator (Breaker)	Reservoir Road	430	No	No

Note 1: No significantly vibration intensive equipment proposed.
Note 2: No noise barrier removal in this interchange area
Note 3: Bridge construction to occur in Reservoir Road interchange area only

Cosmetic Damage Assessment

The separation distance(s) between the proposed works and the nearest receivers would generally be sufficient so that nearby buildings are unlikely to suffer 'Cosmetic Damage' for most of the proposed construction equipment. However, based on the general work zones, some items of construction equipment have the potential to be operated closer than the recommended safe working distances.

Receivers in the following interchange areas may be affected by vibratory rollers or breakers during works on the main corridors and ramps:

- Burnett Street
- Coleman Street
- Cumberland Highway
- Prospect Highway

- Roper Road to M7
- Northern Road
- Mulgoa Road

Receivers in the following interchange areas may be affected by vibratory pile driving during noise barrier removal works:

- Coleman Street
- Cumberland Highway
- Mulgoa Road

The required locations for vibration intensive equipment should be reviewed during detailed design when more specific information is available.

Attended vibration monitoring or vibration trials should be undertaken when proposed works are within the safe working distances to ensure that levels remain below the criterion. Building condition surveys should also be completed both before and after the works at any potentially affected properties to identify existing damage and any proposal related damage.

Human Comfort Vibration Assessment

In relation to human comfort (response), the safe working distances in **Table 105** relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in BS 6472-1.

Receivers in all interchange areas have been identified as likely to perceive vibration impacts at times during the works on the main corridors and ramps. This is expected to be due to works associated with vibratory rollers or breakers.

Receivers in the Coleman Street, Cumberland Highway and Mulgoa Road interchange areas have been identified as likely to perceive vibration impacts at times during the noise barrier removal works. This is expected to be due to works associated with piling rigs (vibratory).

Based on the general work zones, some items of proposed construction equipment have the potential to be operated within the recommended safe working distances. If a vibratory roller (10-12 tonne) is used, receivers have been identified within the recommended 100 metre zone within all adjacent NCAs as shown in **Table 106**. There is therefore potential for ground vibration levels to exceed the human comfort criteria depending on the duration and nature of the construction activity. The required locations for vibration intensive equipment should be reviewed during detailed design when more specific information is available. Any exceedances would be expected to be of short duration.

23.6 Cumulative Vibration Impacts

Due to the intermittent nature of construction works, vibration impacts due to multiple works scenarios are considered unlikely to result in concurrent vibration peaks, but rather, may increase the effective duration of the exposure to vibration. Vibration impacts due to multiple simultaneous works would therefore be managed in the same manner as for single works scenarios (dependant on the operating equipment).

23.7 Vibration Mitigation

Dependent upon the equipment to be used, where vibration intensive construction activities are proposed near sensitive receivers, these works should be confined to the less sensitive daytime period as far as reasonably practicable. The potential impacts from vibration are to be considered in the site-specific CNVMPs, to be developed during the detailed design phase when more information is available on the schedule for the works, the equipment to be used and the localised geotechnical conditions. In general, mitigation measures that should be considered are summarised as follows:

- Relocate vibration generating plant and equipment to areas within the site in order to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Use lower vibration generating items of excavation plant and equipment e.g. smaller capacity rockbreaker hammers.
- Minimise consecutive works in the same locality (if applicable).
- Use dampened rockbreakers and/or 'city' rockbreakers to minimise the impacts associated with rockbreaking works.
- If vibration intensive works are required within the safe working distances, vibration monitoring or attended vibration trials would be undertaken to ensure that levels remain below the cosmetic damage criterion.
- Building condition surveys would be completed both before and after the works to identify existing damage and any damage due to the works.

Measurements of existing ambient vibration levels would be undertaken at receivers with vibration sensitive equipment during the detailed design phase. This information would be used to inform the site-specific CNVMPS for works near these locations.

24 REFERENCES

[i] Road Noise Policy, NSW EPA, 2011
[ii] Noise Criteria Guideline, Roads and Maritime, December 2014, RMS 14.583
[iii] Noise Mitigation Guideline, Roads and Maritime, December 2014, RMS 14.584
[iv] Environmental Noise Management Manual, Roads and Maritime, 2001
[v] Interim Construction Noise Guideline, DECC, 2009
[vi] Assessing Vibration: a technical guideline, DEC, 2006
[vii] AS IEC 61672.1—2004 - Electroacoustics—Sound level meters, Part 1: Specifications, Standards Australia, 2004
[viii] Calculation of Road Traffic Noise, UK Department of Transport, 1988
[ix] Brown R, The Effect of Signalisation on Road Traffic Noise Levels – A Case Study, AAS, 1996
[x] Brown R, The Effect of Signalisation on Road Traffic Noise Levels – A Case Study, AAS, 1996
[xi] BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993
[xii] AS 2187: Part 2-2006 Explosives - Storage and Use - Part 2: Use of Explosives, Standards Australia, 2006
[xiii] DIN 4150:Part 3-1999 Structural vibration - Effects of vibration on structures, Deutsches Institute fur Normung, 1999
[xiv] Construction Noise Strategy, TfNSW, 2012

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 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 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

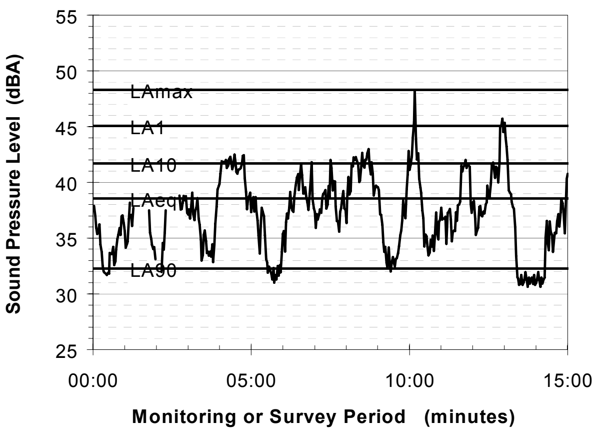
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

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

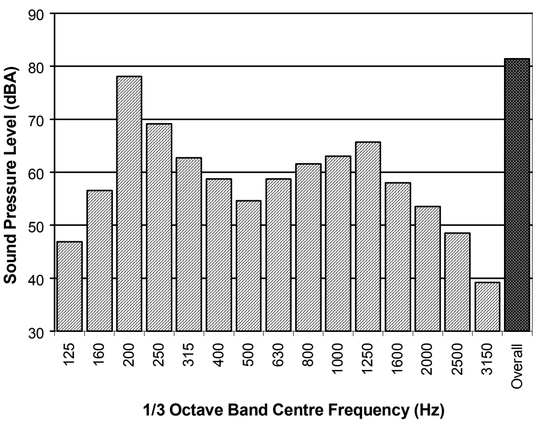
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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

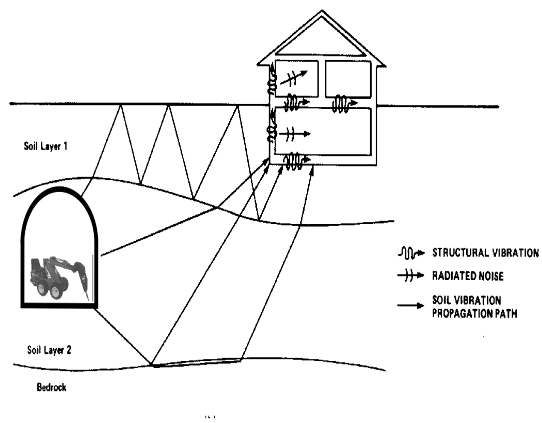
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

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
Report 610.12109-R1

Noise Sensitive Receivers

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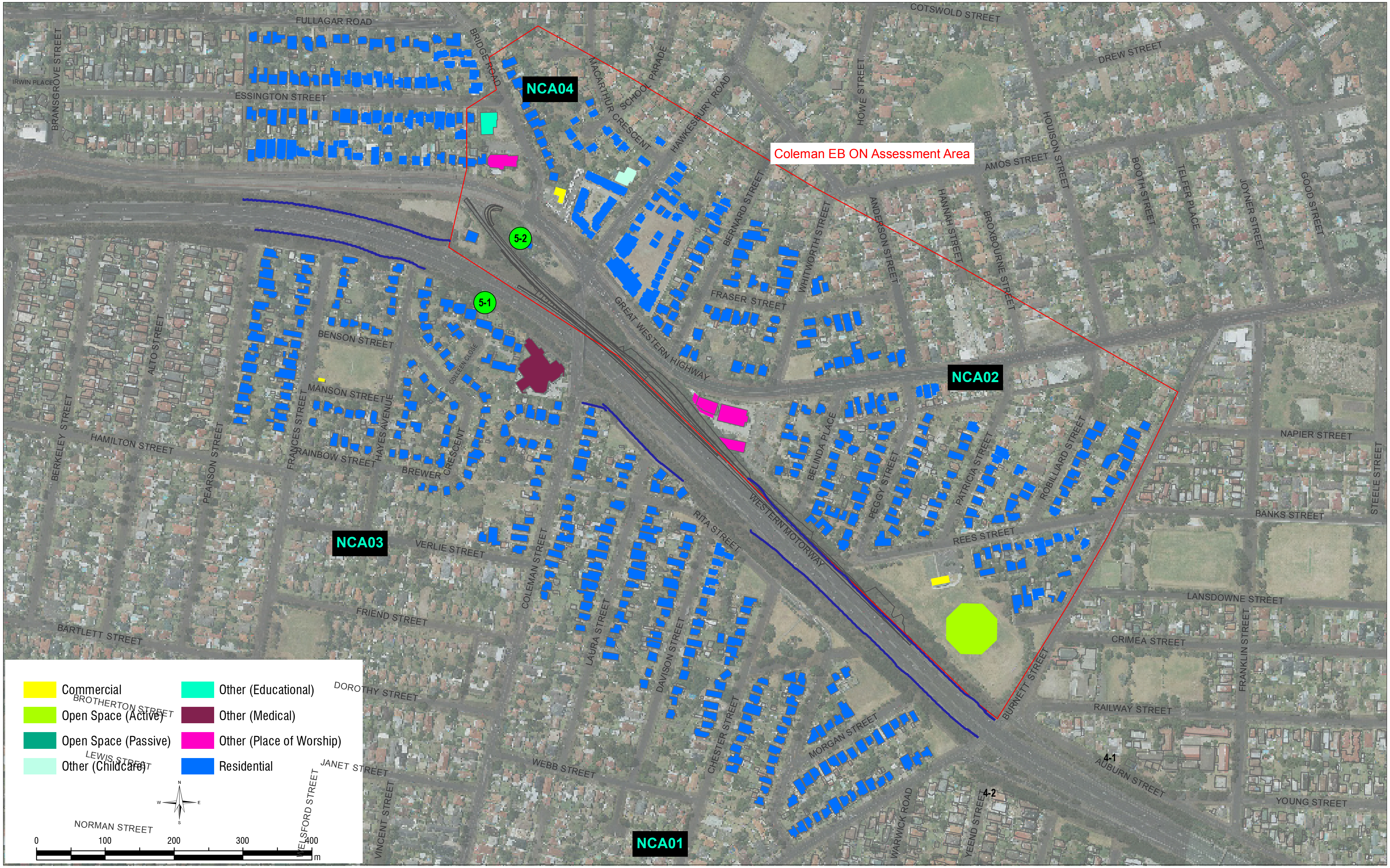
Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Burnett Street Interchange
Noise Assessment Area



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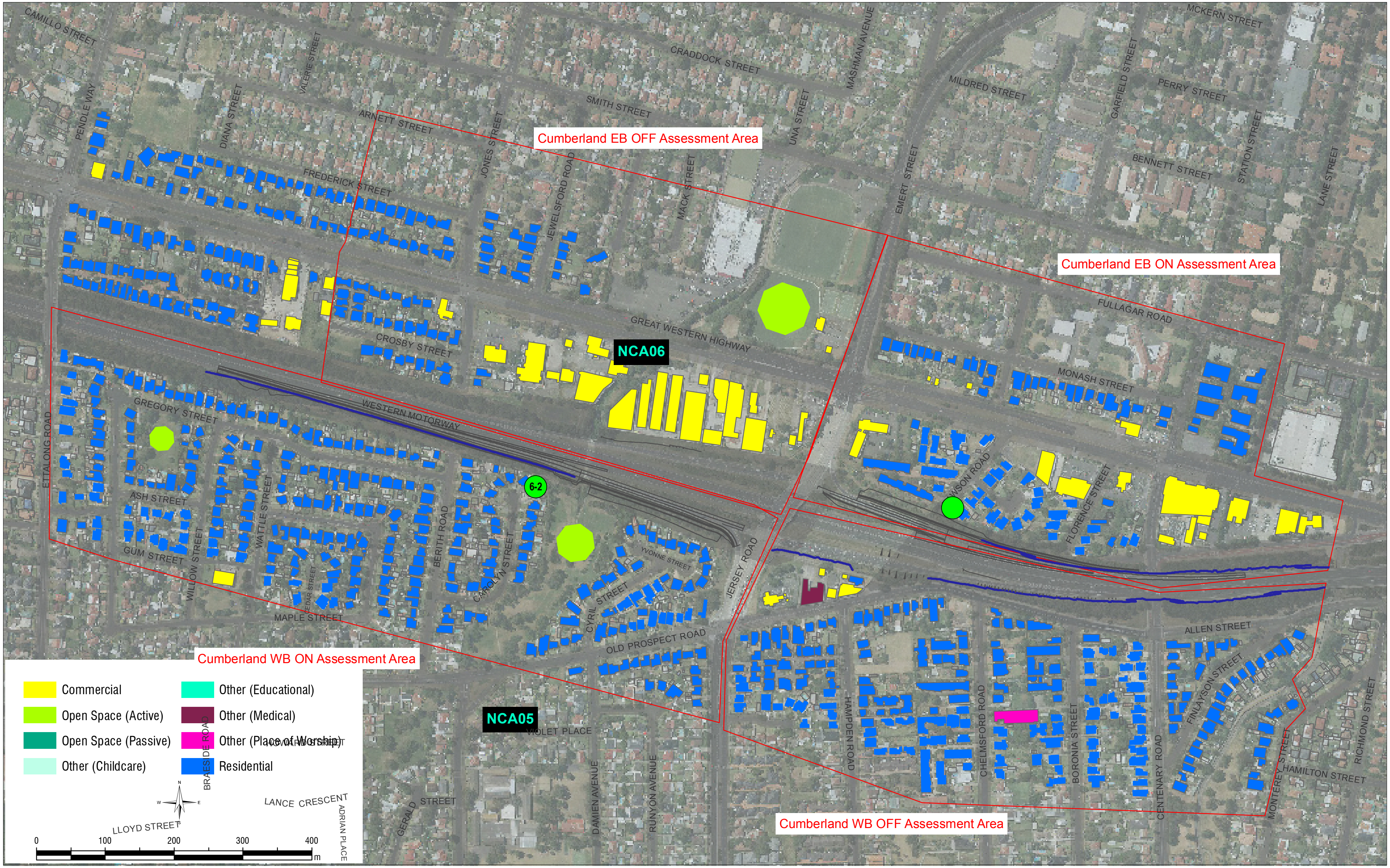
Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Coleman Street Interchange
Noise Assessment Area



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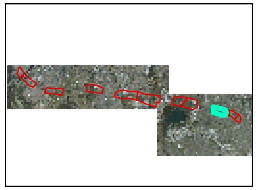
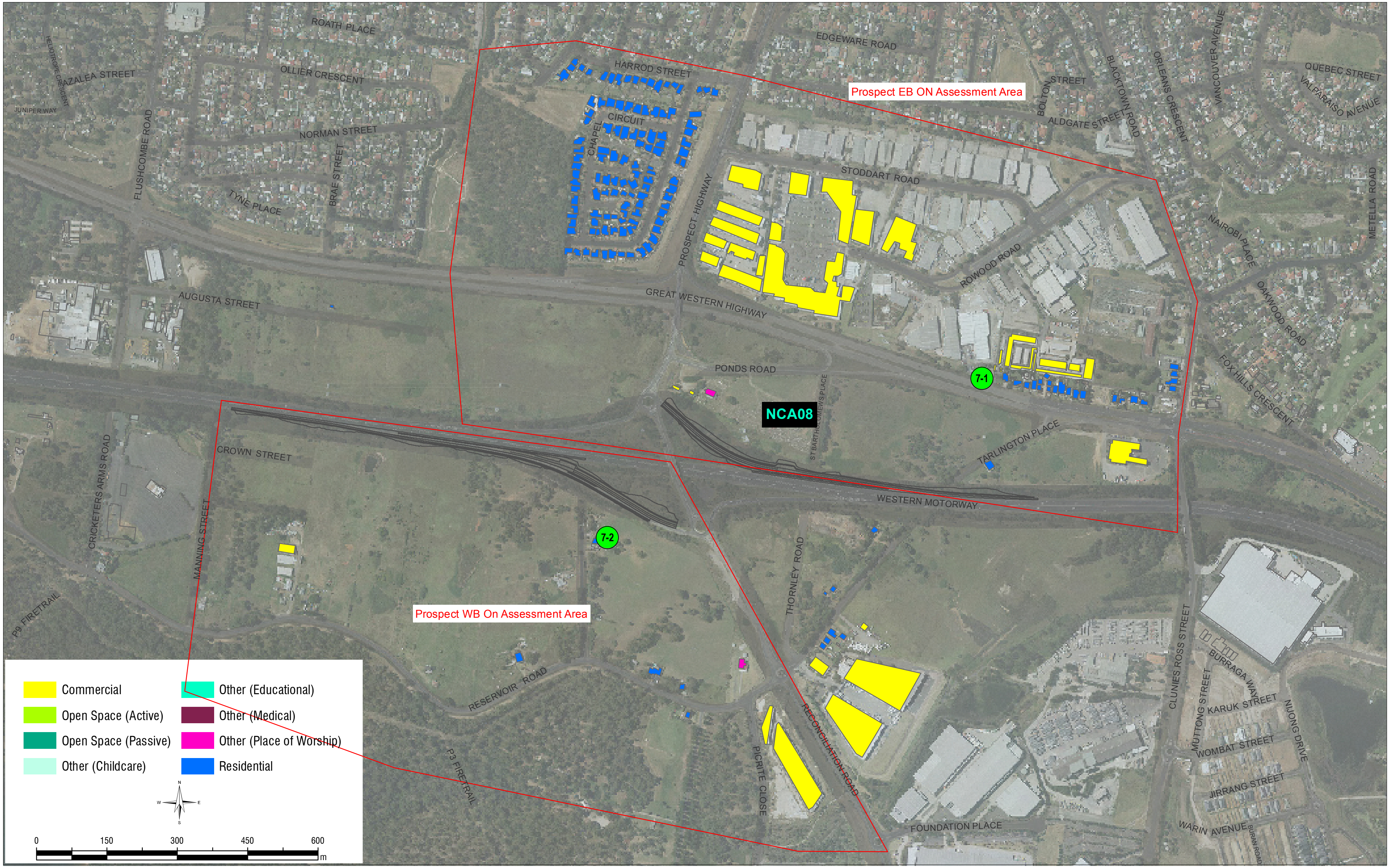


Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Cumberland Highway Interchange Noise Assessment Area



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Date:	17/10/2014
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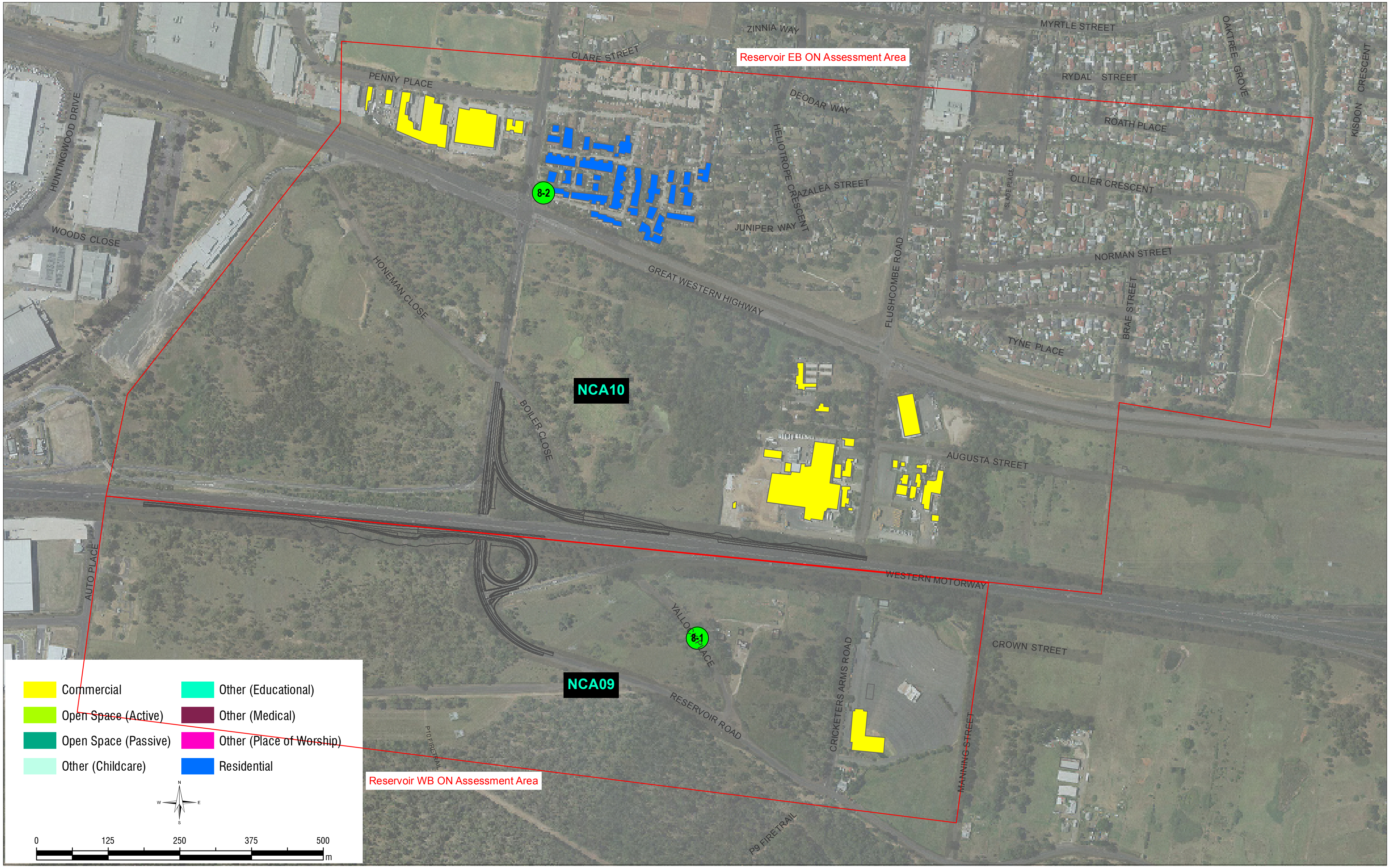
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Prospect Highway Interchange
Noise Assessment Area



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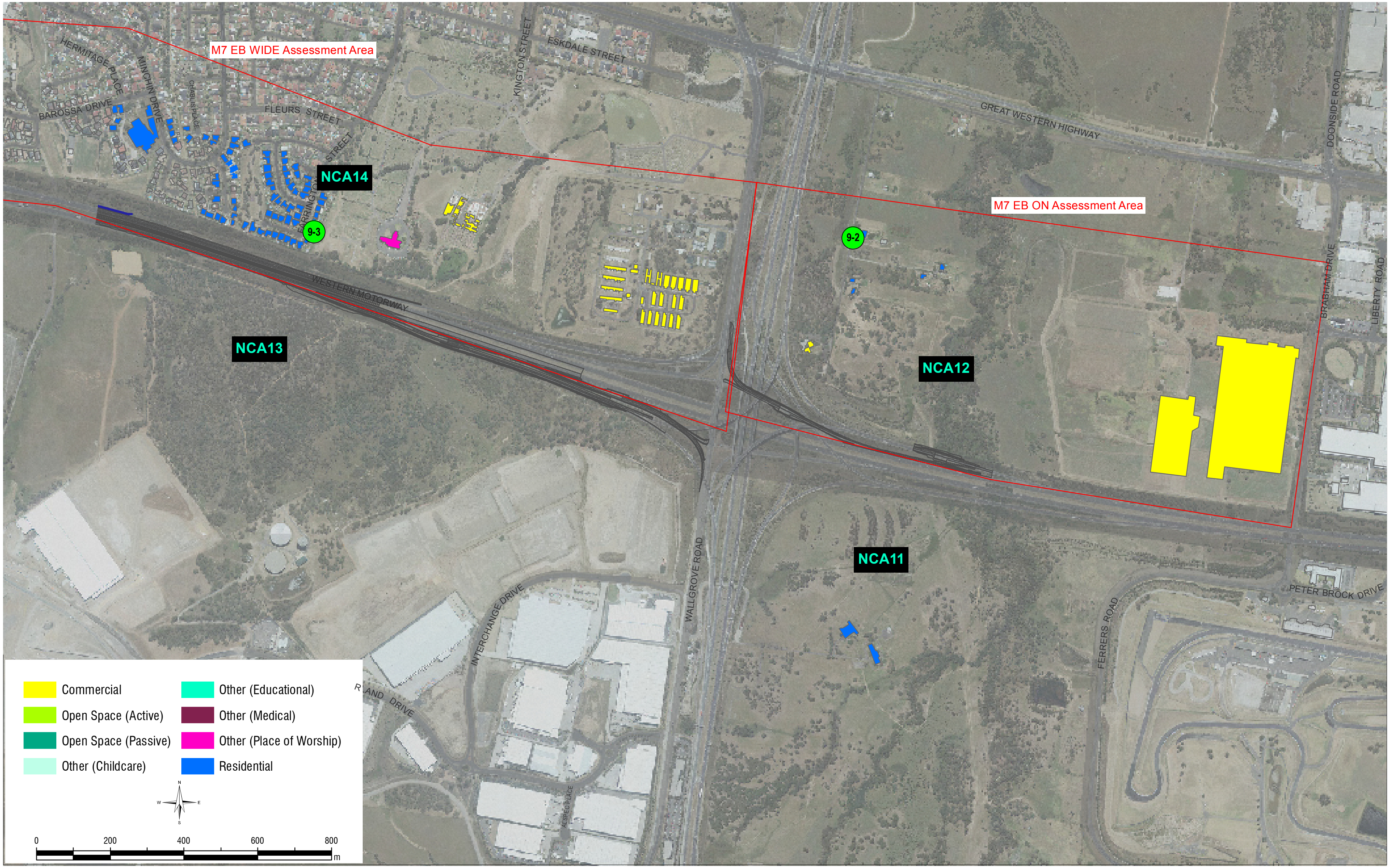
Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Reservoir Road Interchange
Noise Assessment Area



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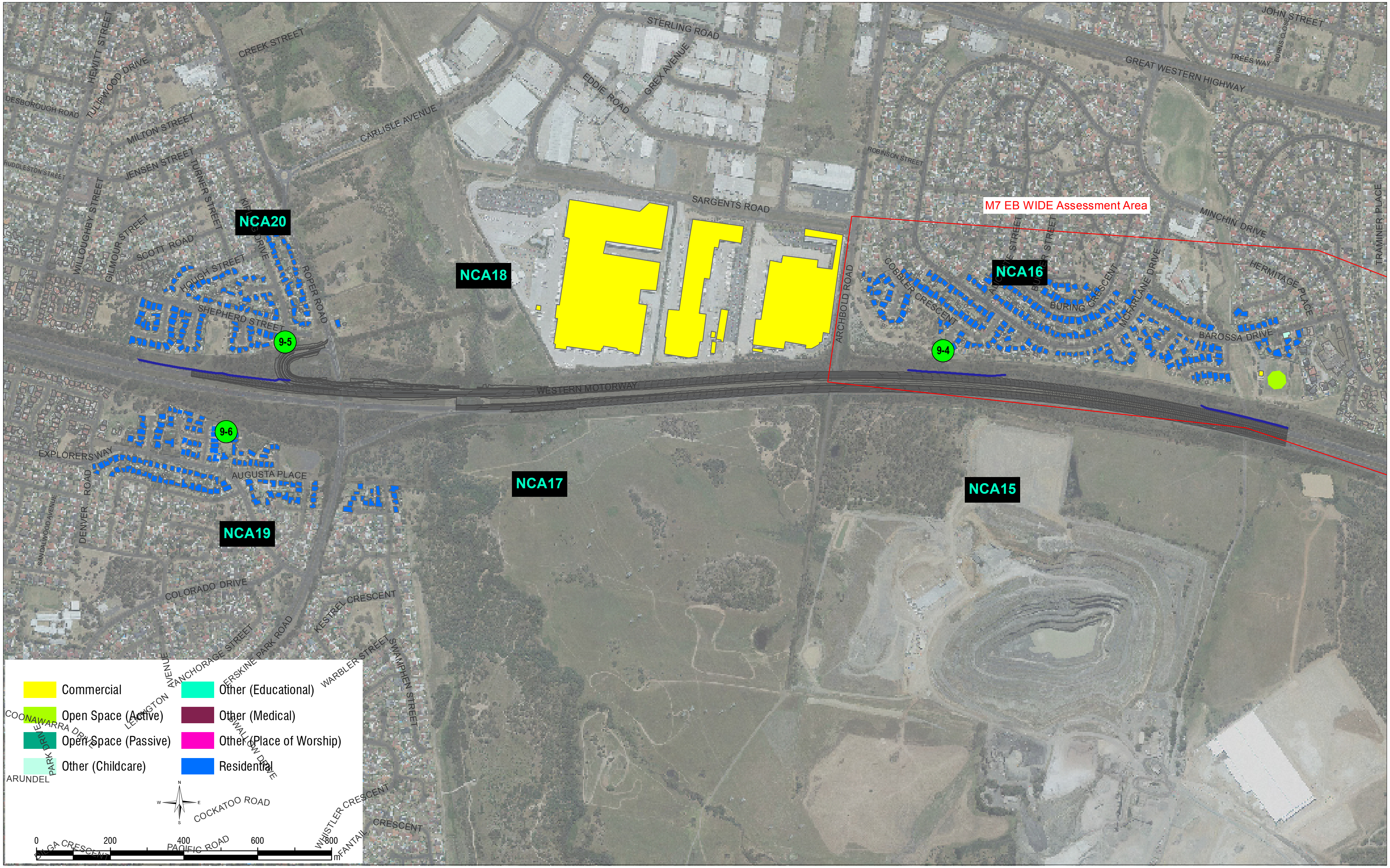
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Roper - M7 Interchanges (east)
Noise Assessment Area



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Scale:	1:14,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Roper - M7 Interchanges (west)
Noise Assessment Area

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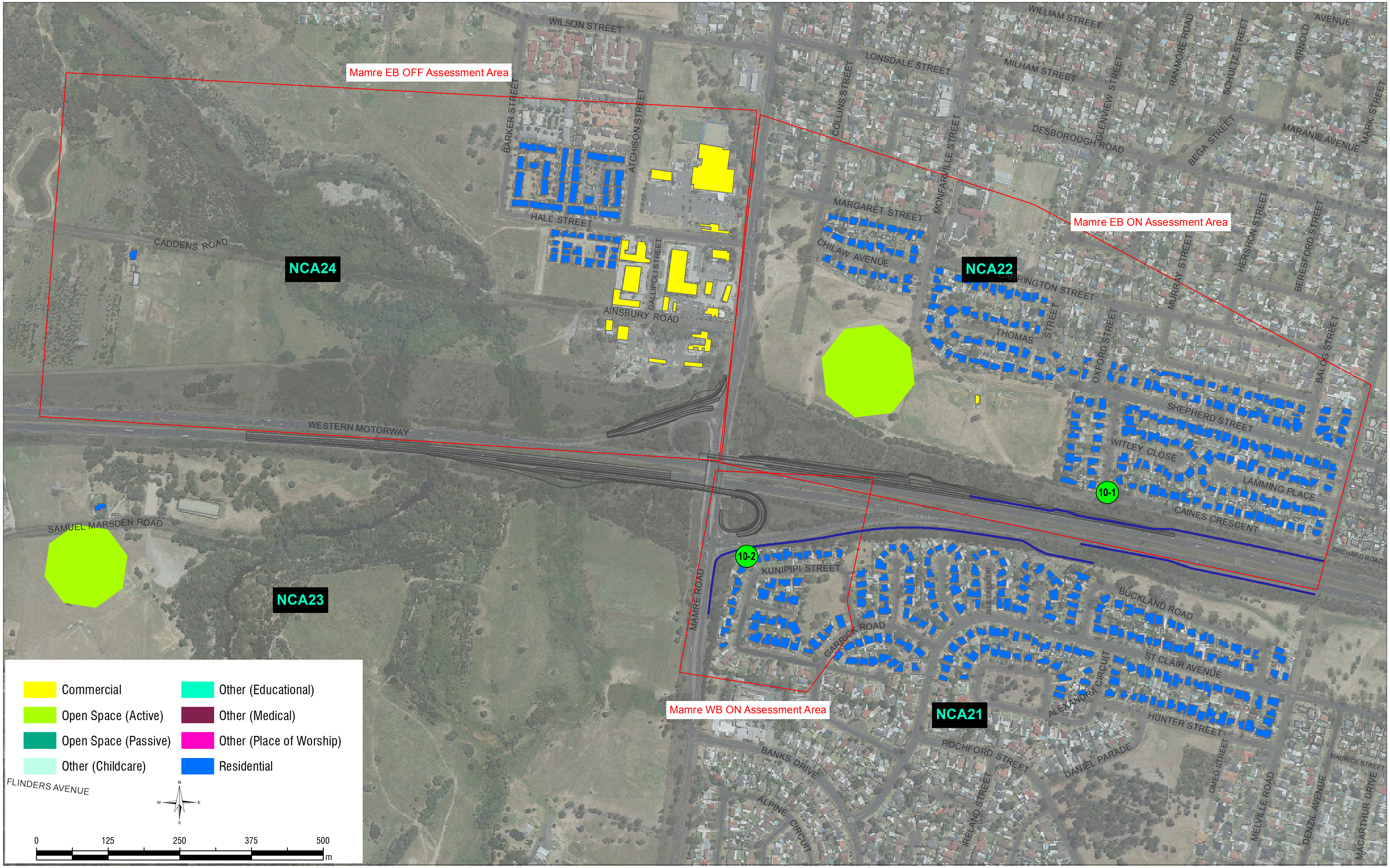

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Date:	17/10/2014
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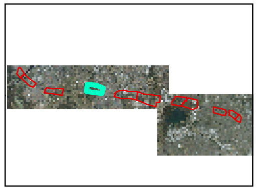
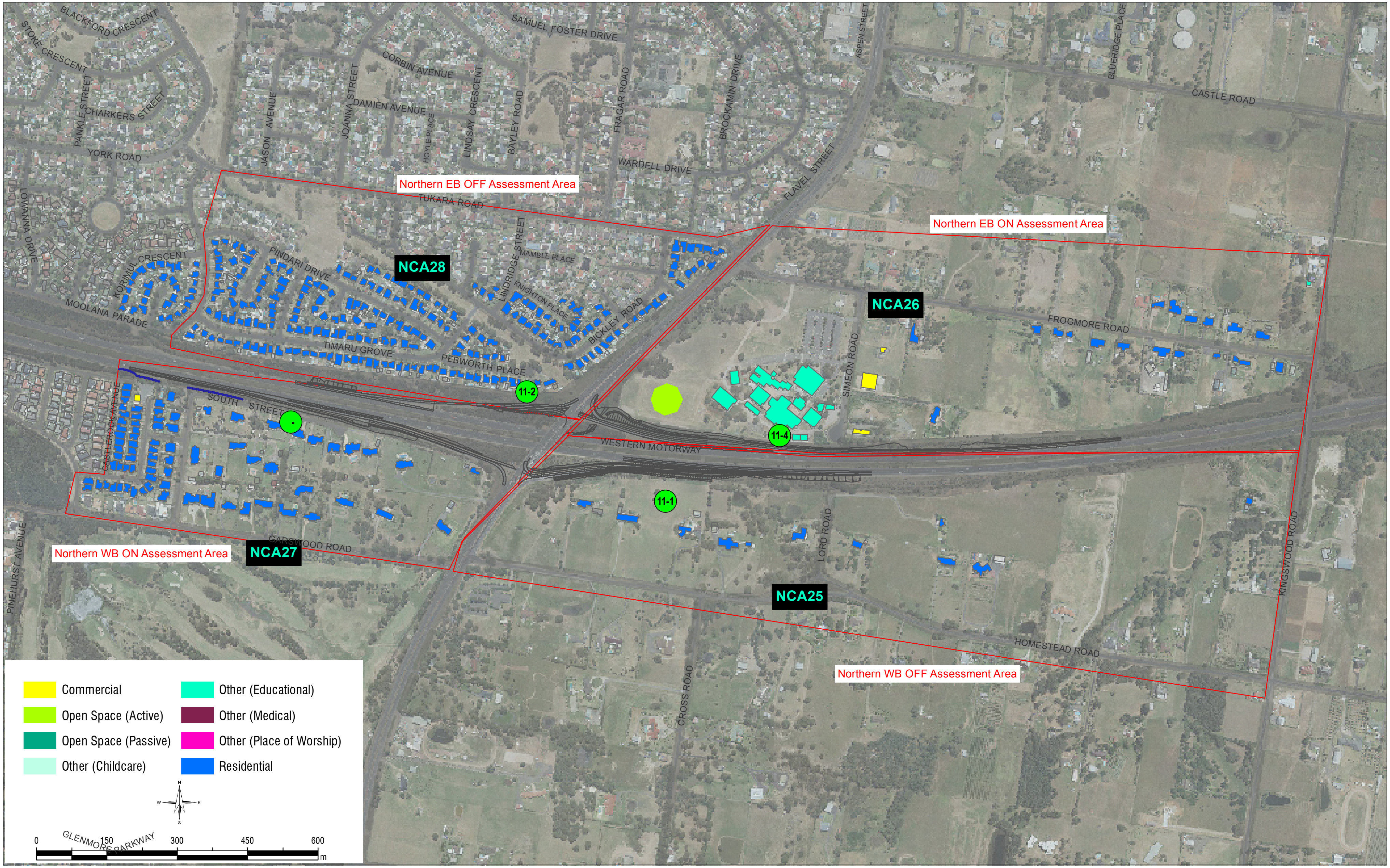


Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Mamre Road Interchange
Noise Assessment Area



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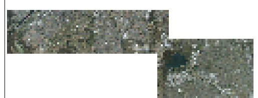
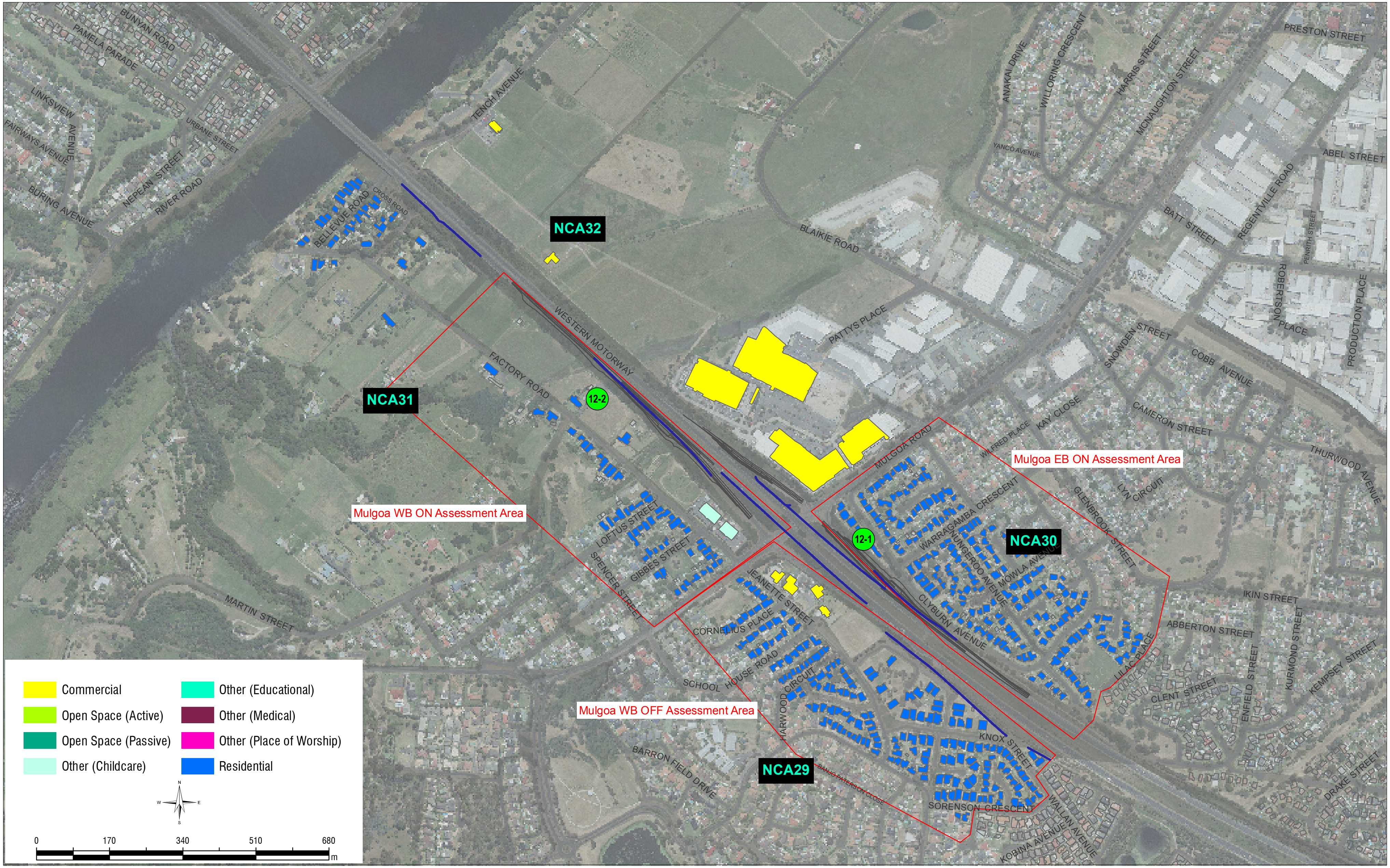


Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Northern Road Interchange
Noise Assessment Area



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Date:	17/10/2014
Drawn by:	NT
Scale:	1:12,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Mulgoa Road Interchange
Noise Assessment Area

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Date:	17/10/2014
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Scale:	1:9,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

Existing Noise Barriers
Extent of Works
Noise Assessment Area
Noise Logger Locations

Roads and Maritime Services

M4 Smart Motorway

Russell Street Interchange
Noise Assessment Area

A4 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A4.1**
Noise Monitoring Address:	**59 Auburn Street, Parramatta**

Logger Device Type: Svantek 957

Logger Serial No: 20670

Ambient noise logger deployed immediately outside residential address 59 Auburn Street, Parramatta. Logger located in front yard on southern side of property.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 during the daytime. Constant tyre-pavement noise from light-vehicle traffic on the M4 can be heard at this location with discrete traffic noise level peaks from heavy vehicle movements occurring frequently.

Recorded Noise Levels (LAmax):

M4 Heavy-vehicle road traffic: 59-62dBA, Local road traffic: 62 - 66 dBA, Insects: 60 – 68 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	53	61	60	65
Evening	53	58	59	63
Night-time	48	54	55	58

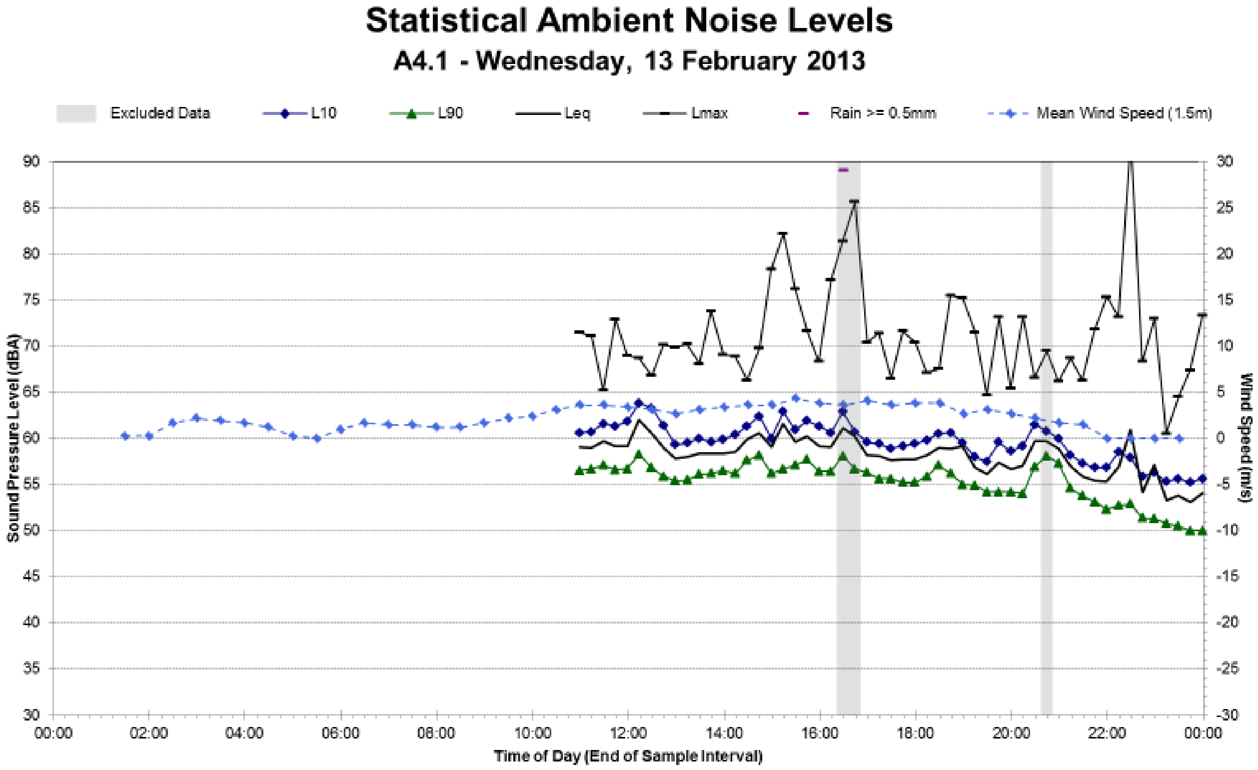
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	3	N/A (7 Day Average)
Daytime (7am-10pm)	61	59	60
Night-time (10pm-7am)	54	54	54

Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
13/02/2013	08:53:23	54	57	69

Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
A4.1 - Wednesday, 13 February 2013
Excluded Data
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Lmax
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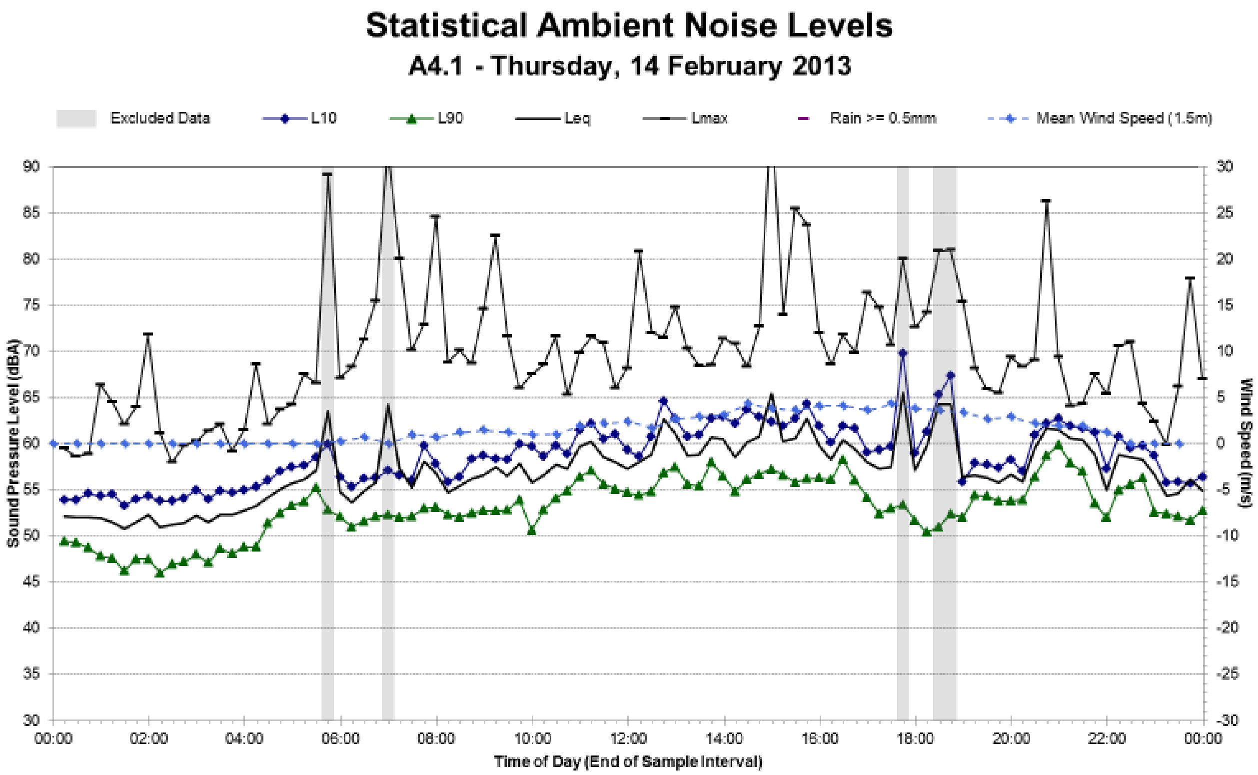
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A4.1 - Thursday, 14 February 2013
Excluded Data
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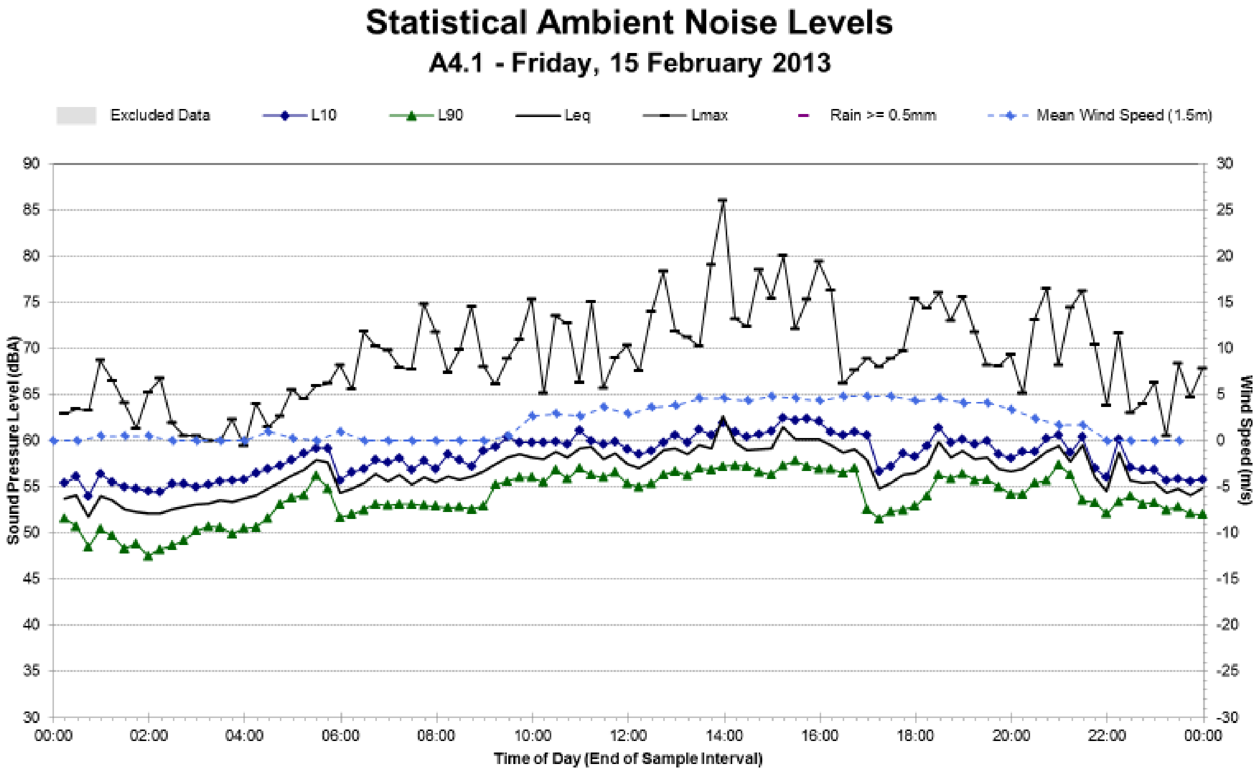
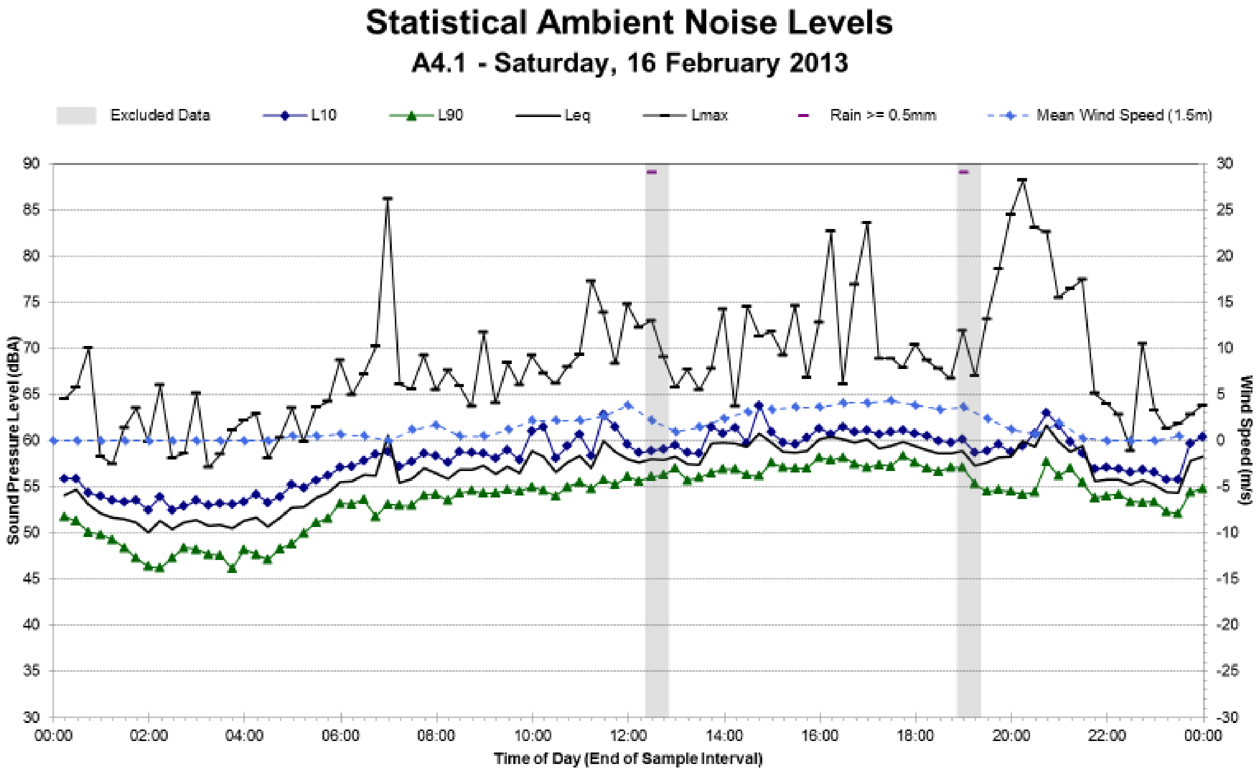
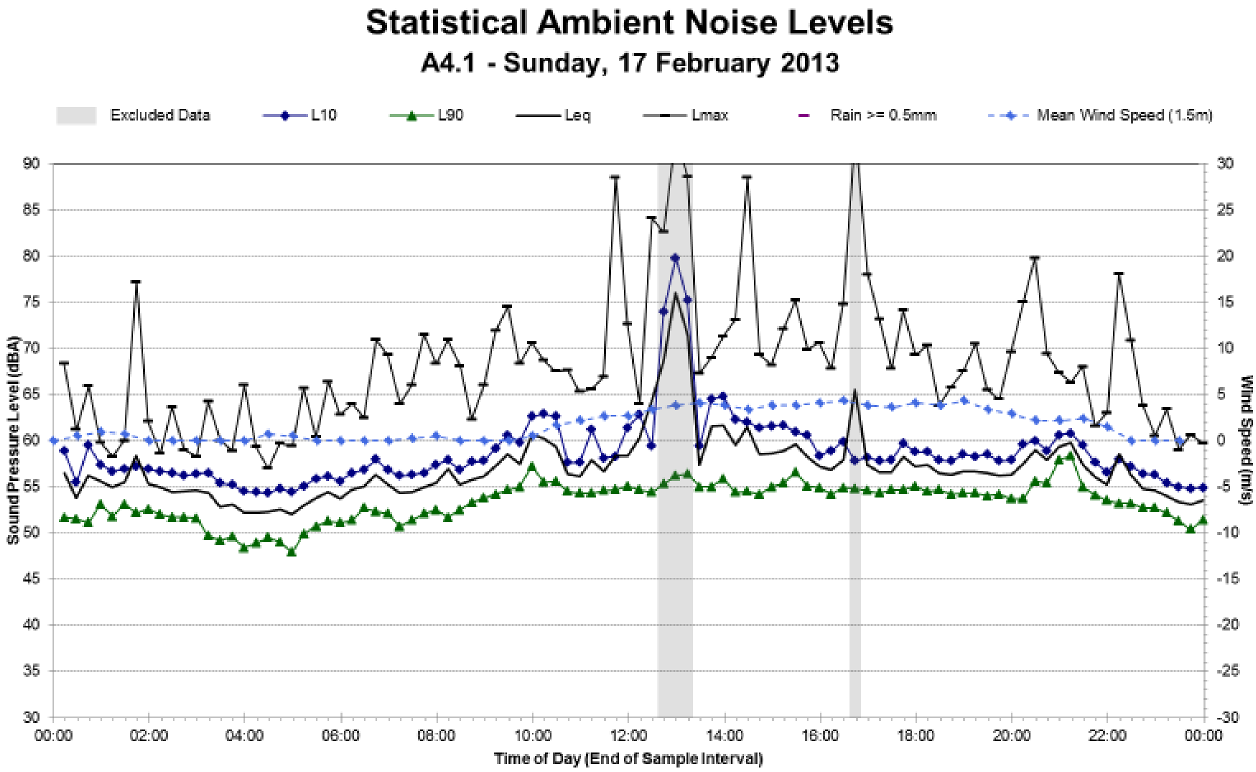
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

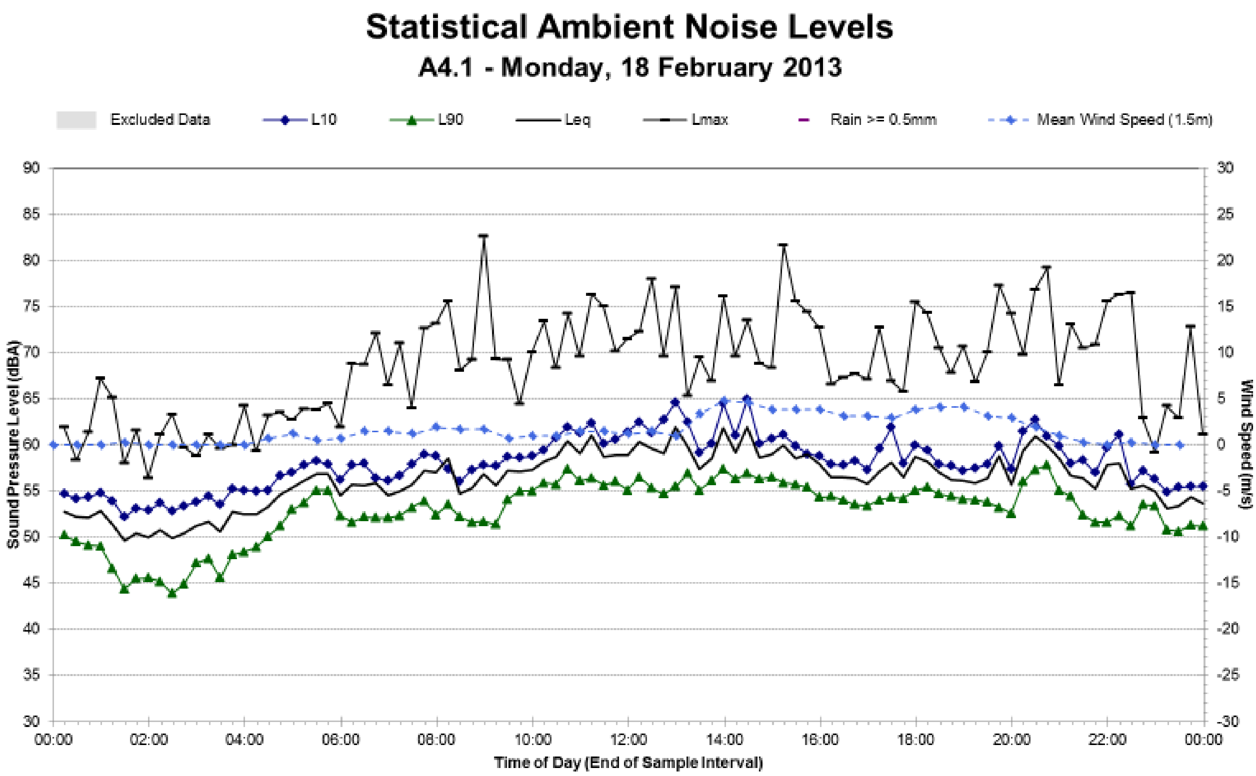
A4 Ambient Noise Monitoring Results

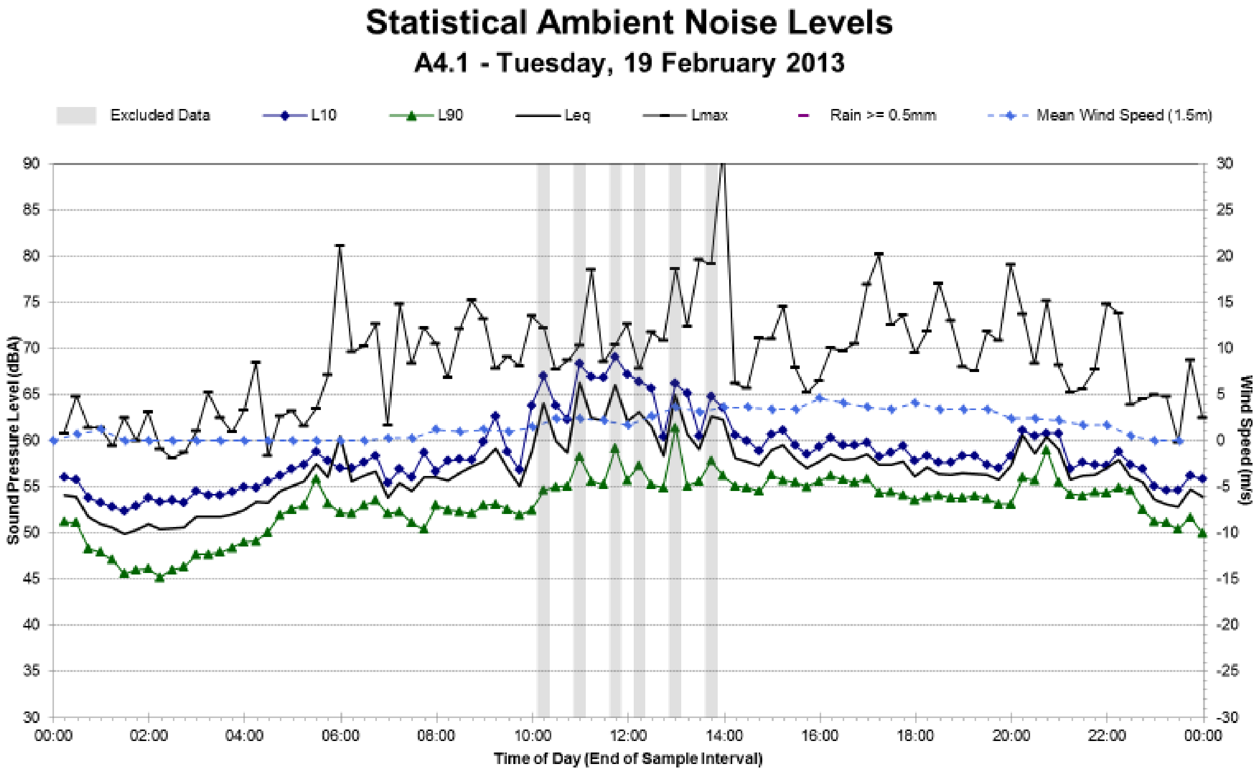




A4 Ambient Noise Monitoring Results






Statistical Ambient Noise Levels
A4.1 - Tuesday, 19 February 2013
Excluded Data
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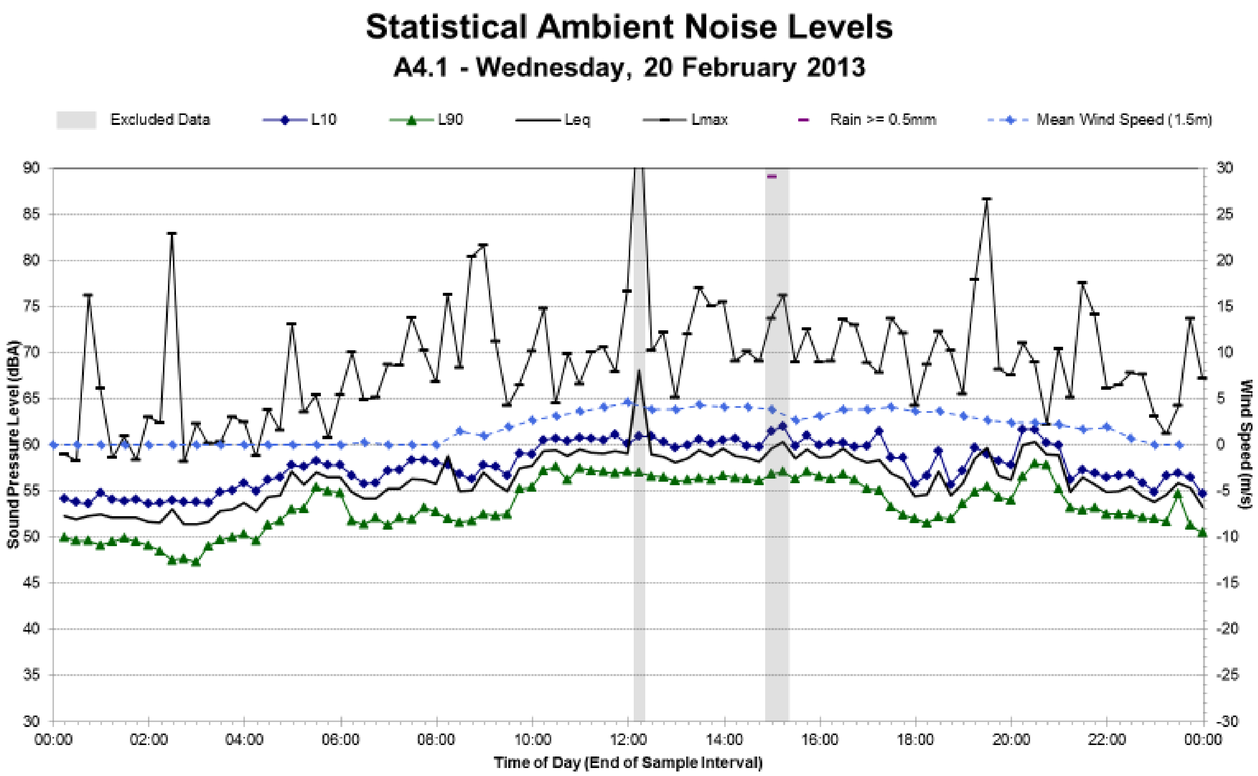
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A4.1 - Wednesday, 20 February 2013
Excluded Data
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L90
Leq
Lmax
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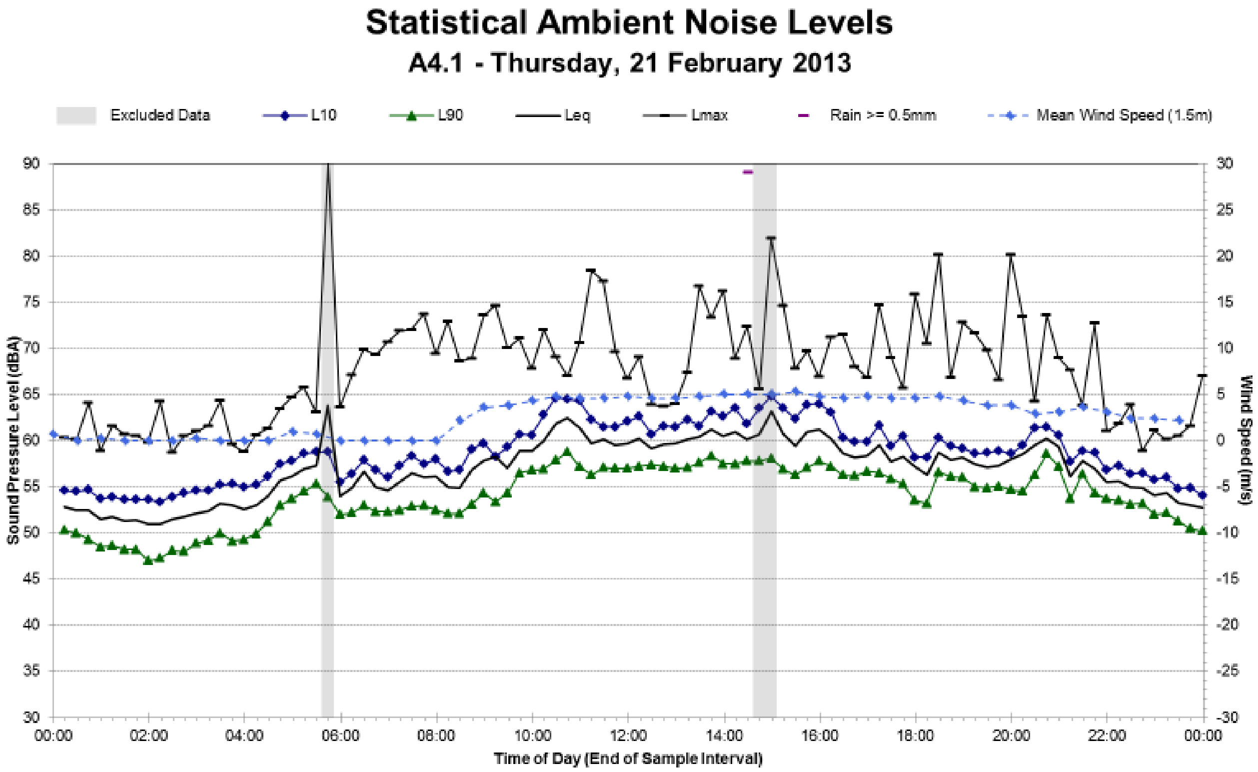
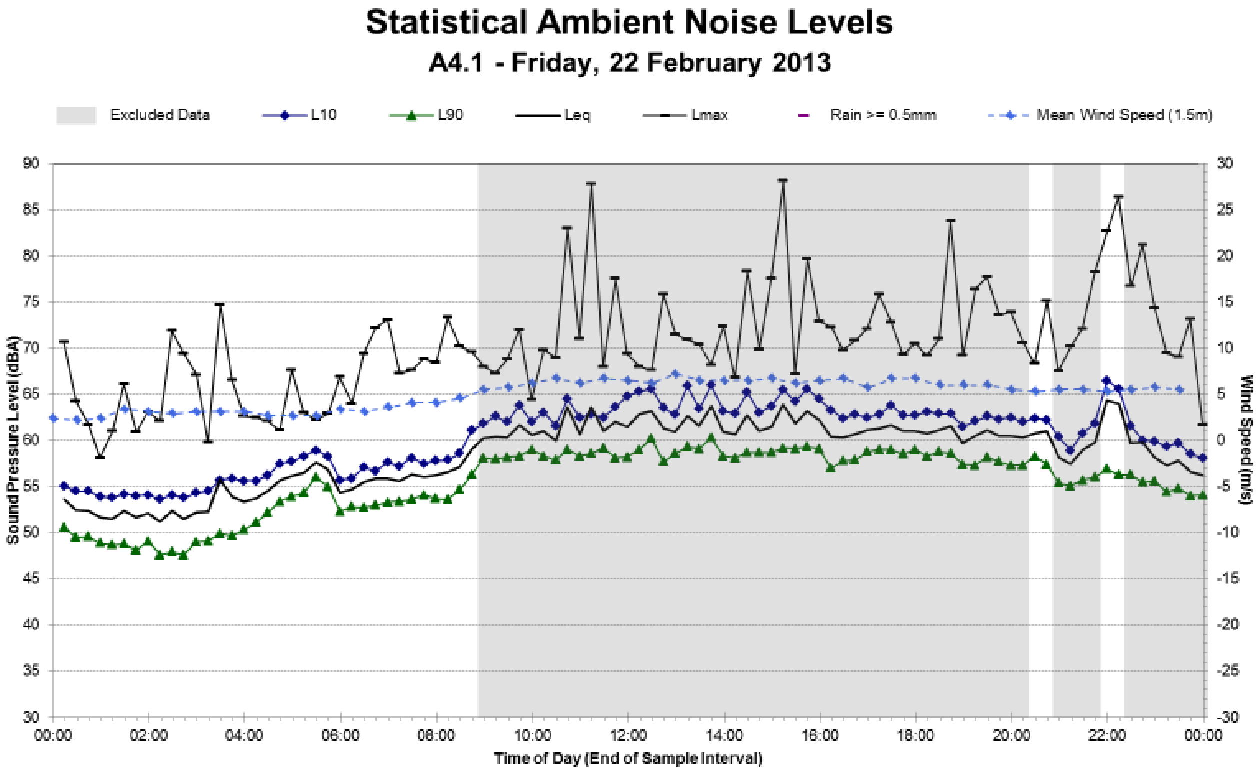
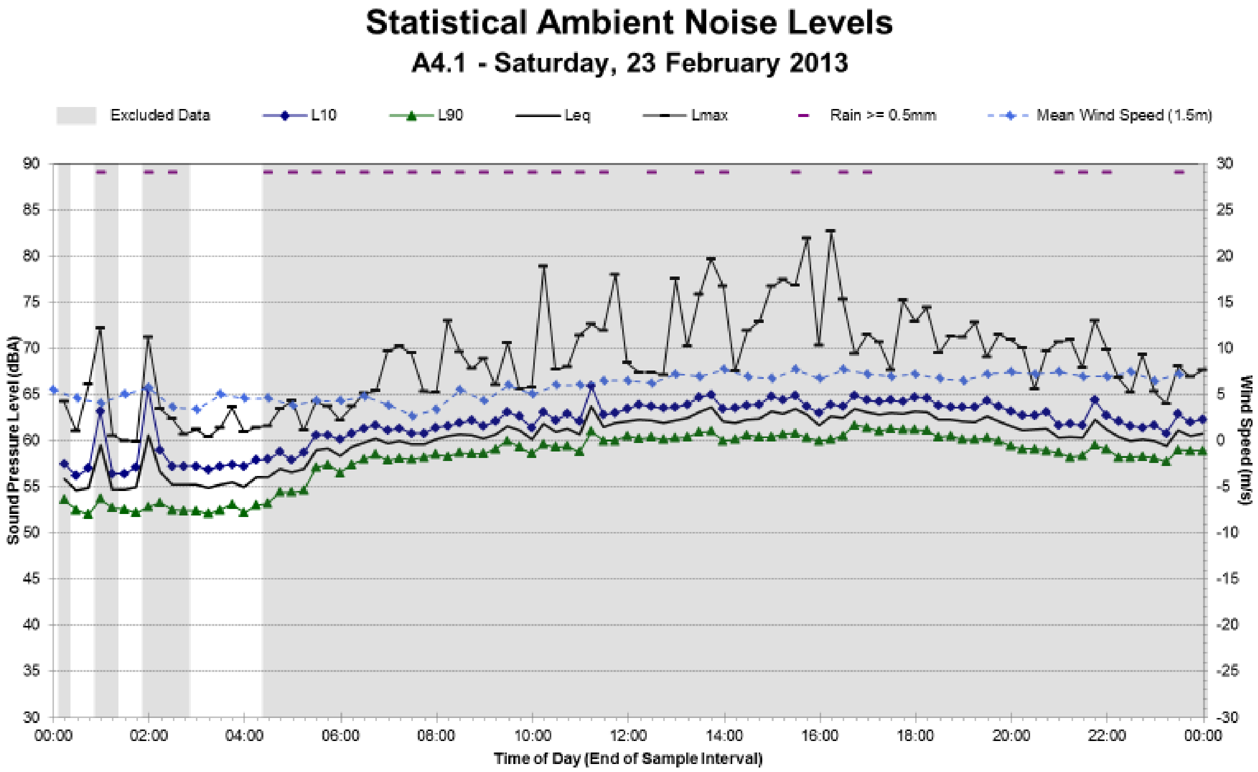
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A4 Ambient Noise Monitoring Results






Statistical Ambient Noise Levels
A4.1 - Saturday, 23 February 2013
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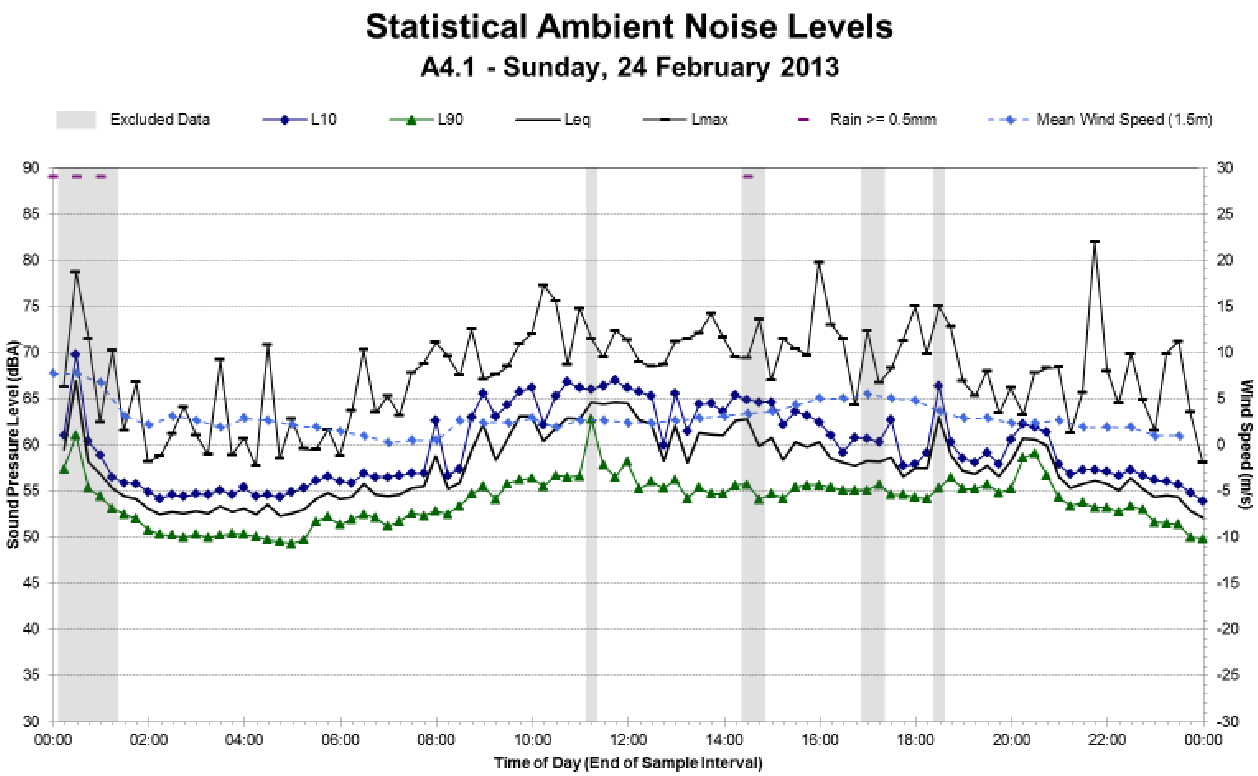
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A4.1 - Sunday, 24 February 2013
Excluded Data
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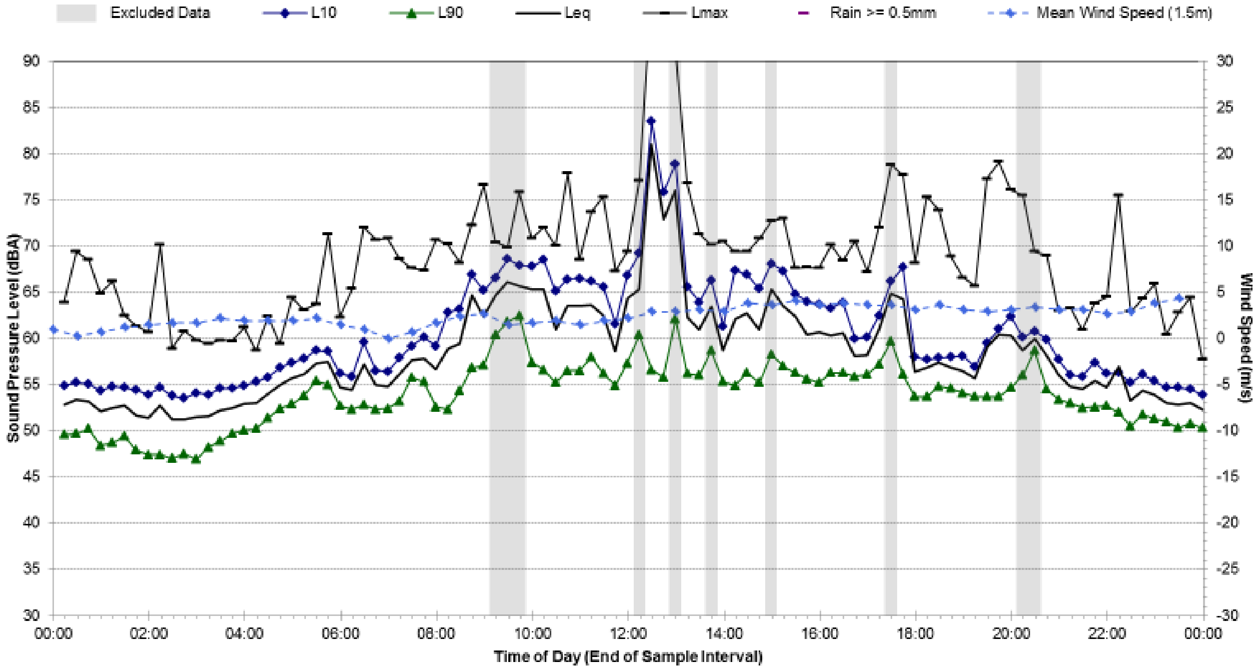
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Statistical Ambient Noise Levels
A4.1 - Monday, 25 February 2013



Statistical Ambient Noise Levels
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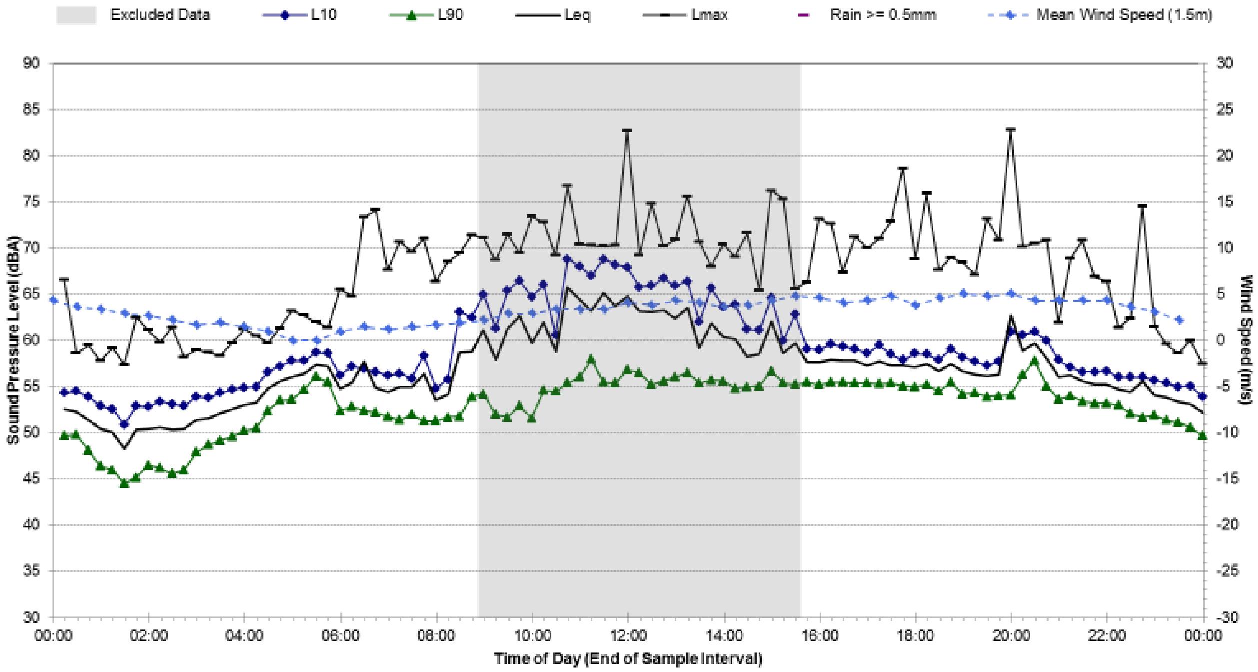
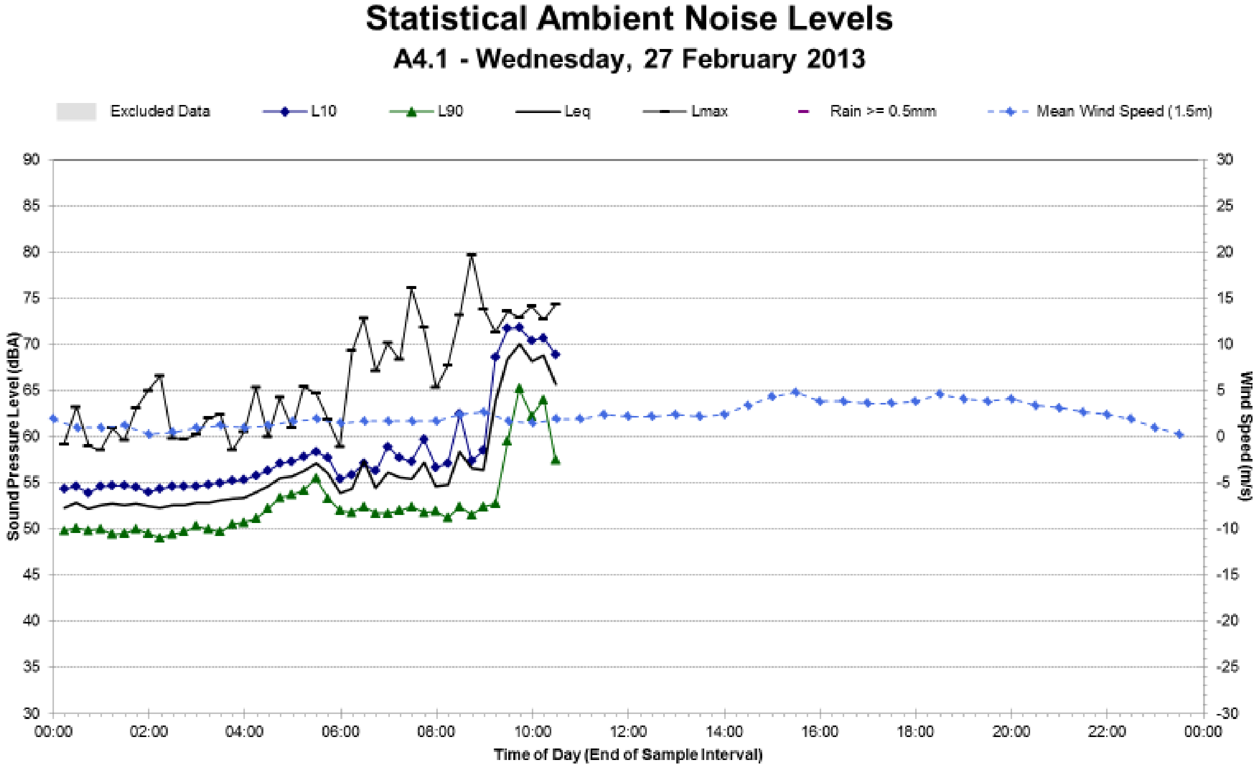


A4 Ambient Noise Monitoring Results



Noise Monitoring Location:	**A4.2**
Noise Monitoring Address:	**8 Yeend Street, Merrylands**

Logger Device Type: Svantek 957
Logger Serial No: 27578

Ambient noise logger deployed immediately outside residential address 8 Yeend Street, Merrylands. Logger located in front yard on western side of property.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 during the daytime. Constant tyre-pavement noise from light-vehicle traffic on the M4 can be heard at this location with discrete traffic noise level peaks from heavy vehicle movements occurring frequently.

Recorded Noise Levels (LAmax):
M4 Heavy-vehicle road traffic: 62-67dBA, Local road traffic: 63 - 66 dBA, Insects: 60 – 62 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	57	61	63	66
Evening	57	61	62	65
Night-time	51	58	60	63

Ambient Noise Logging Results – RNP Defined Time Periods

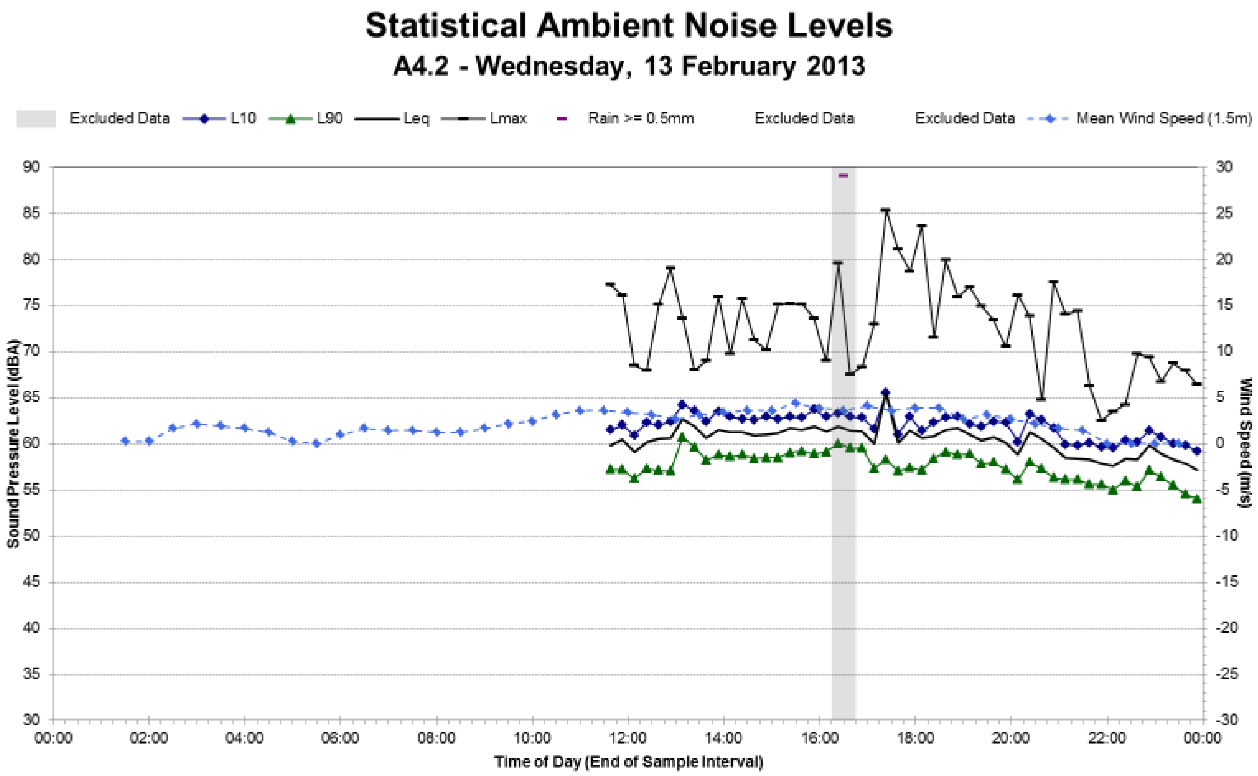
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	8	2	N/A (7 Day Average)
Daytime (7am-10pm)	61	60	61
Night-time (10pm-7am)	58	59	58

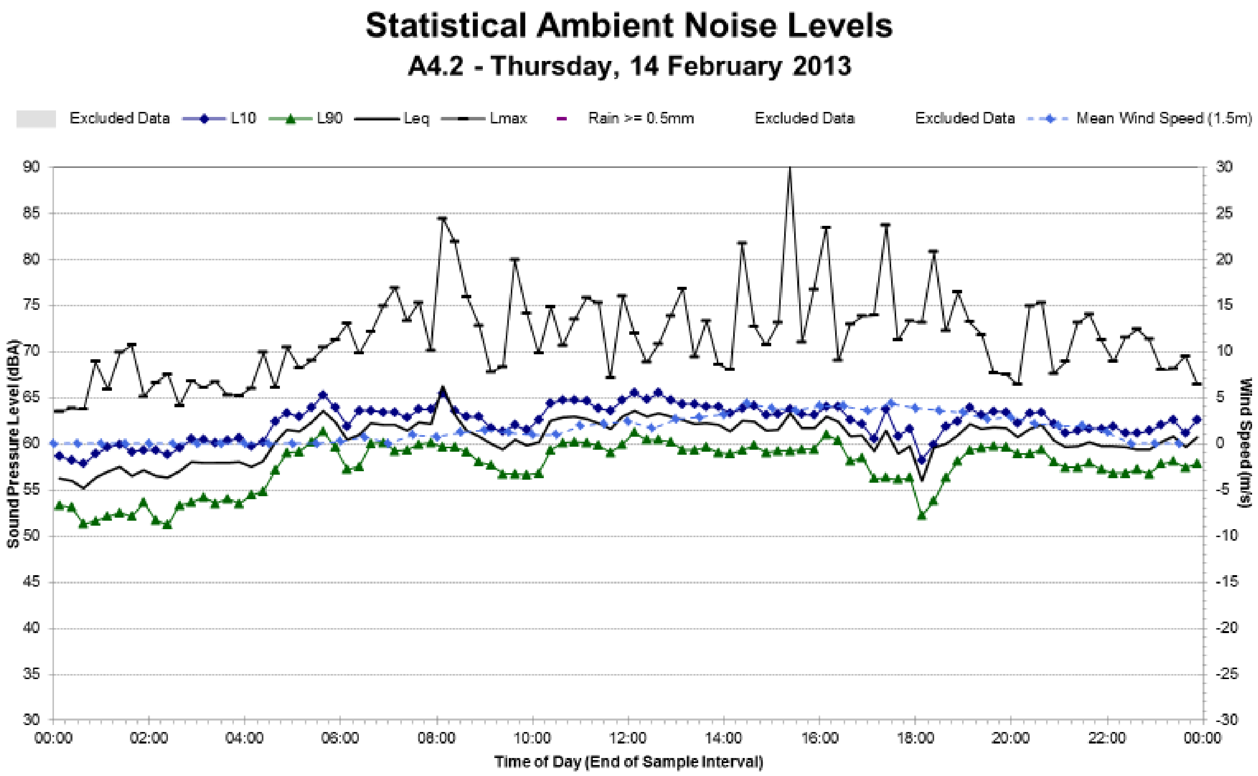
Attended Noise Measurement Results

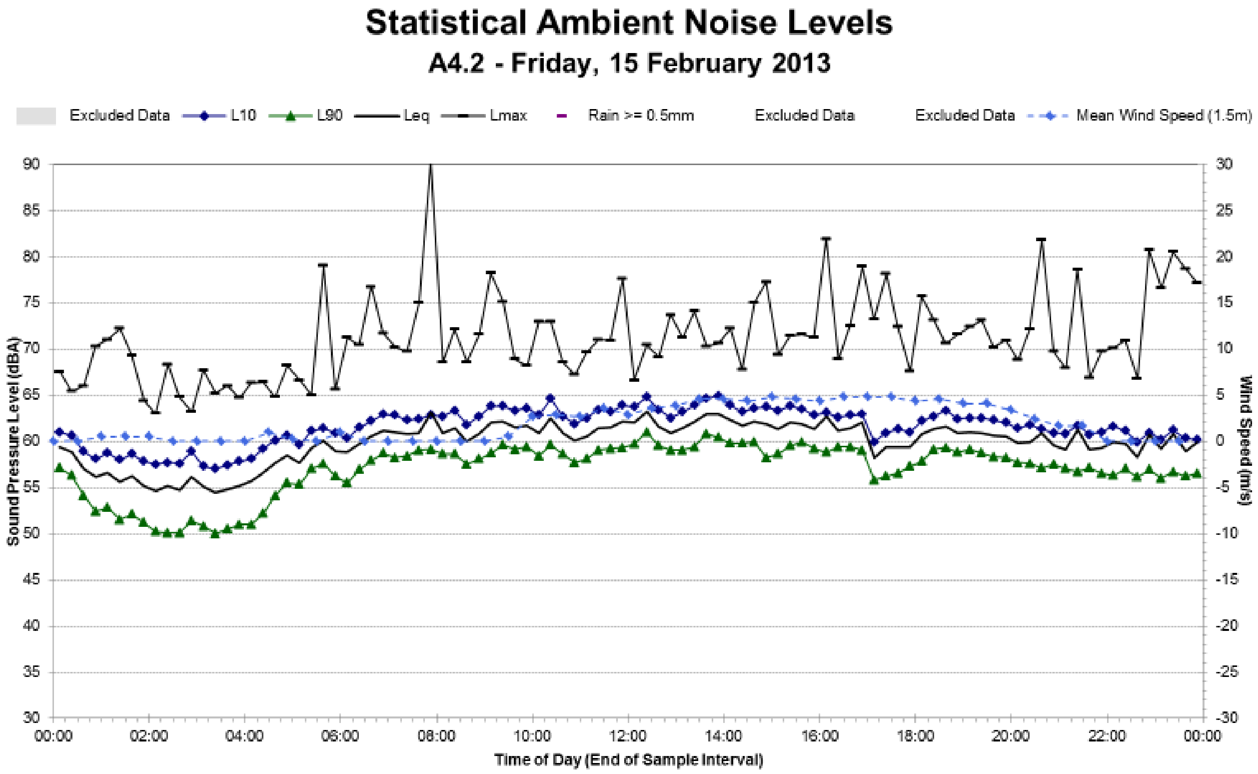
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
13/02/2013		57	60	72

Photo of Noise Monitoring Location

A4 Ambient Noise Monitoring Results



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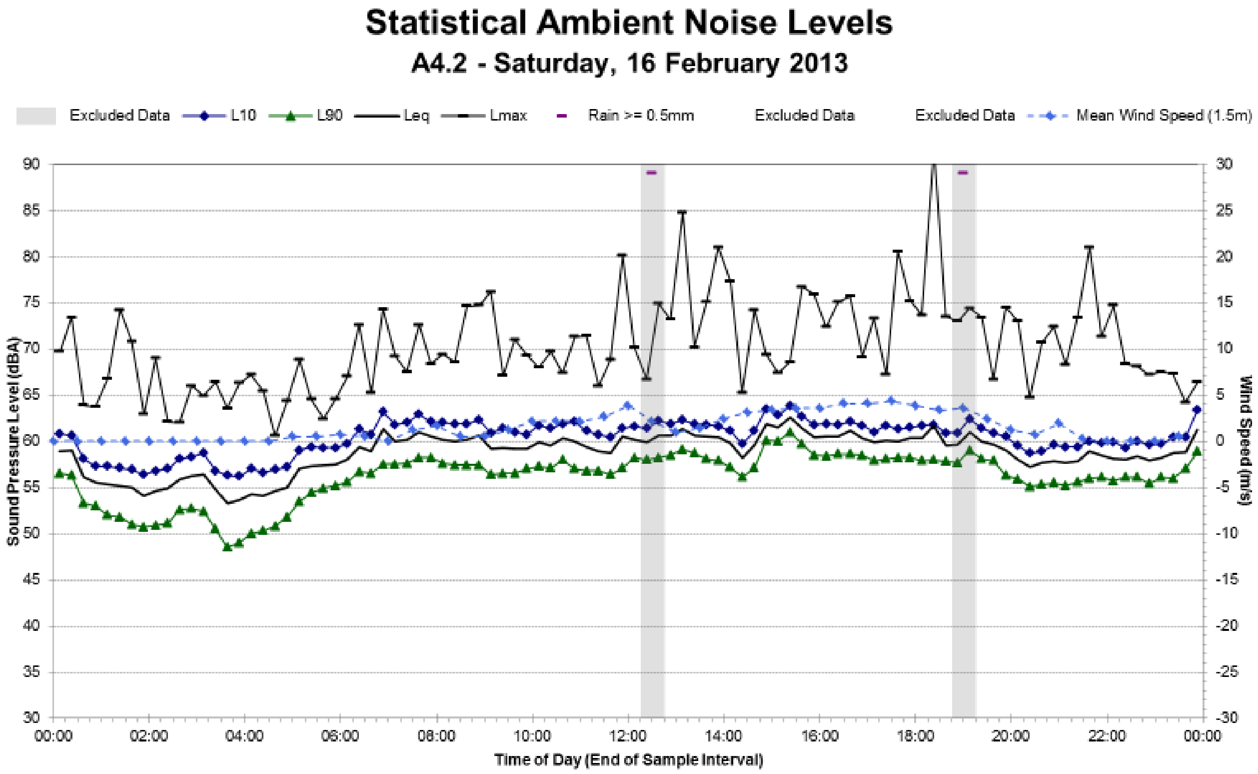
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)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Lmax
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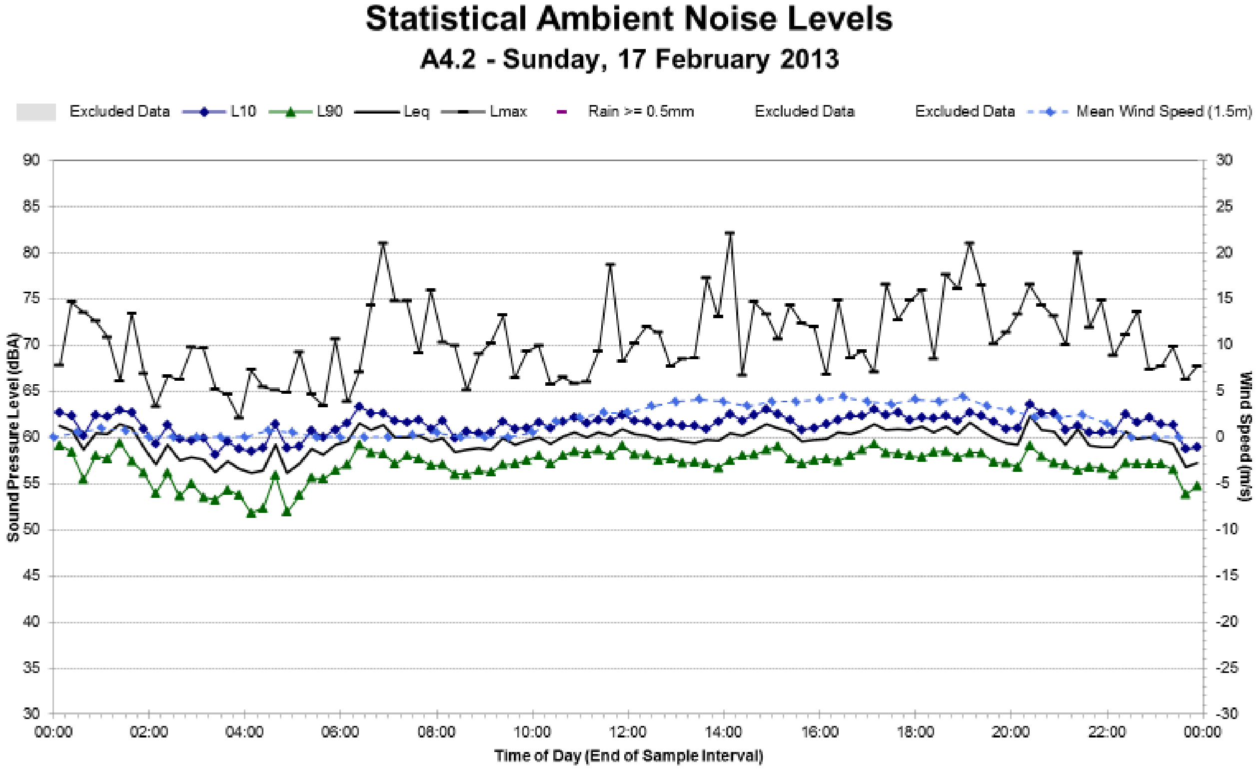
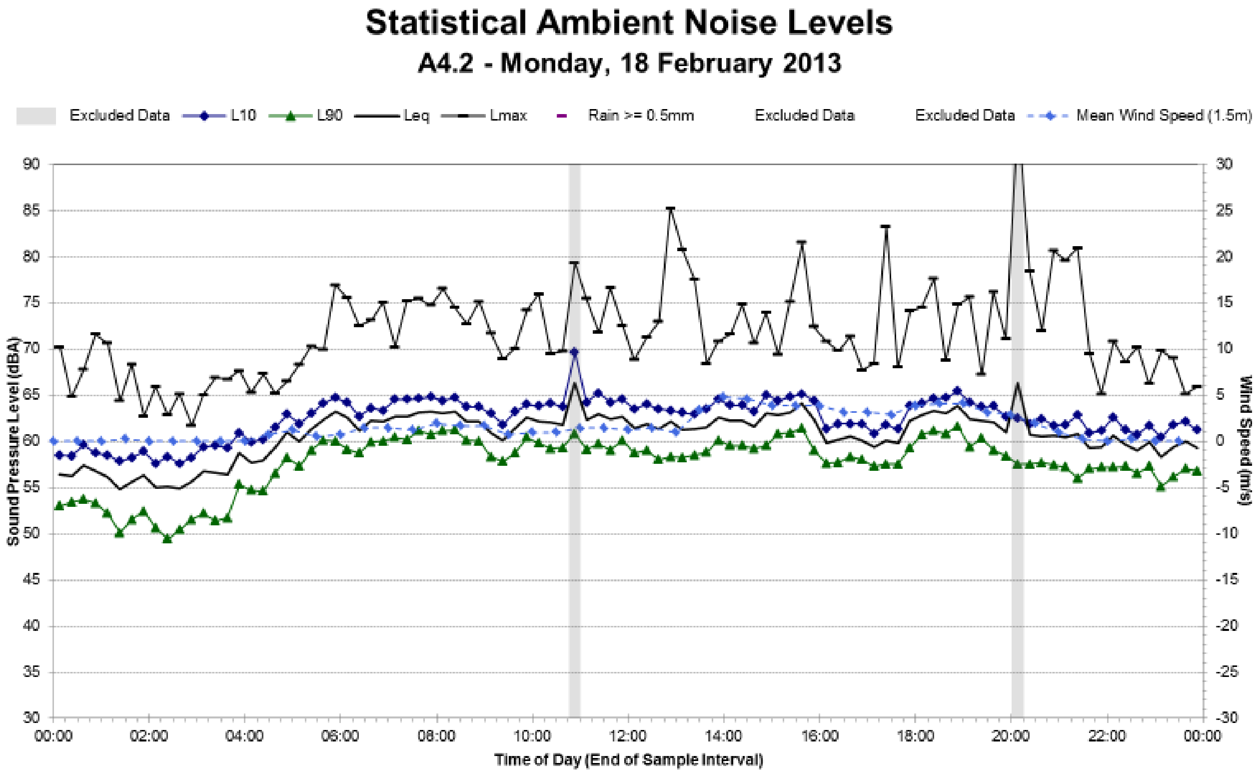
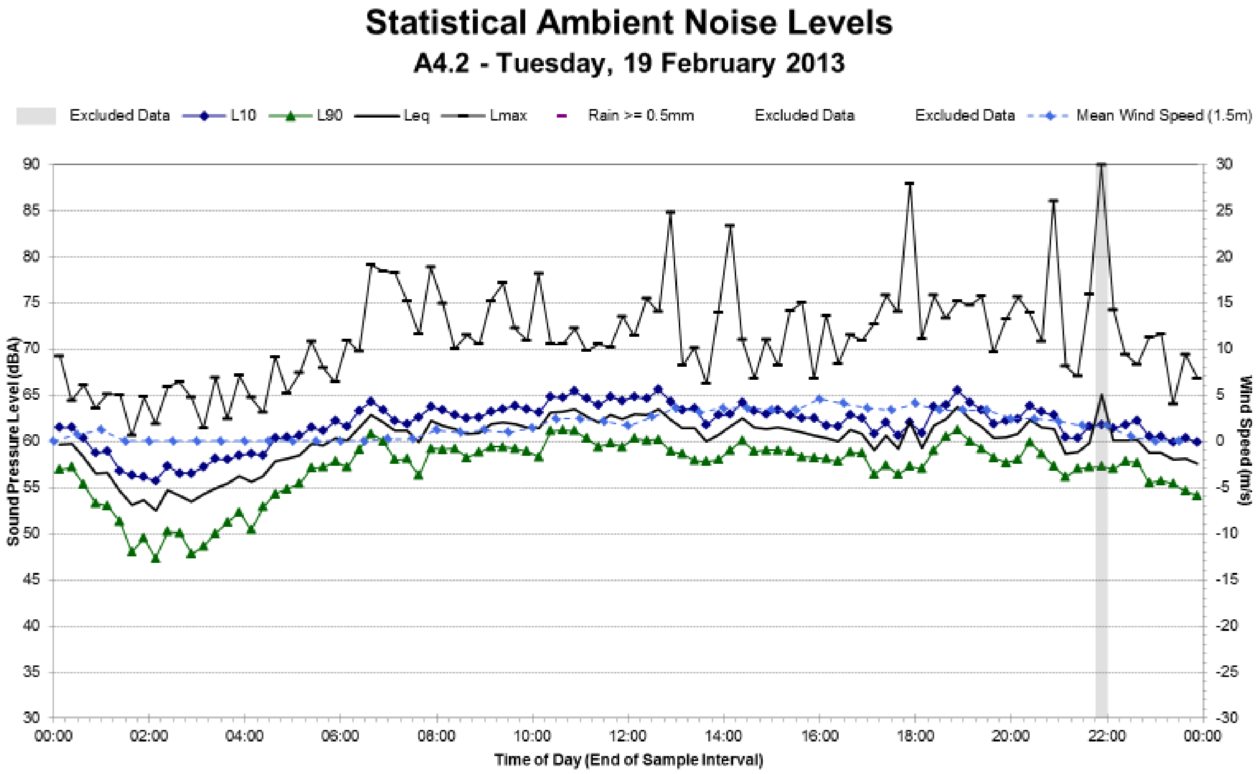
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

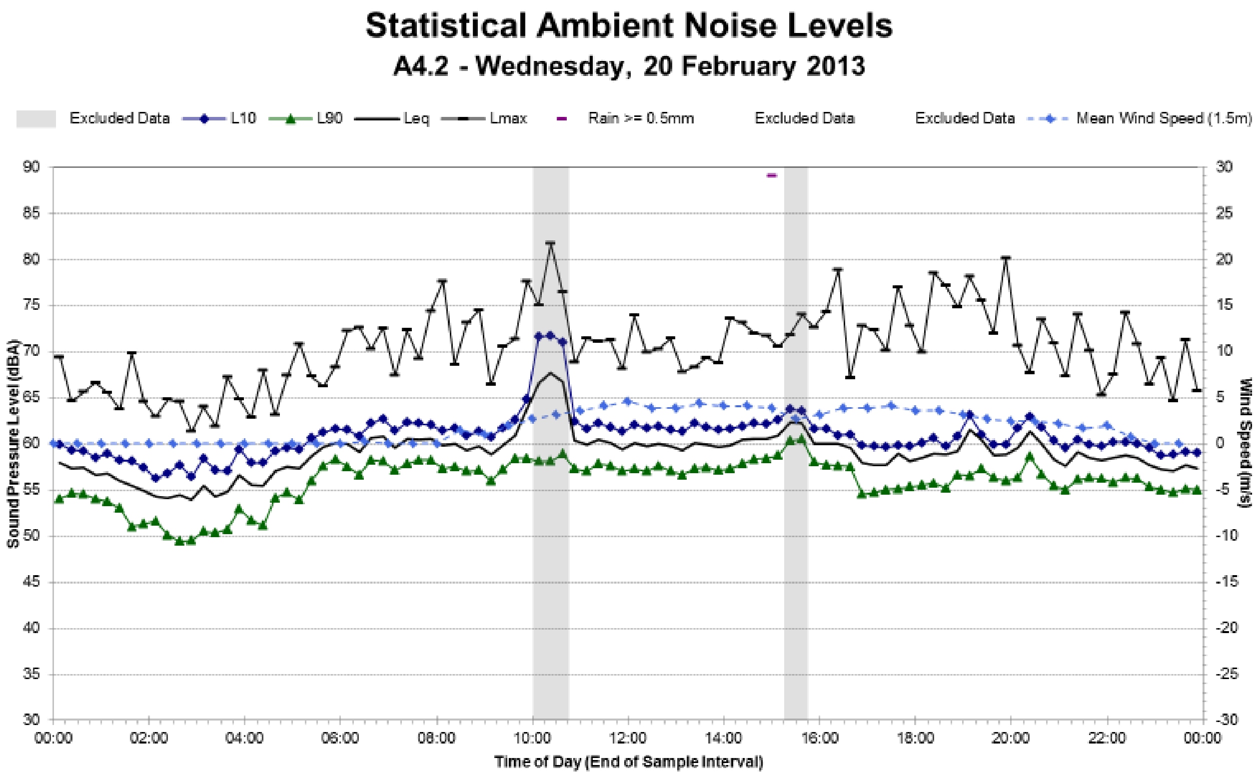
A4 Ambient Noise Monitoring Results

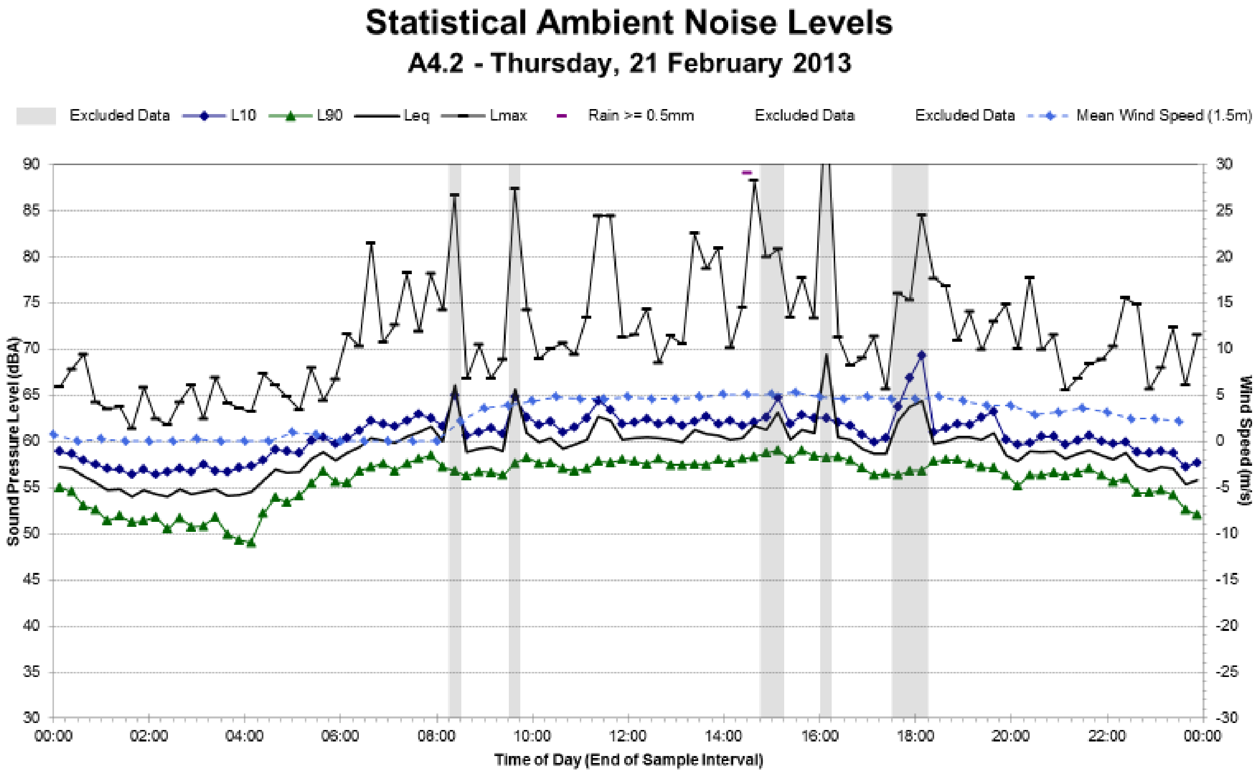




A4 Ambient Noise Monitoring Results



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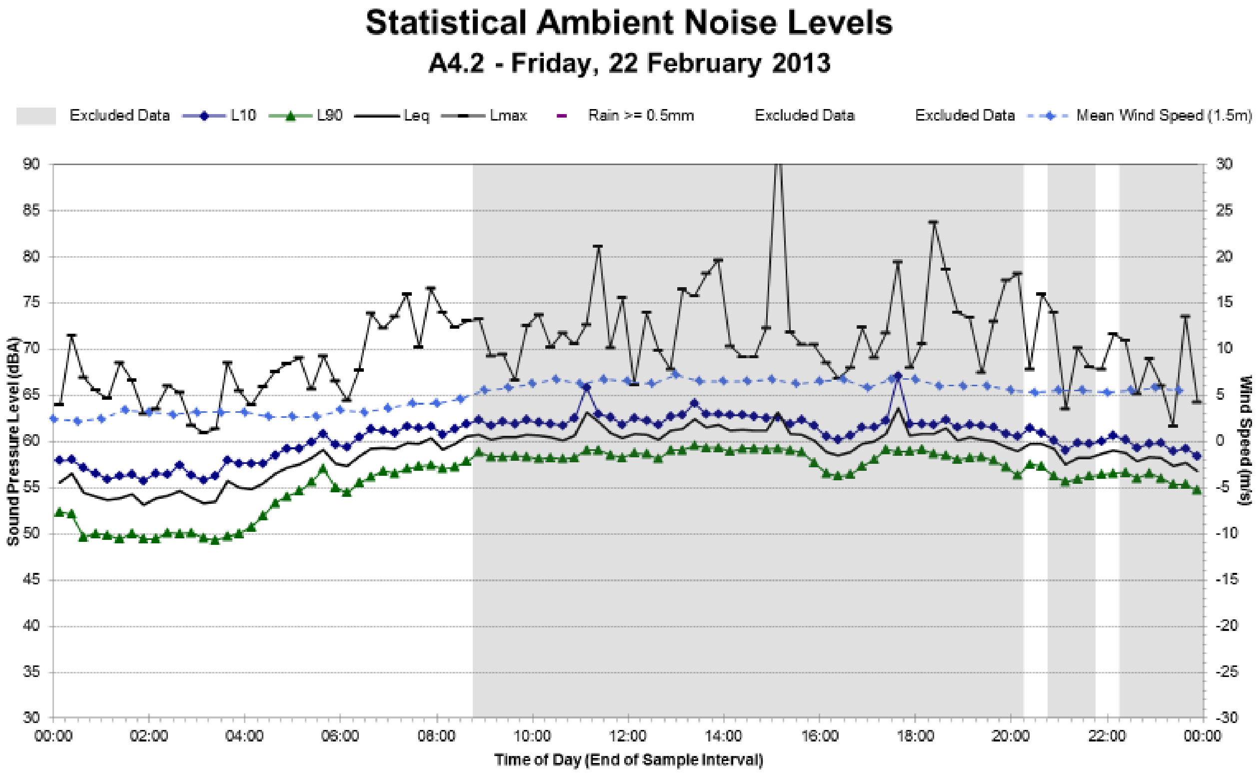
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)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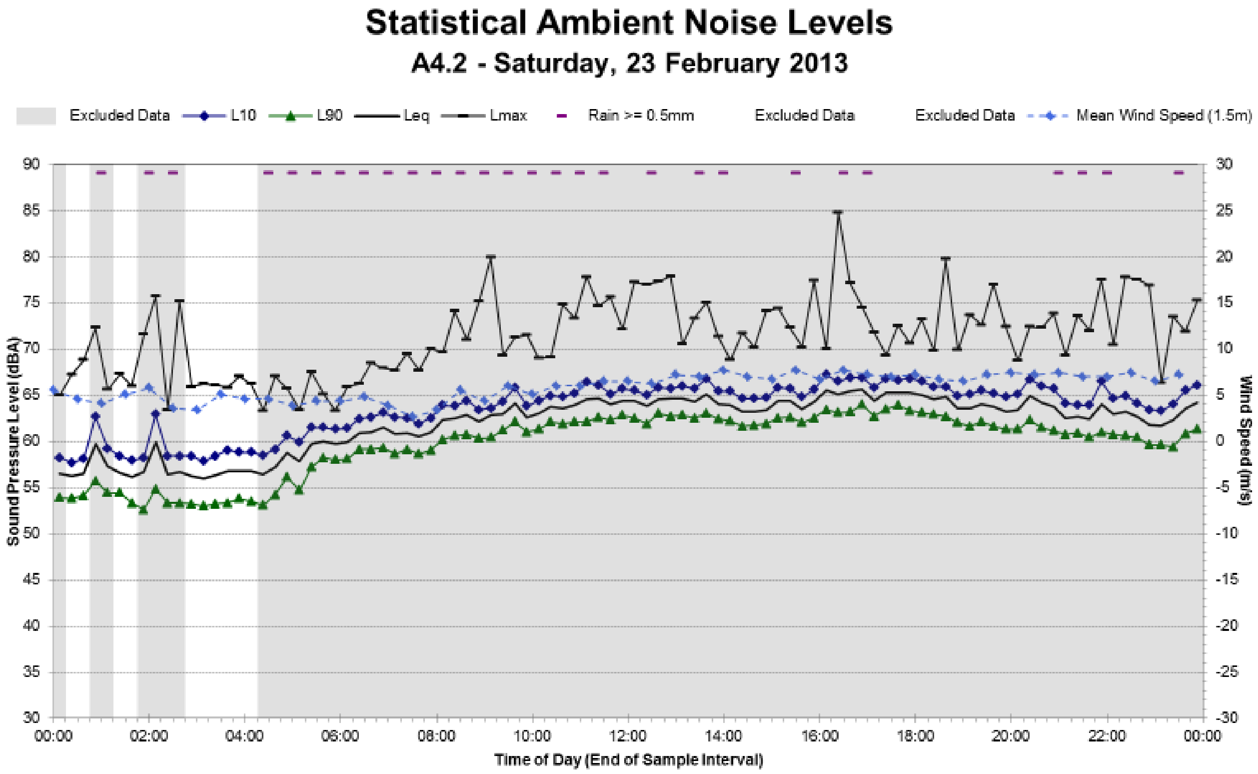
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A4.2 - Saturday, 23 February 2013
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Rain >= 0.5mm
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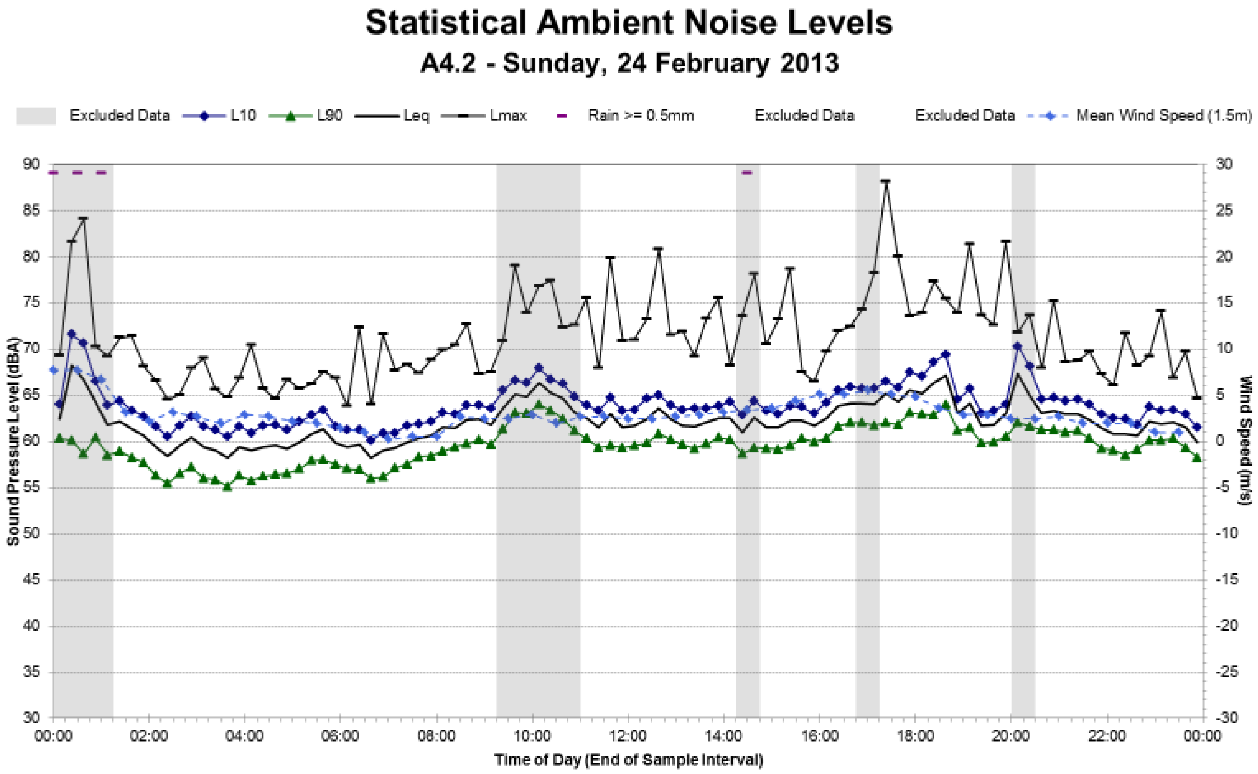
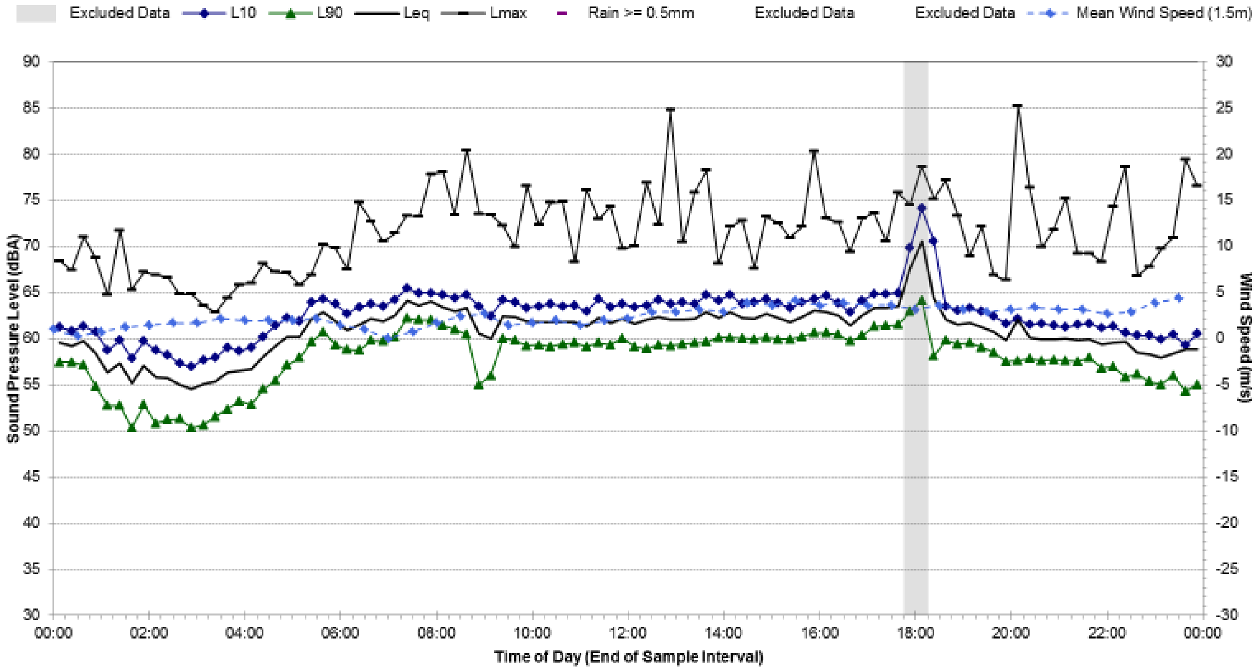
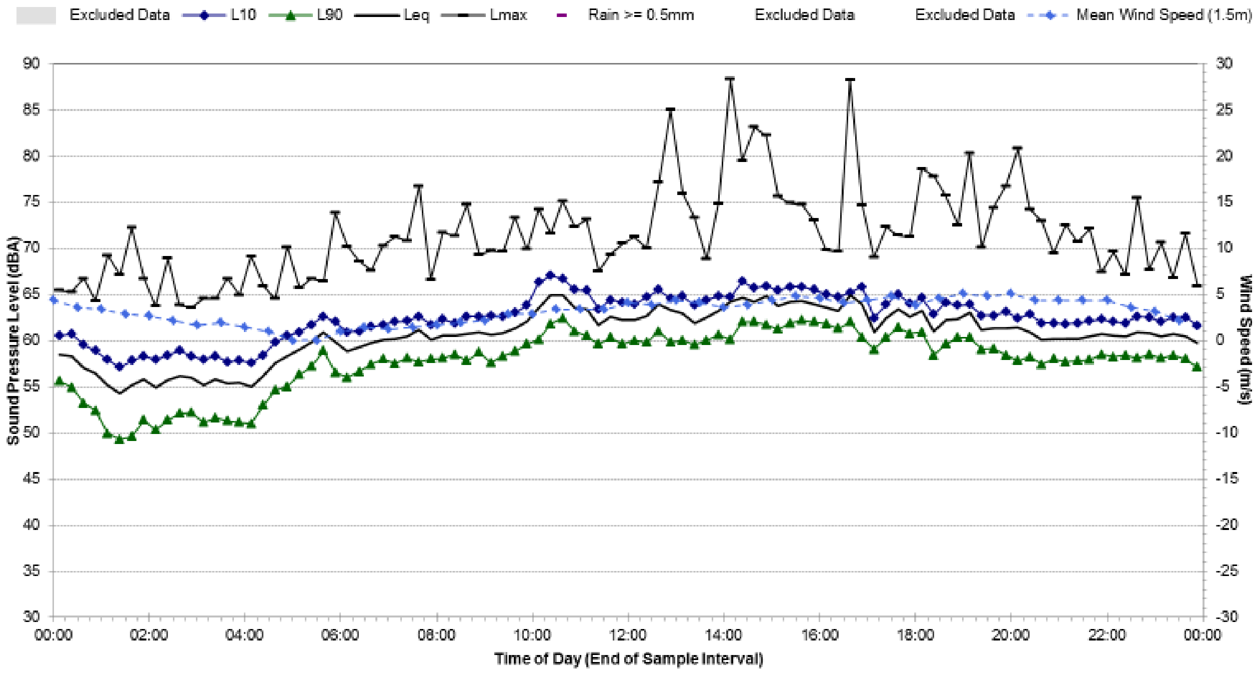
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

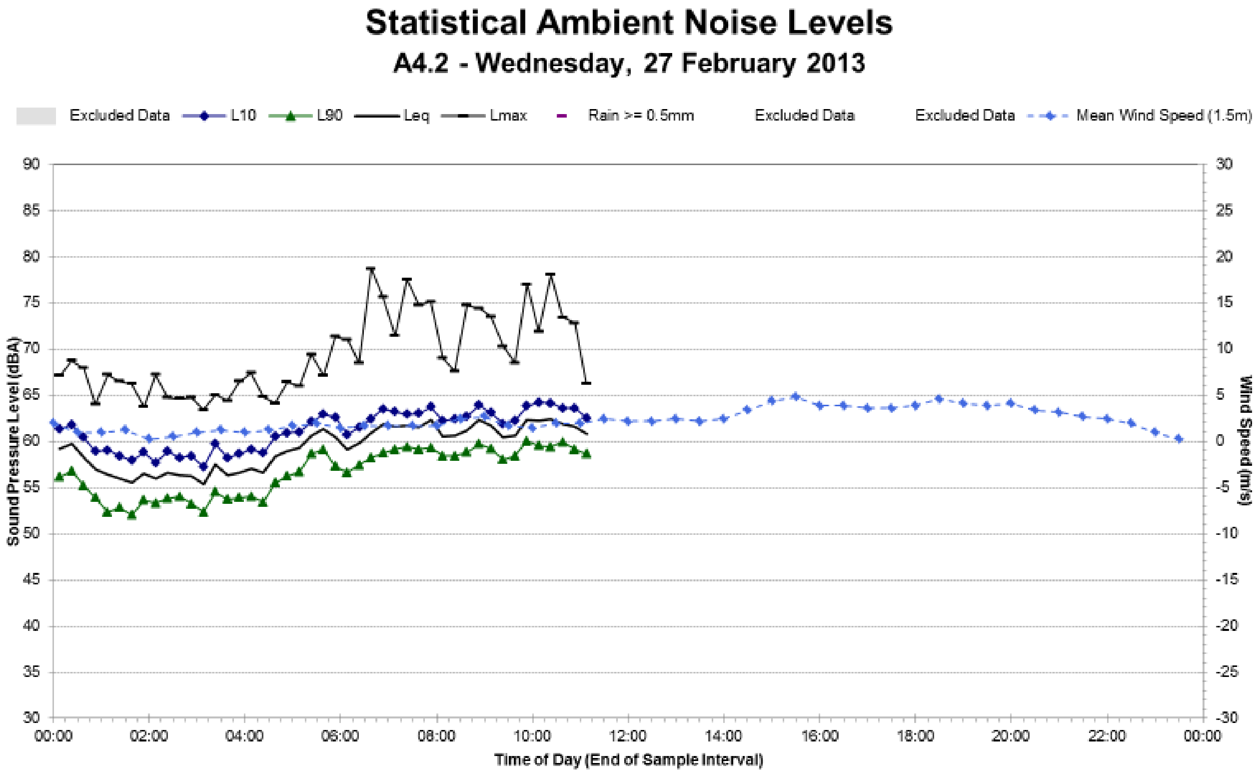

Statistical Ambient Noise Levels
A4.2 - Sunday, 24 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Statistical Ambient Noise Levels
A4.2 - Monday, 25 February 2013



Statistical Ambient Noise Levels
A4.2 - Tuesday, 26 February 2013




Statistical Ambient Noise Levels
A4.2 - Wednesday, 27 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A5 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A5.1**
Noise Monitoring Address:	**13/35 Brewer Crescent, South Wentworthville**

Logger Device Type: Svantek 957
Logger Serial No: 23814

Ambient noise logger deployed immediately outside residential address 13/35 Brewer Crescent, South Wentworthville. Logger located in rear yard on northern side of property.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 during the daytime. Constant tyre-pavement noise from light-vehicle traffic on the M4 can be heard at this location with discrete traffic noise level peaks from heavy vehicle movements occurring frequently.

Recorded Noise Levels (LAmax):
M4 Heavy-vehicle road traffic: 61-72dBA, Light vehicle traffic: 60 - 62 dBA, Birds: 57 – 58 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	54	61	63	66
Evening	54	60	62	64
Night-time	46	57	59	63

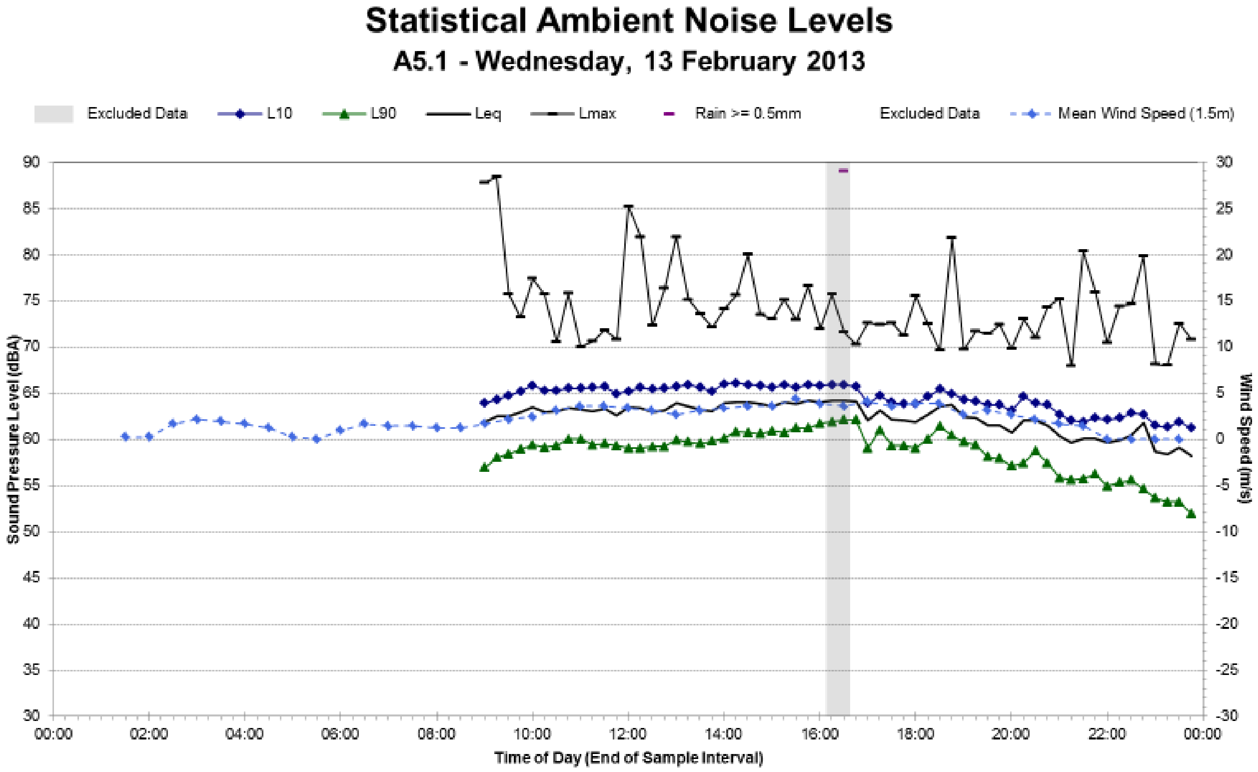
Ambient Noise Logging Results – RNP Defined Time Periods

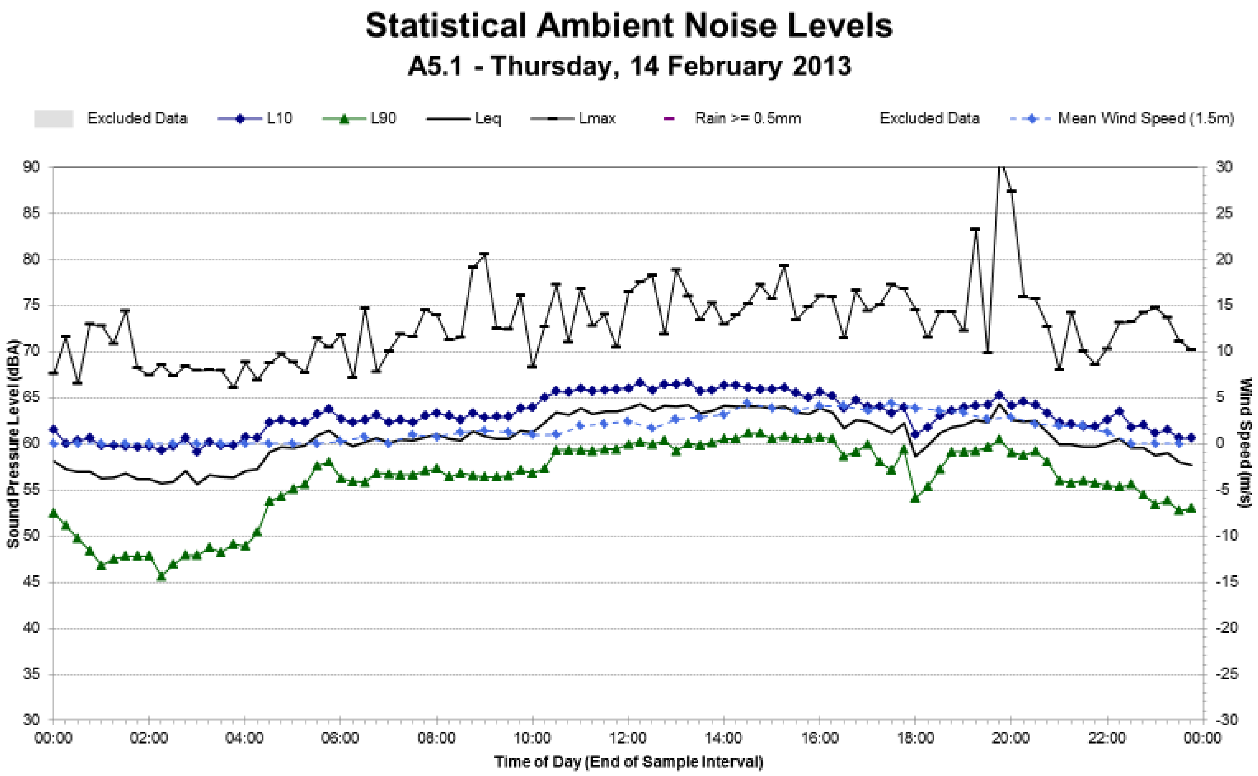
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	2	N/A (7 Day Average)
Daytime (7am-10pm)	61	60	61
Night-time (10pm-7am)	57	56	57

Attended Noise Measurement Results

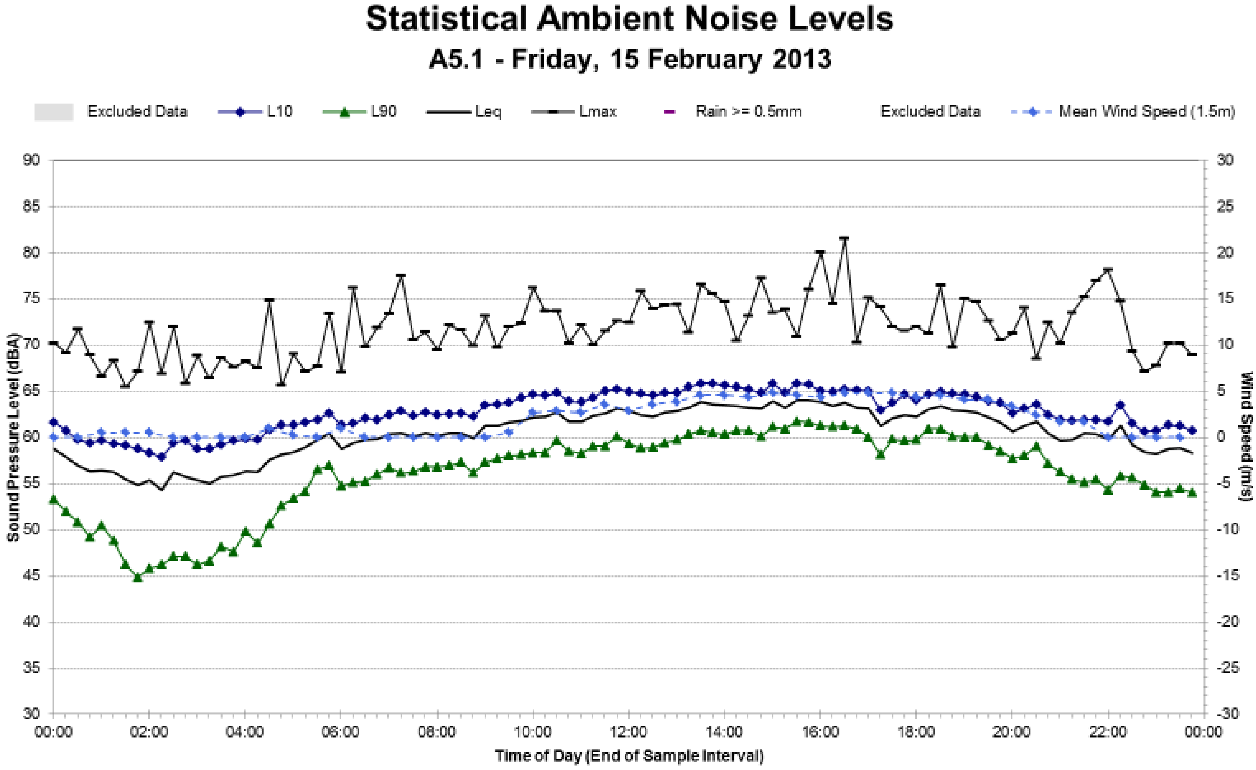
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
13/02/2013	08:56	58	62	81

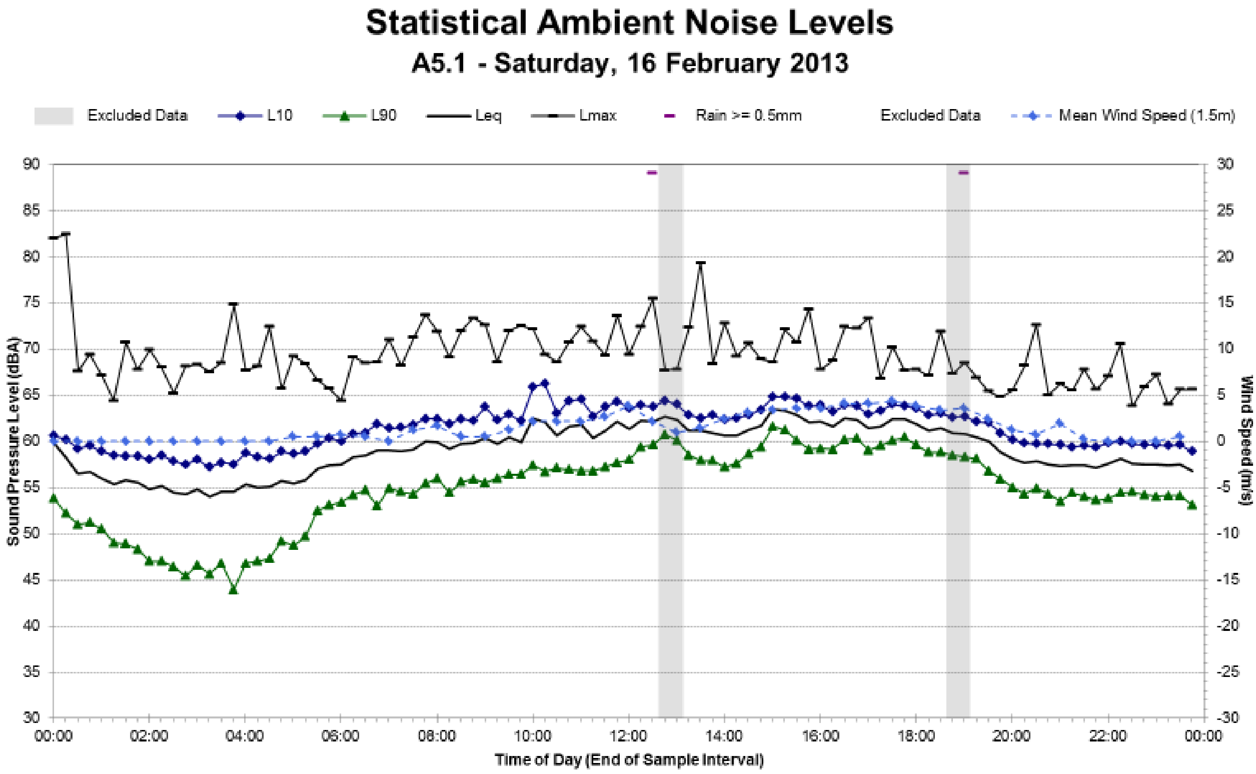
Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
A5.1 - Wednesday, 13 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
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
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

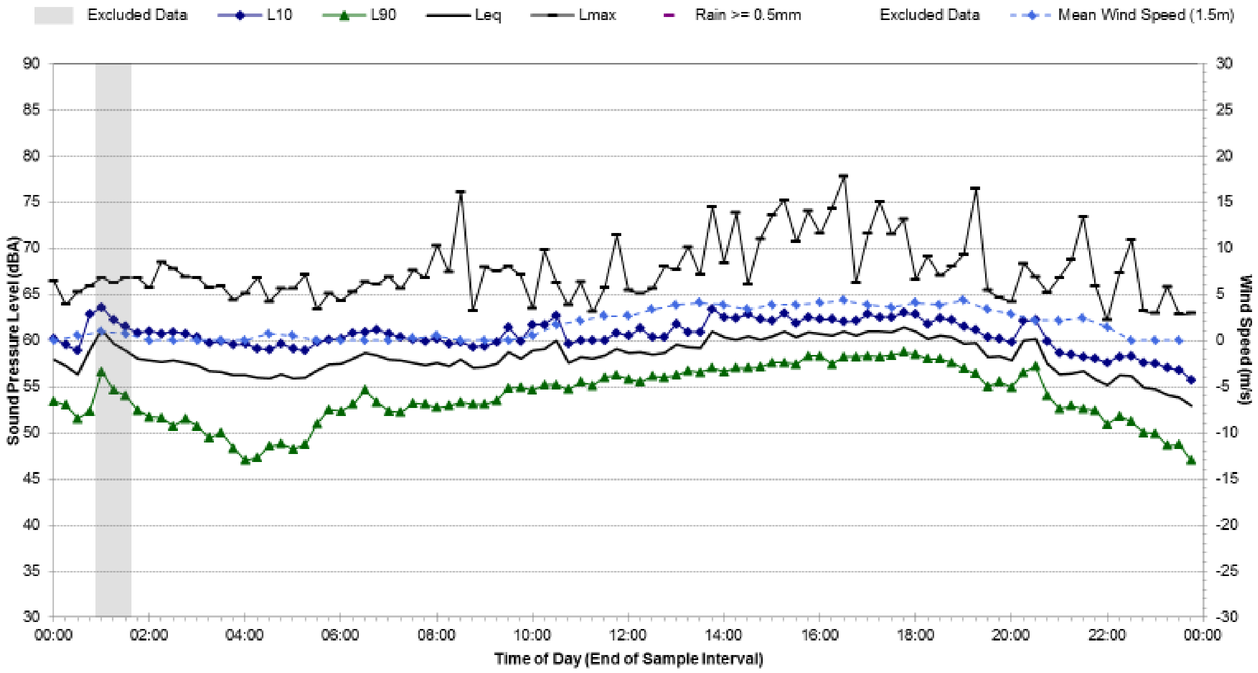

Statistical Ambient Noise Levels
A5.1 - Thursday, 14 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

A5 Ambient Noise Monitoring Results

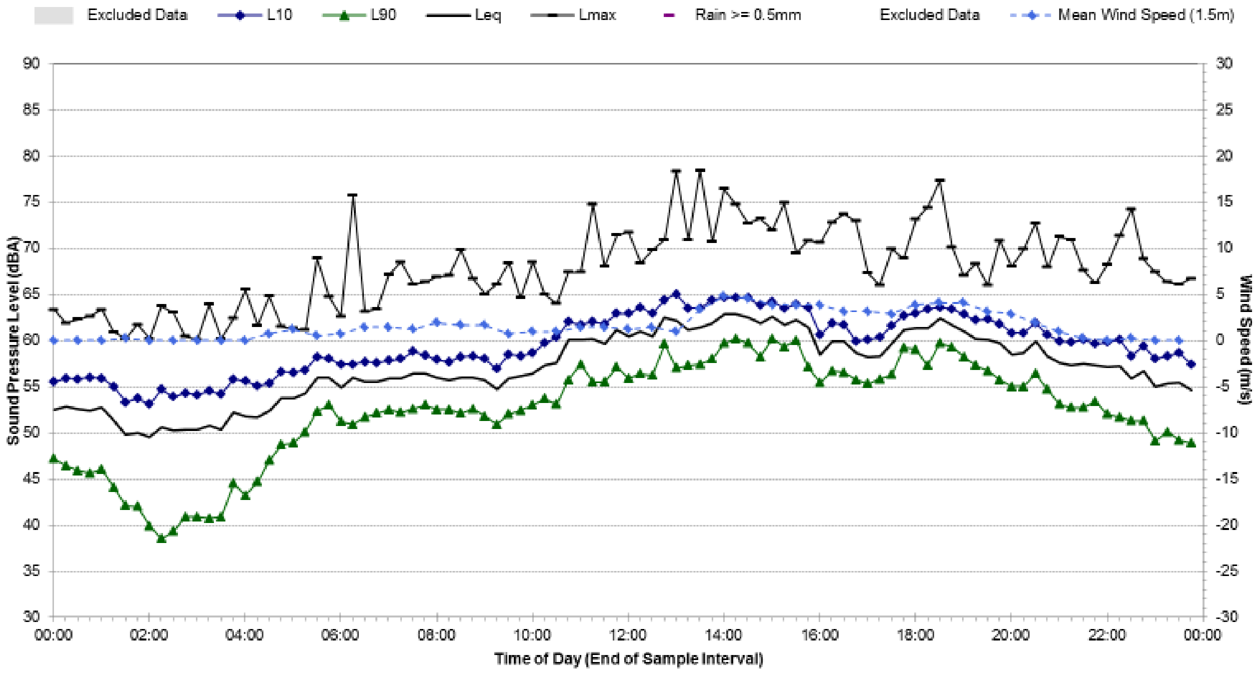


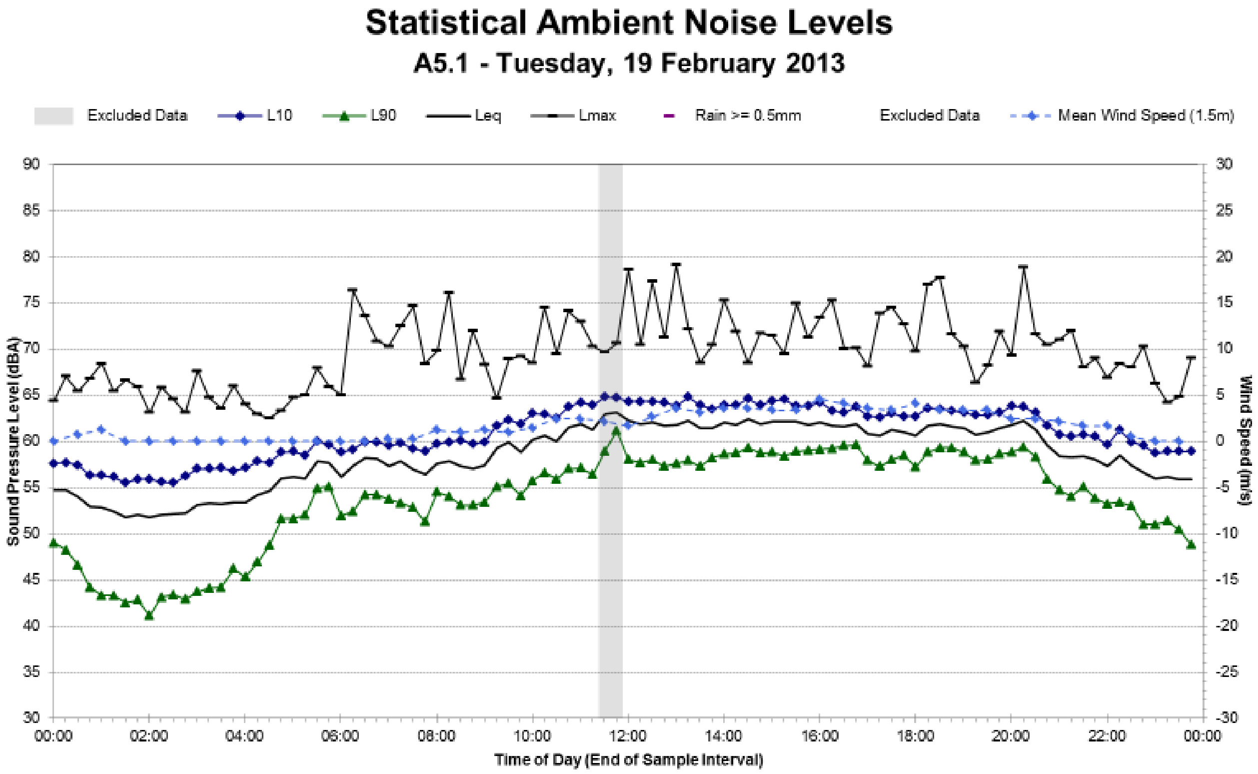


Statistical Ambient Noise Levels
A5.1 - Sunday, 17 February 2013



Statistical Ambient Noise Levels
A5.1 - Monday, 18 February 2013




Statistical Ambient Noise Levels
A5.1 - Tuesday, 19 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
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
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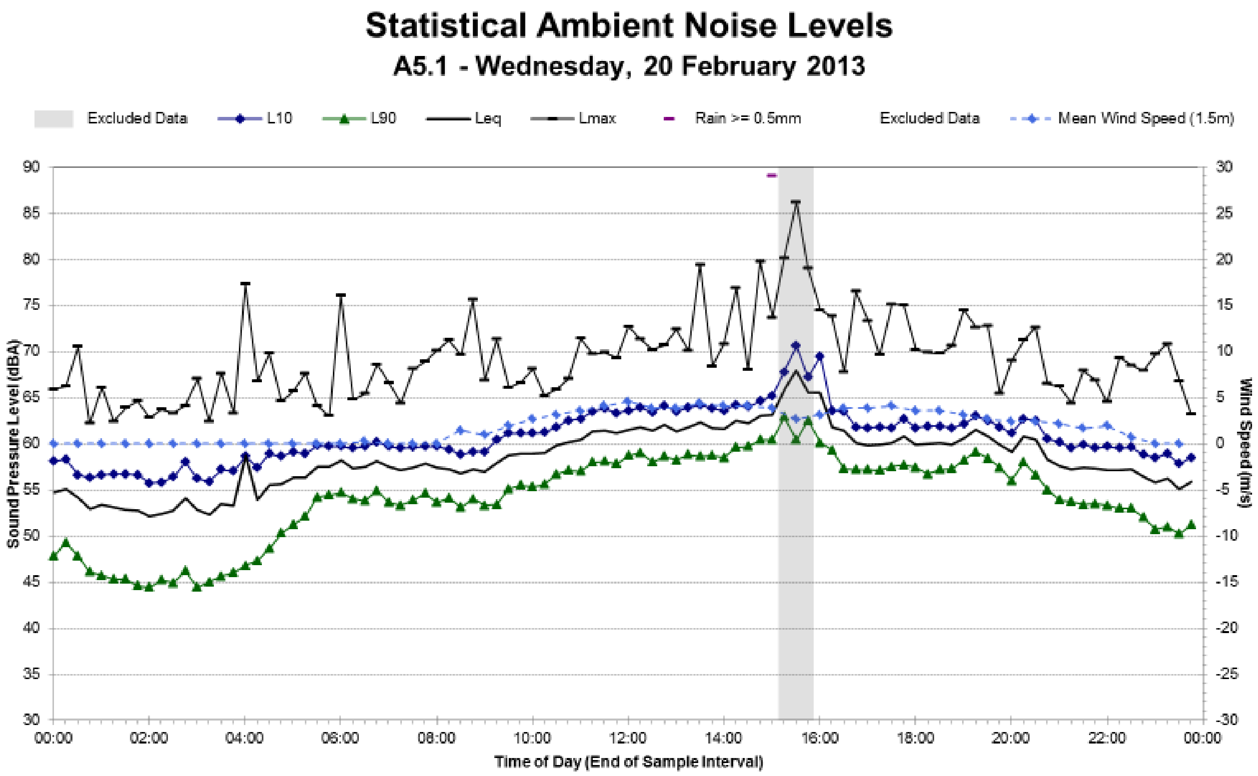
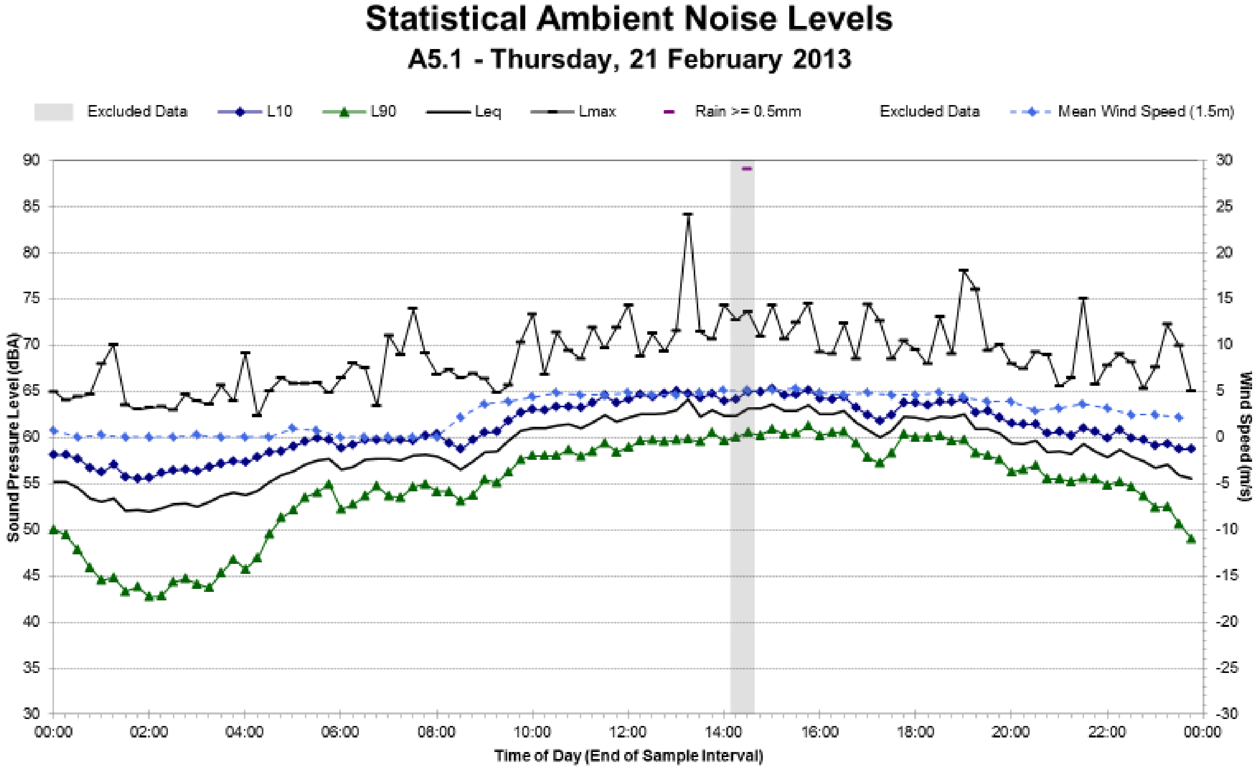
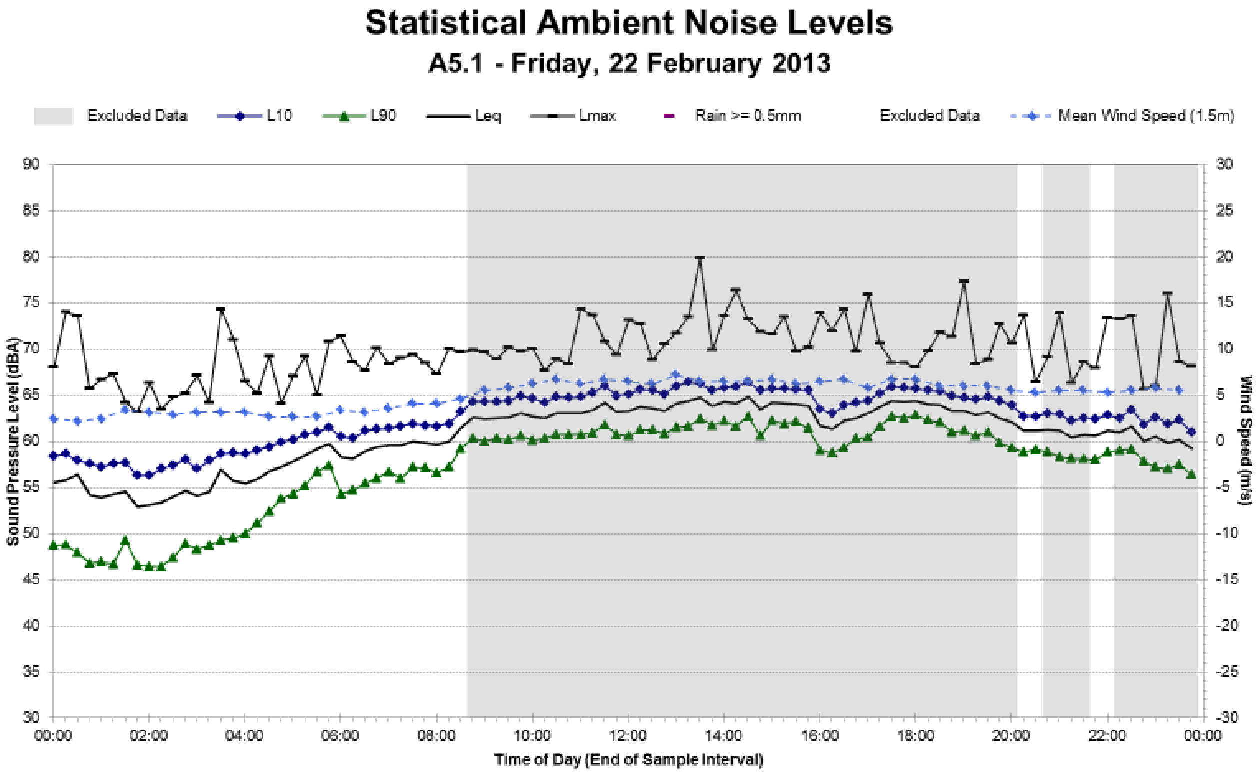
20:00
22:00
00:00

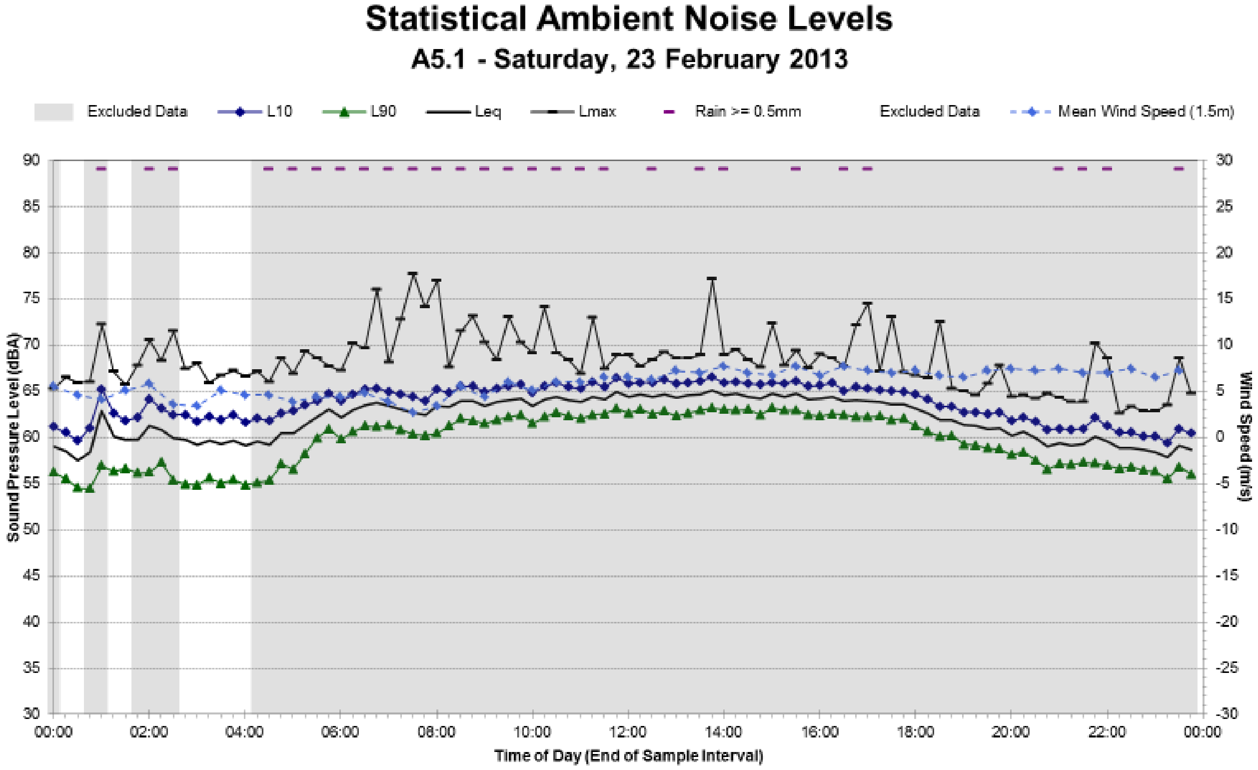

Statistical Ambient Noise Levels
A5.1 - Wednesday, 20 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-10
-15
-20
-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

A5 Ambient Noise Monitoring Results





A5 Ambient Noise Monitoring Results



Noise Monitoring Location:	**A5.2**
Noise Monitoring Address:	**233A Great Western Highway, South Wentworthville**

Logger Device Type: Svantek 957
Logger Serial No: 20665

Ambient noise logger deployed immediately outside residential 233A Great Western Highway, South Wentworthville. Logger located to the western side of property.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 during the daytime. Constant tyre-pavement noise from light-vehicle traffic on the M4 can be heard at this location with discrete traffic noise level peaks from heavy vehicle movements occurring frequently. Analysis of the ambient background noise levels indicated an extraneous noise source typically operates at 20:30 for approximately 30 minutes most nights. This discrete artefact event has been removed from the data set.

Recorded Noise Levels (LAmax):
M4 Heavy-vehicle road traffic: 64-70dBA, Light vehicle traffic: 65 - 67 dBA, Birds: 70 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	56	62	64	69
Evening	55	62	63	68
Night-time	47	58	59	64

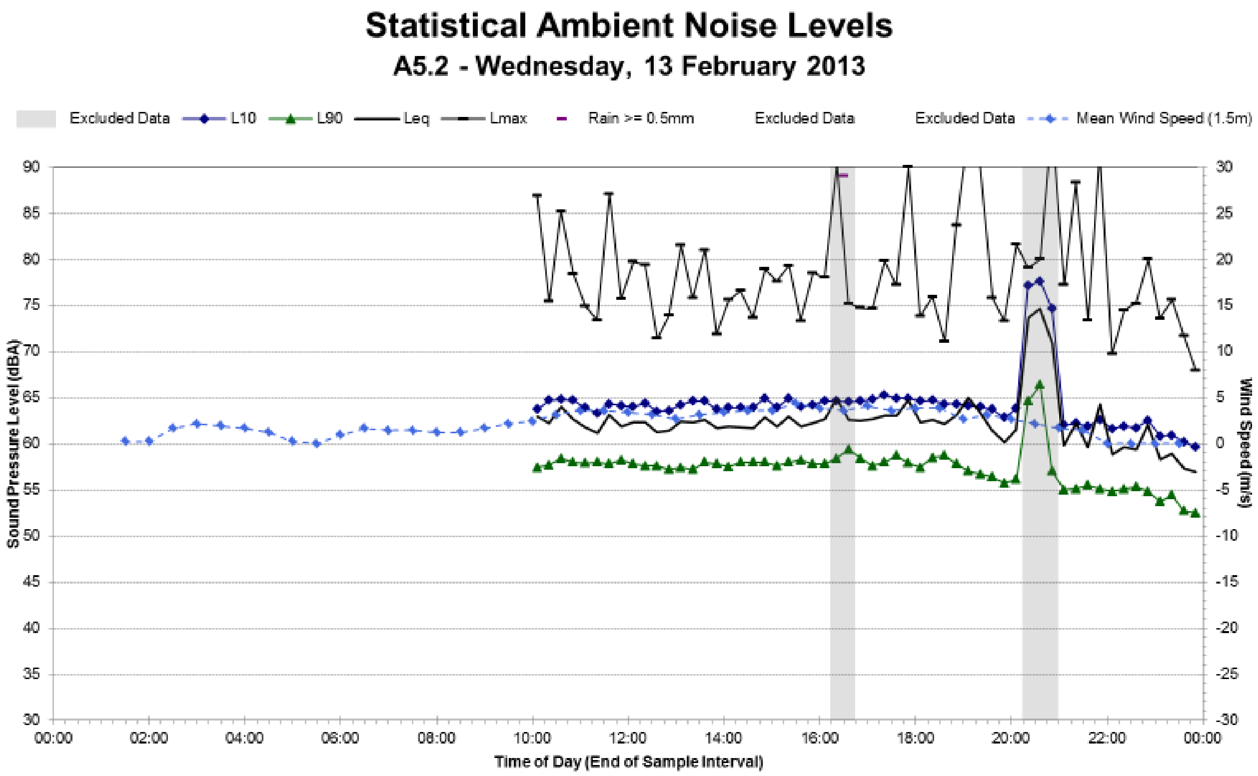
Ambient Noise Logging Results – RNP Defined Time Periods

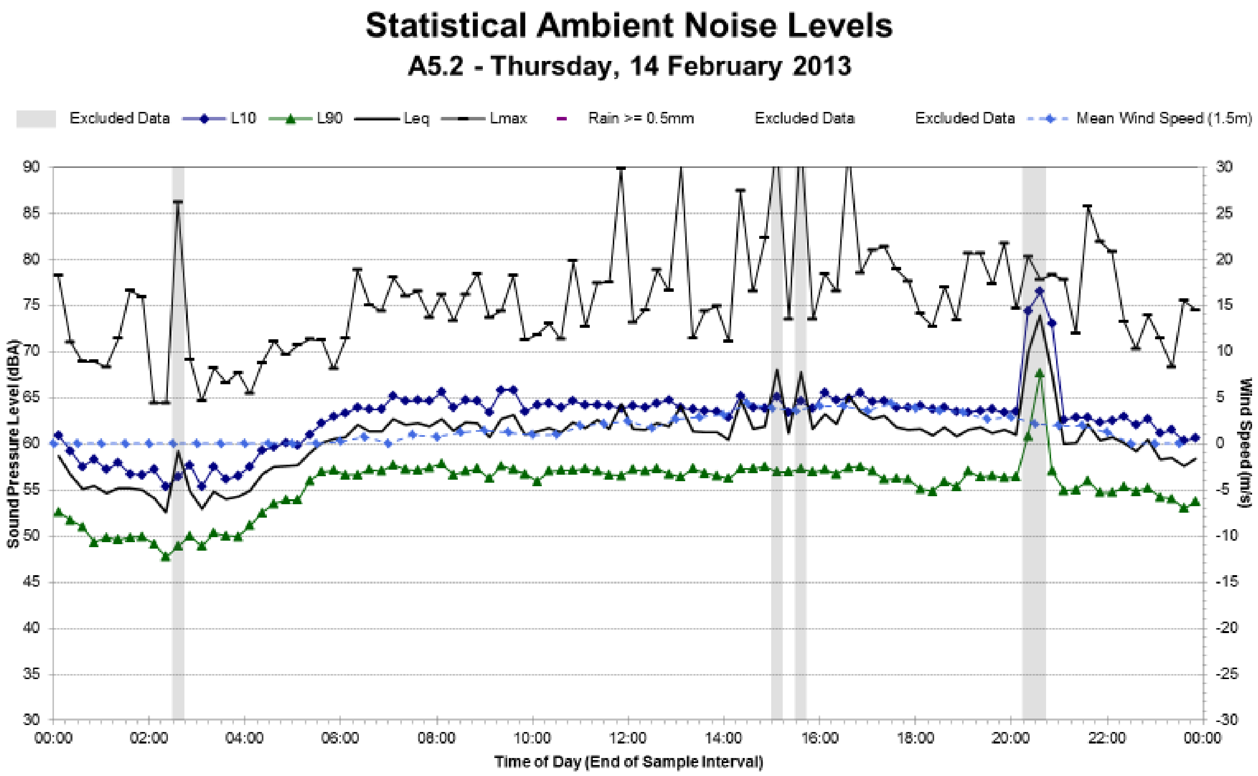
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	3	N/A (7 Day Average)
Daytime (7am-10pm)	62	62	62
Night-time (10pm-7am)	57	58	58

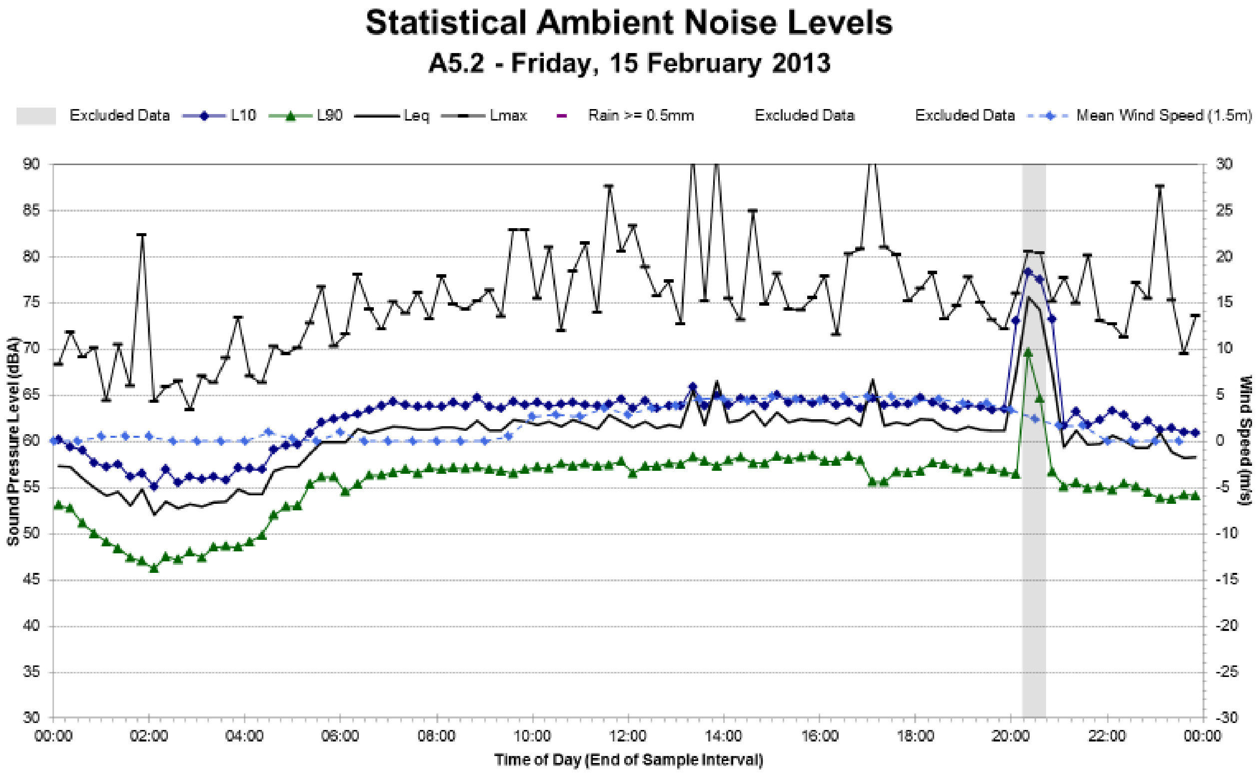
Attended Noise Measurement Results

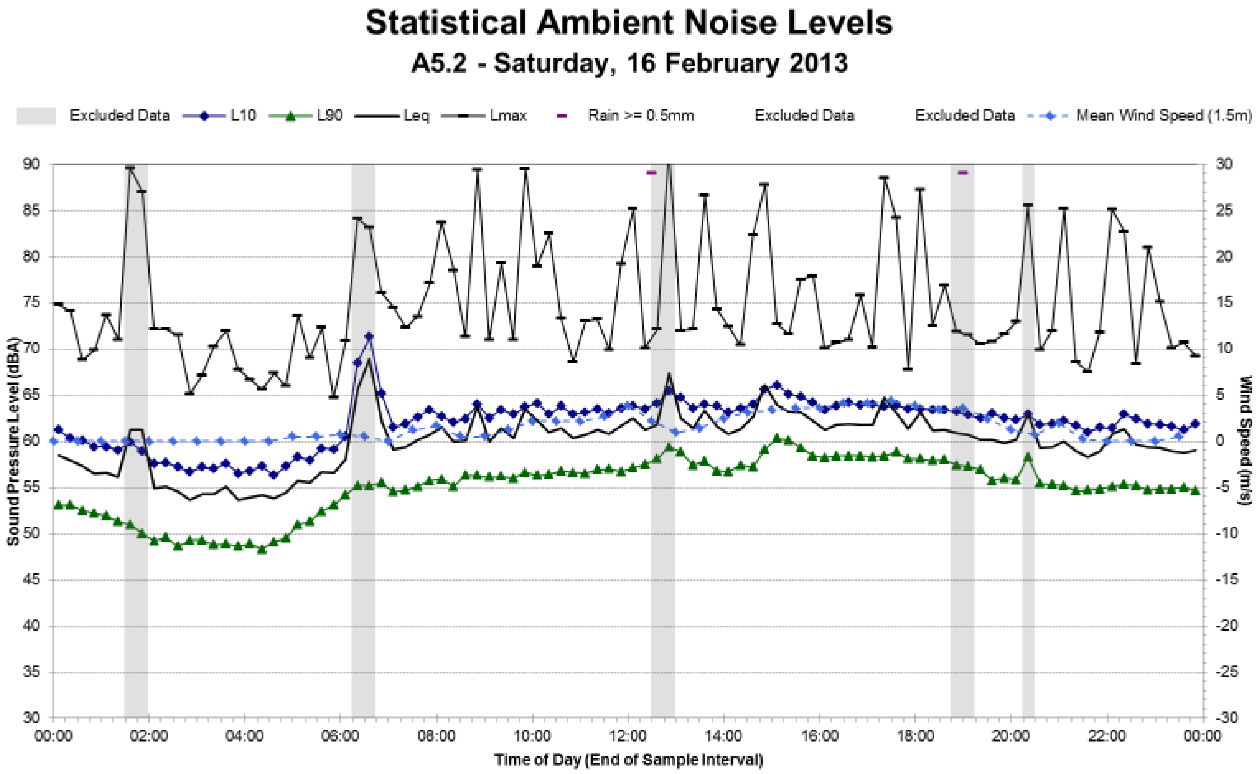
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
13/02/2013	11:10	58	64	87

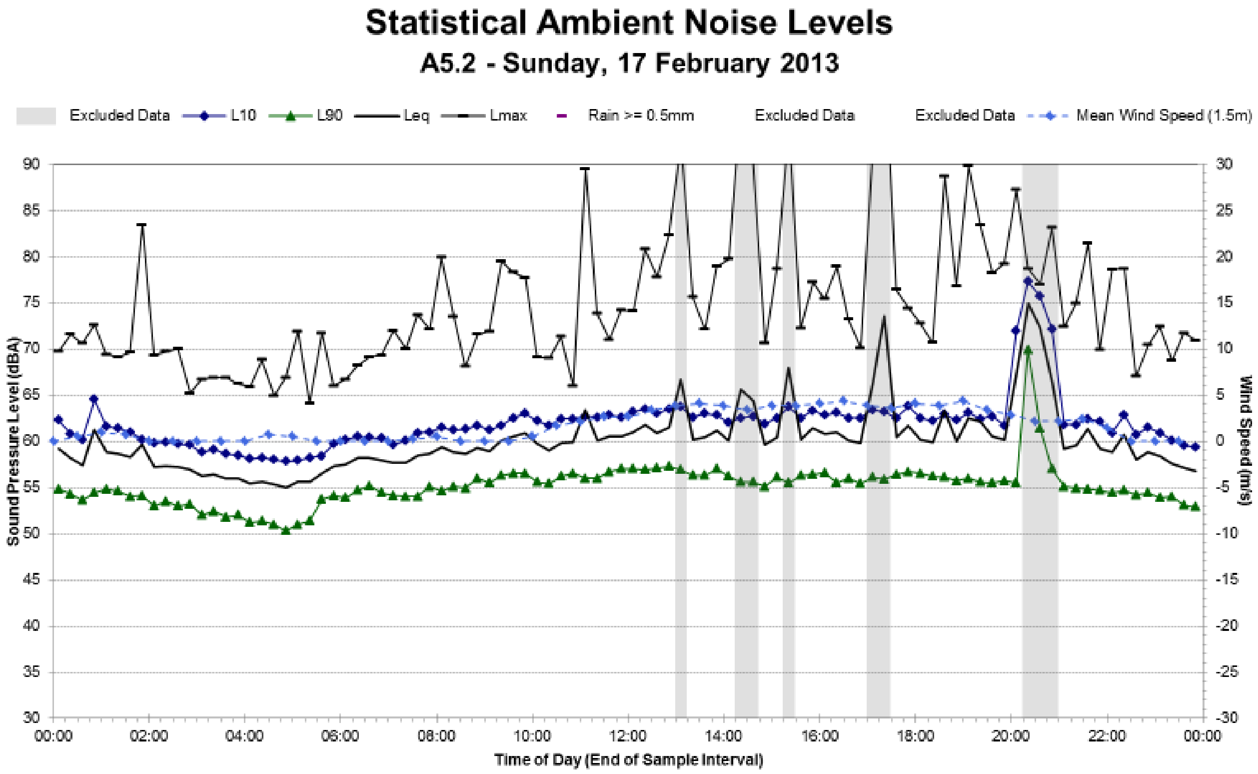
Photo of Noise Monitoring Location

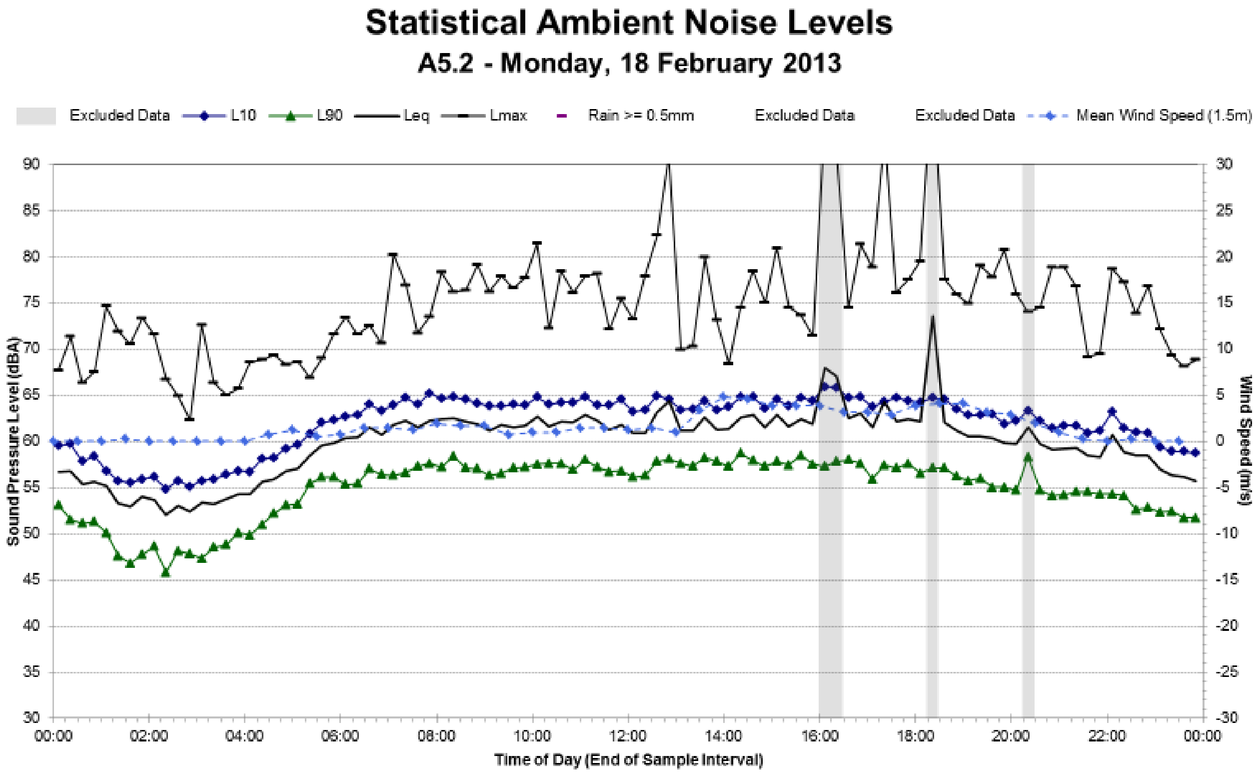

Statistical Ambient Noise Levels
A5.2 - Wednesday, 13 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

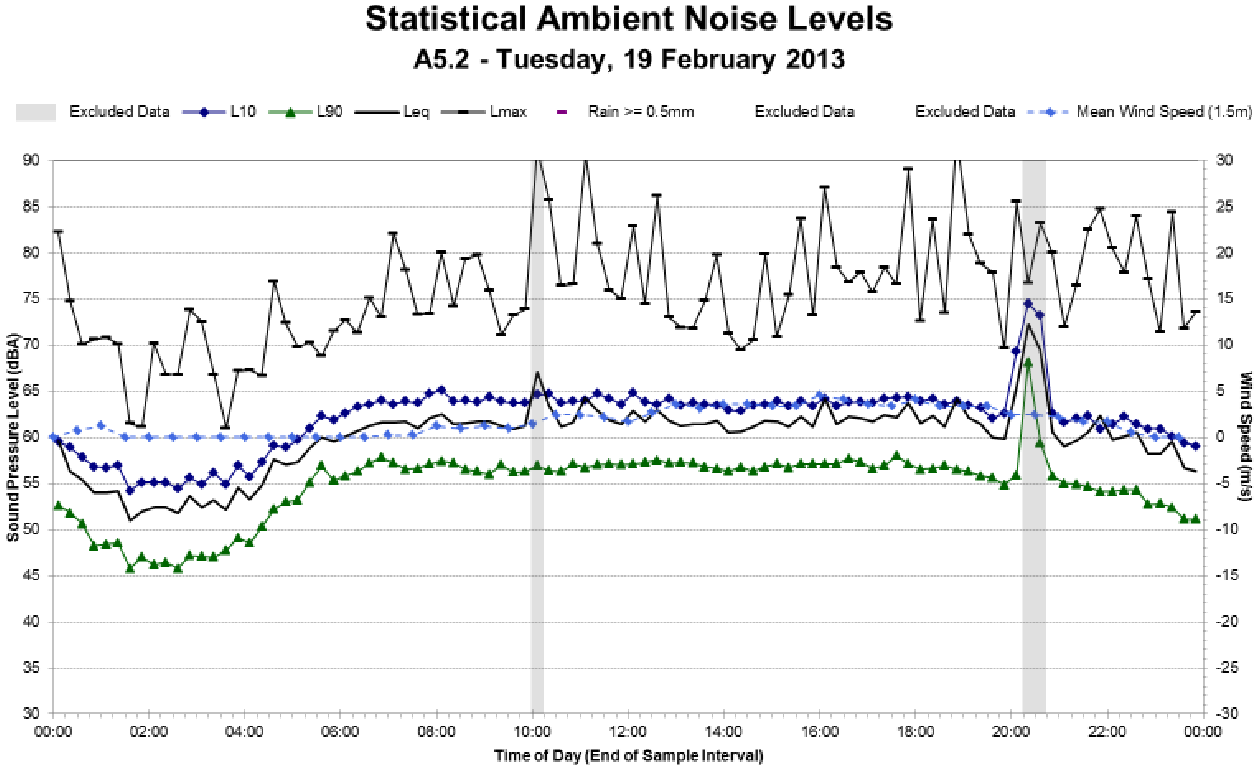

Statistical Ambient Noise Levels
A5.2 - Thursday, 14 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

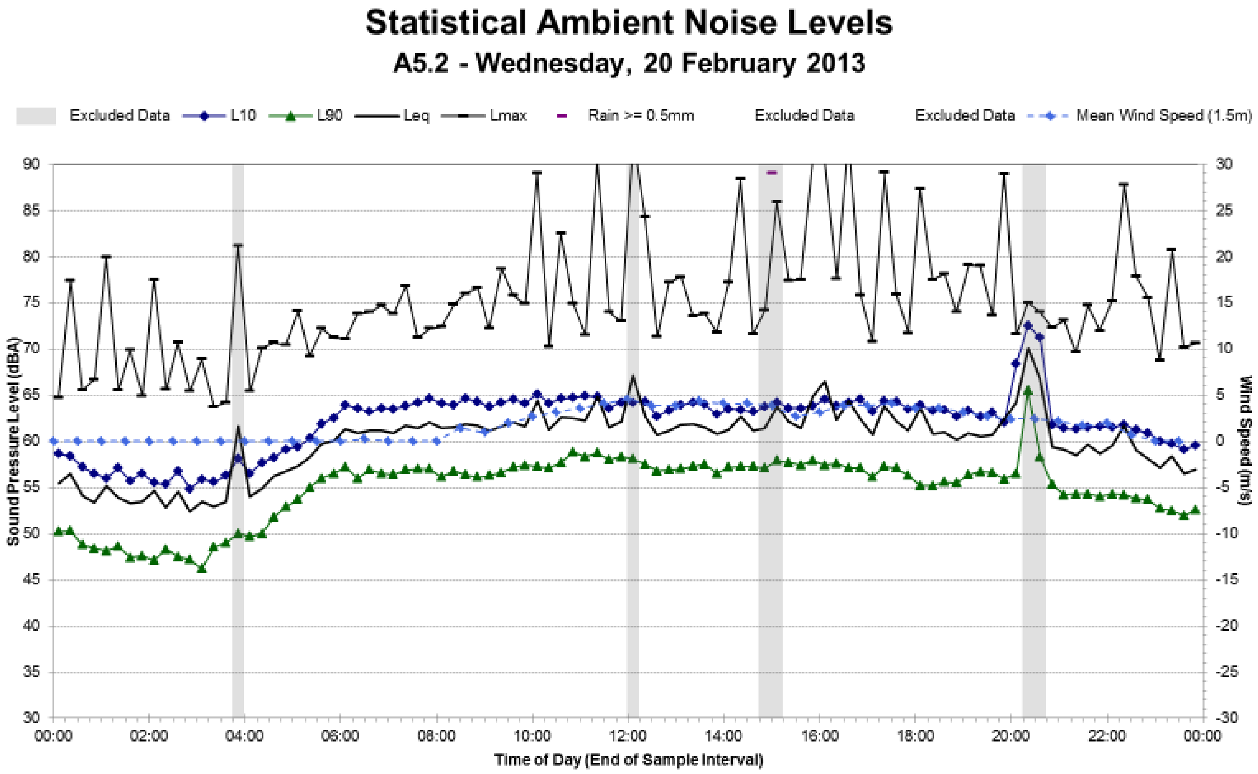

Statistical Ambient Noise Levels
A5.2 - Friday, 15 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

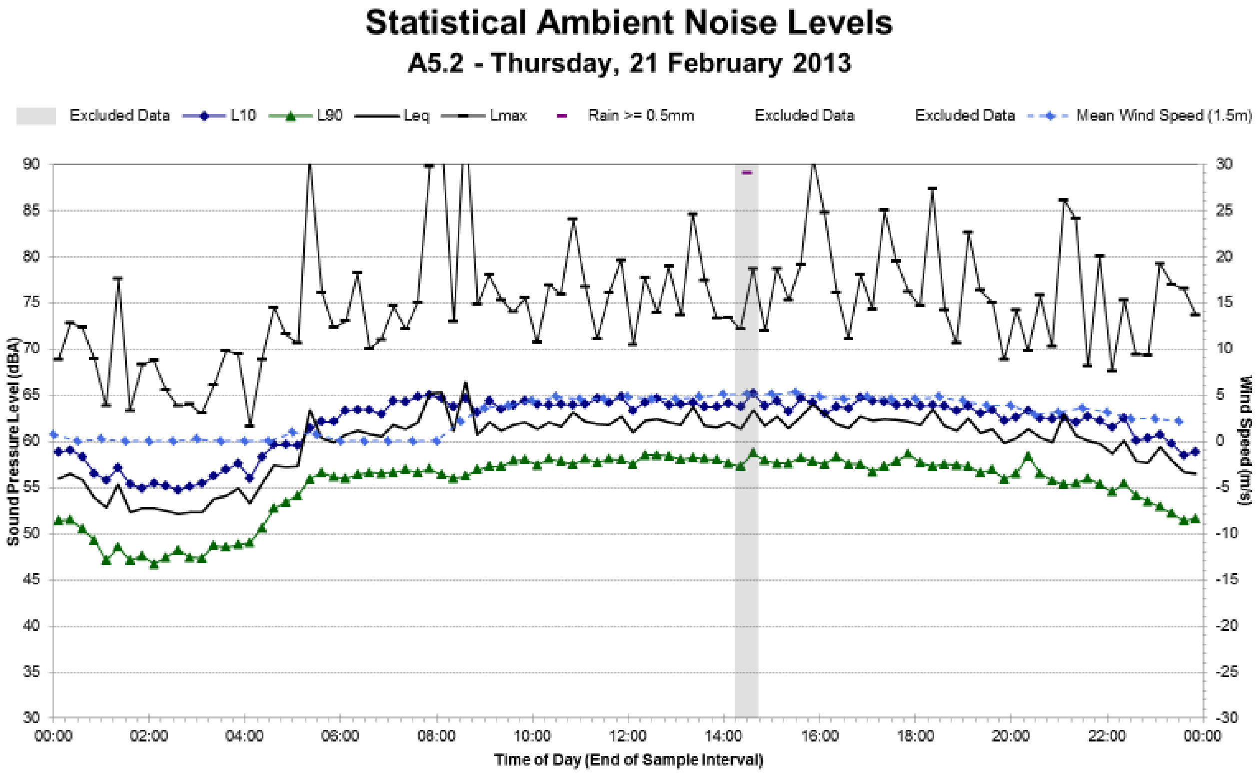

Statistical Ambient Noise Levels
A5.2 - Saturday, 16 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

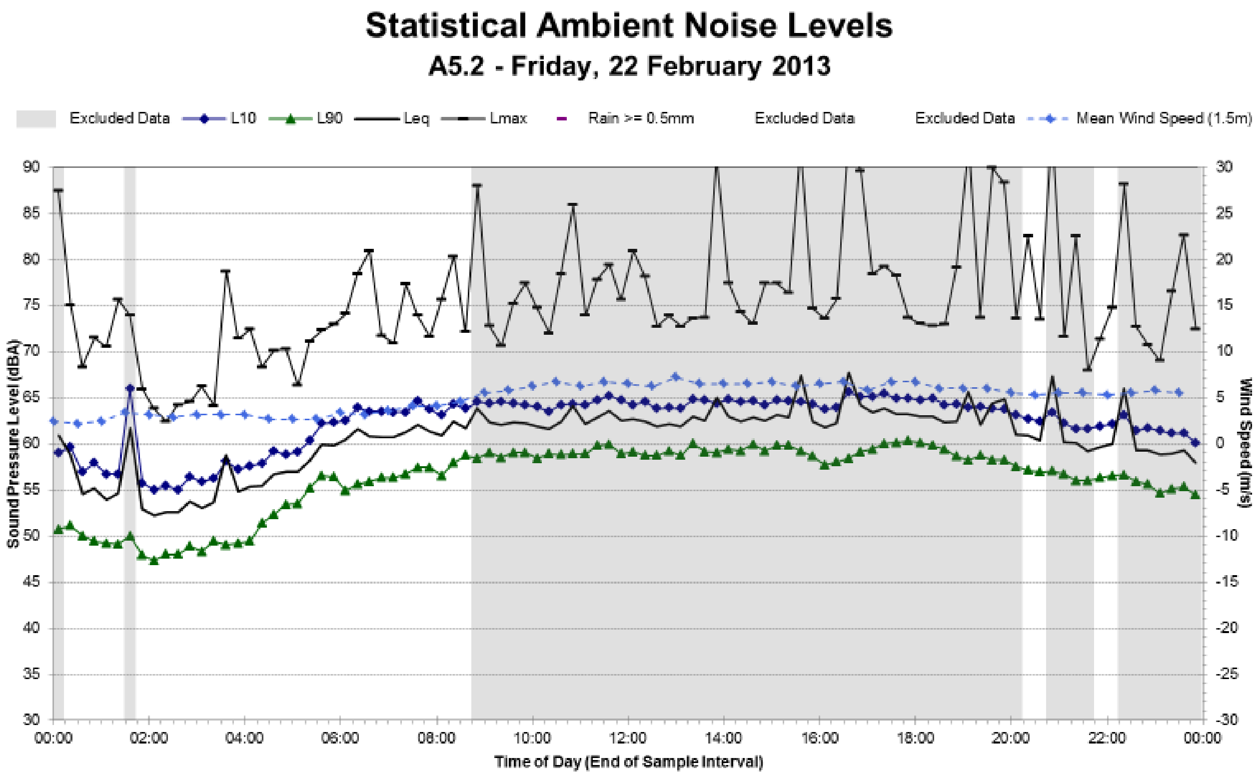

Statistical Ambient Noise Levels
A5.2 - Sunday, 17 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

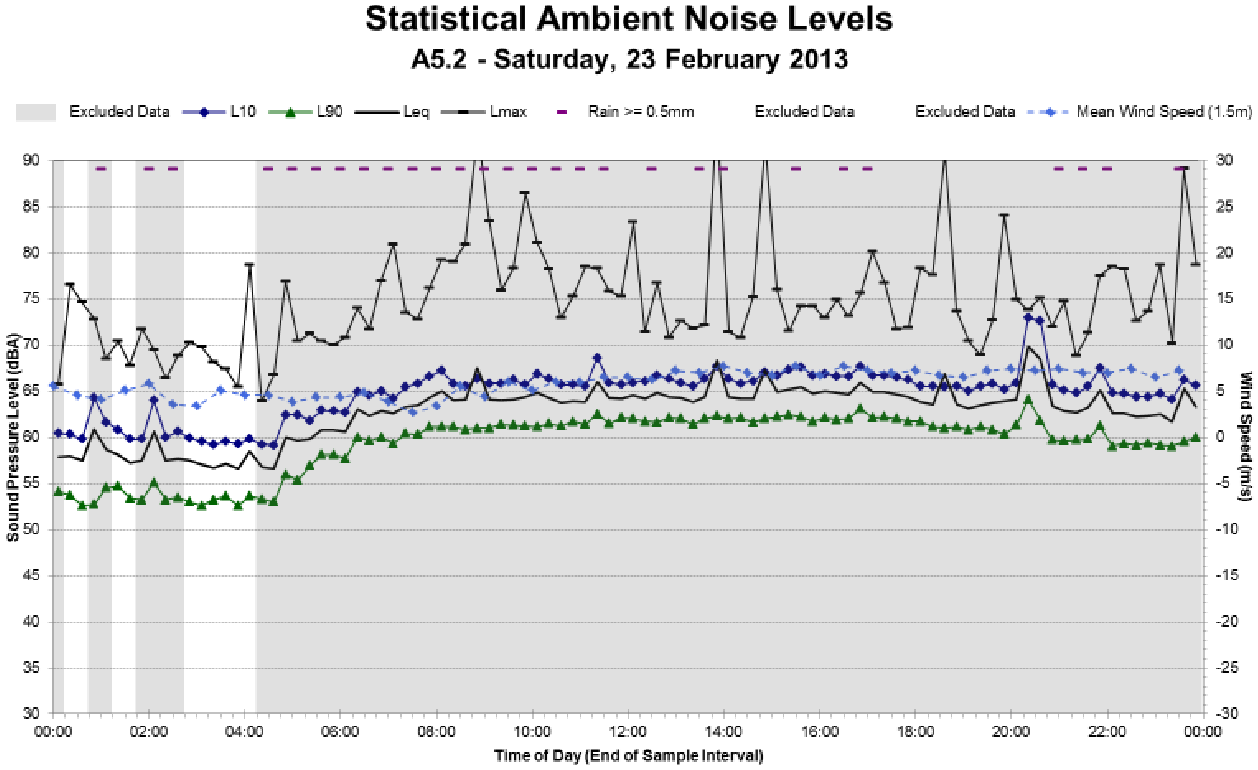

Statistical Ambient Noise Levels
A5.2 - Monday, 18 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A5.2 - Tuesday, 19 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A5.2 - Wednesday, 20 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A5.2 - Thursday, 21 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A5.2 - Friday, 22 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A5.2 - Saturday, 23 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
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
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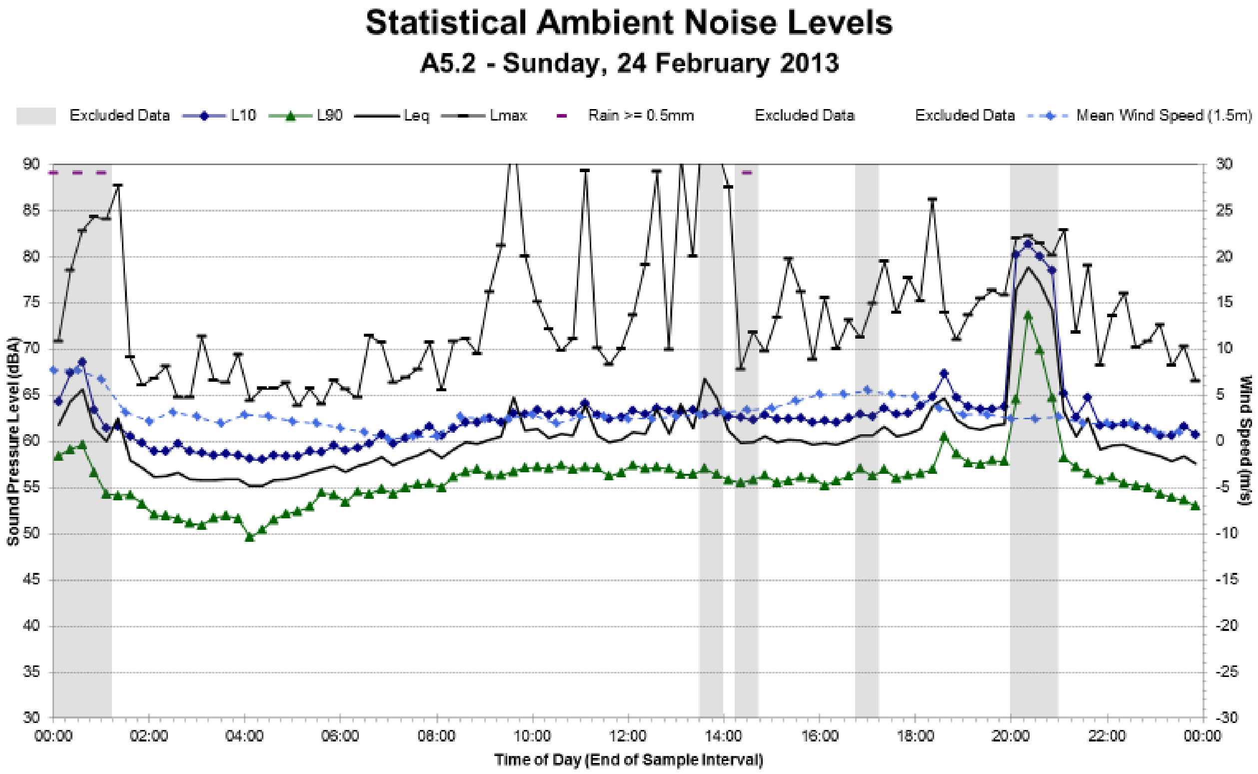
Statistical Ambient Noise Levels
A5.2 - Sunday, 24 February 2013
Excluded Data
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L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
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20:00
22:00
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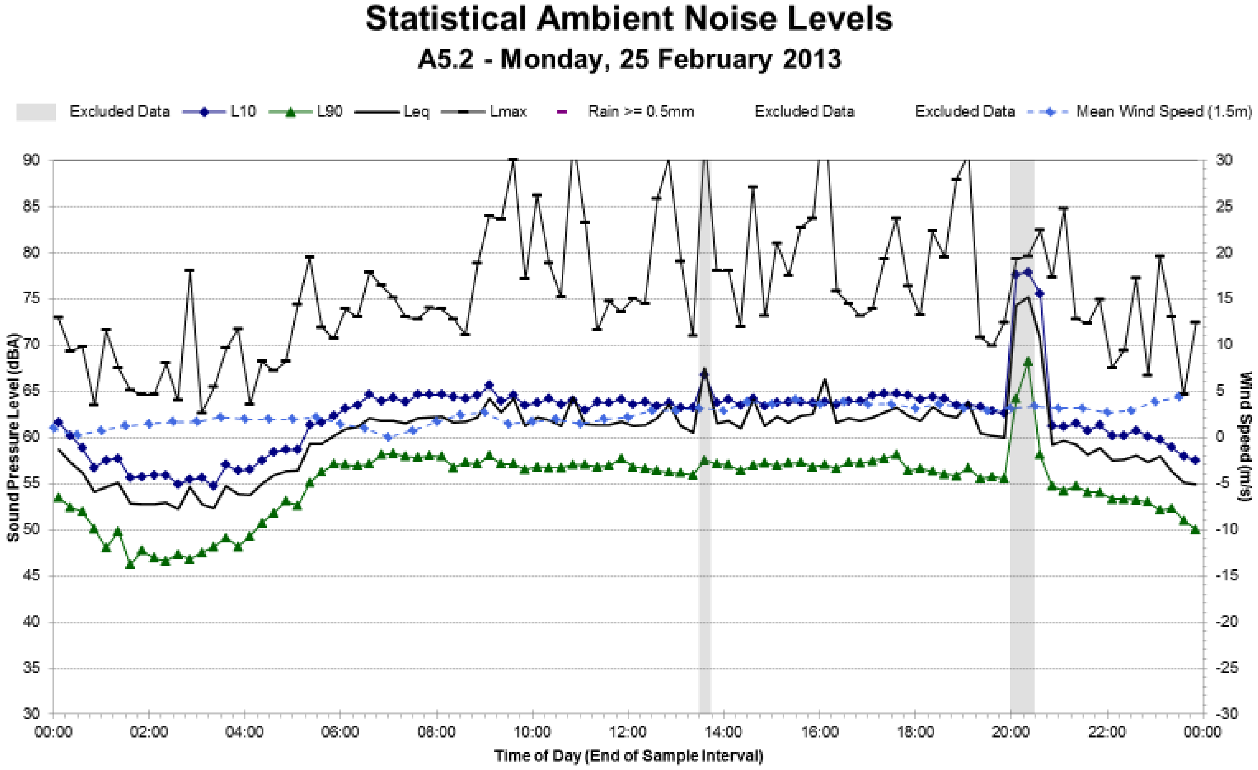
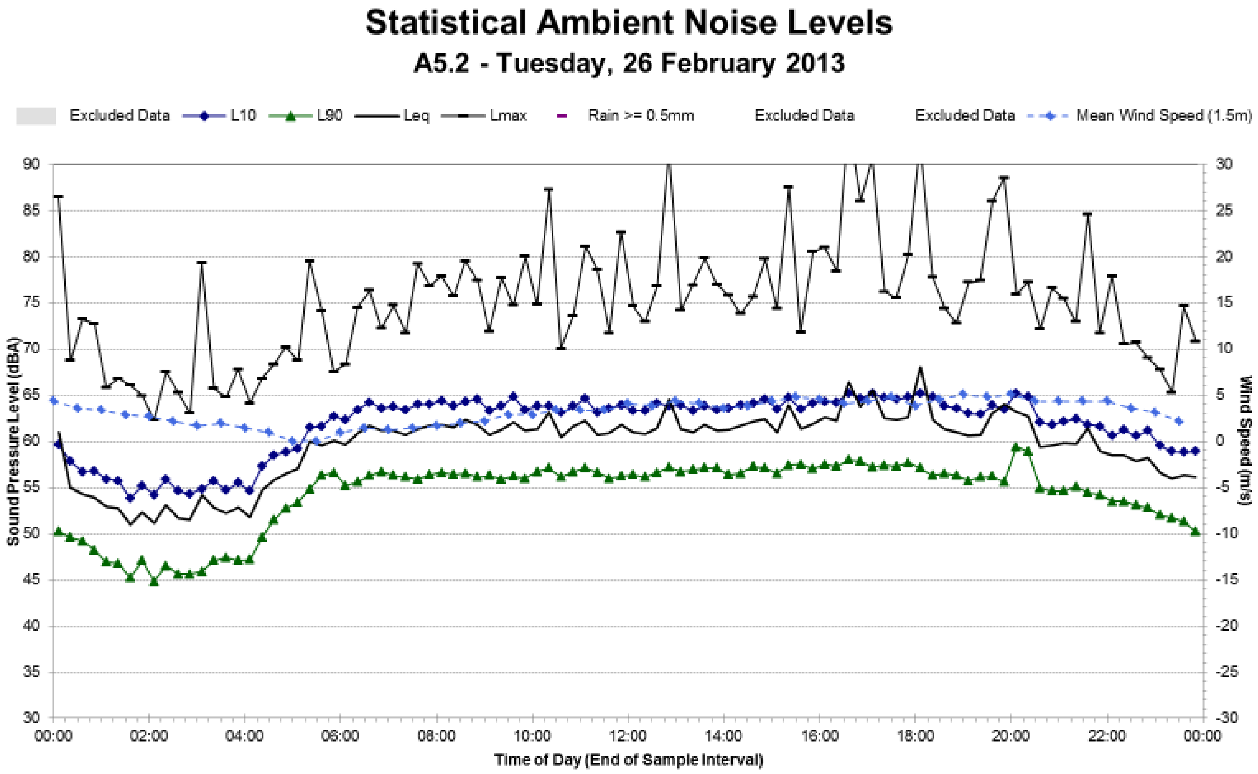
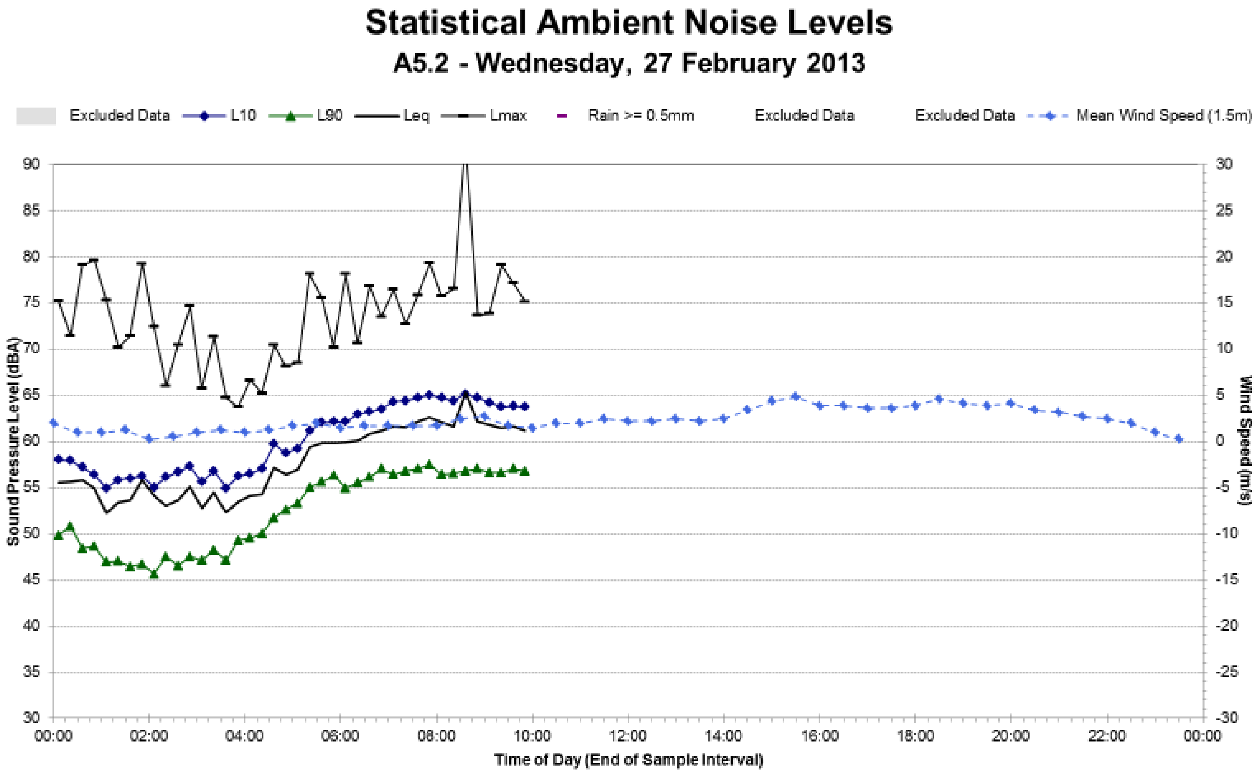

Statistical Ambient Noise Levels
A5.2 - Monday, 25 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A5.2 - Tuesday, 26 February 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A5 Ambient Noise Monitoring Results



A6 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A6.1**
Noise Monitoring Address:	**18 Rawson Road, South Wentworthville**

Logger Device Type: Svantek 957
Logger Serial No: 20667

Ambient noise logger deployed outside residential address 18 Rawson Road, South Wentworthville. Logger located in front yard on western side of property.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 during the daytime. Constant tyre-pavement noise from light-vehicle traffic on the M4 can be heard at this location with discrete traffic noise level events from heavy vehicle movements occurring frequently.

Recorded Noise Levels (LAmax):
M4 Heavy-vehicle road traffic: 55-70dBA, M4 Light-vehicle road traffic: ~54-55 dBA, Birds: 55 – 65 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	53	58	60	64
Evening	51	57	58	63
Night-time	46	54	56	61

Ambient Noise Logging Results – RNP Defined Time Periods

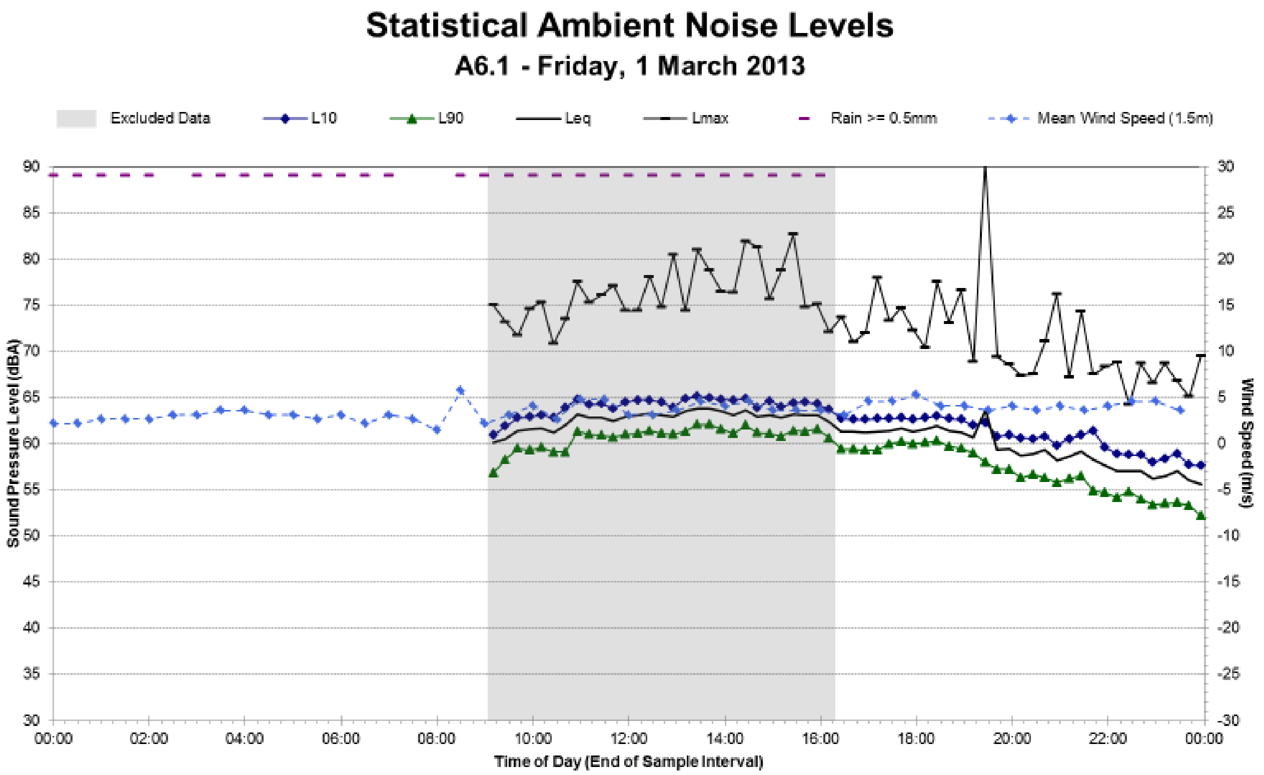
Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	Weekend LAeq(Period)	Weekly LAeq(Period)
Number of Valid Days	5	3	N/A (7 Day Average)
Daytime (7am-10pm)	58	58	58
Night-time (10pm-7am)	54	54	54

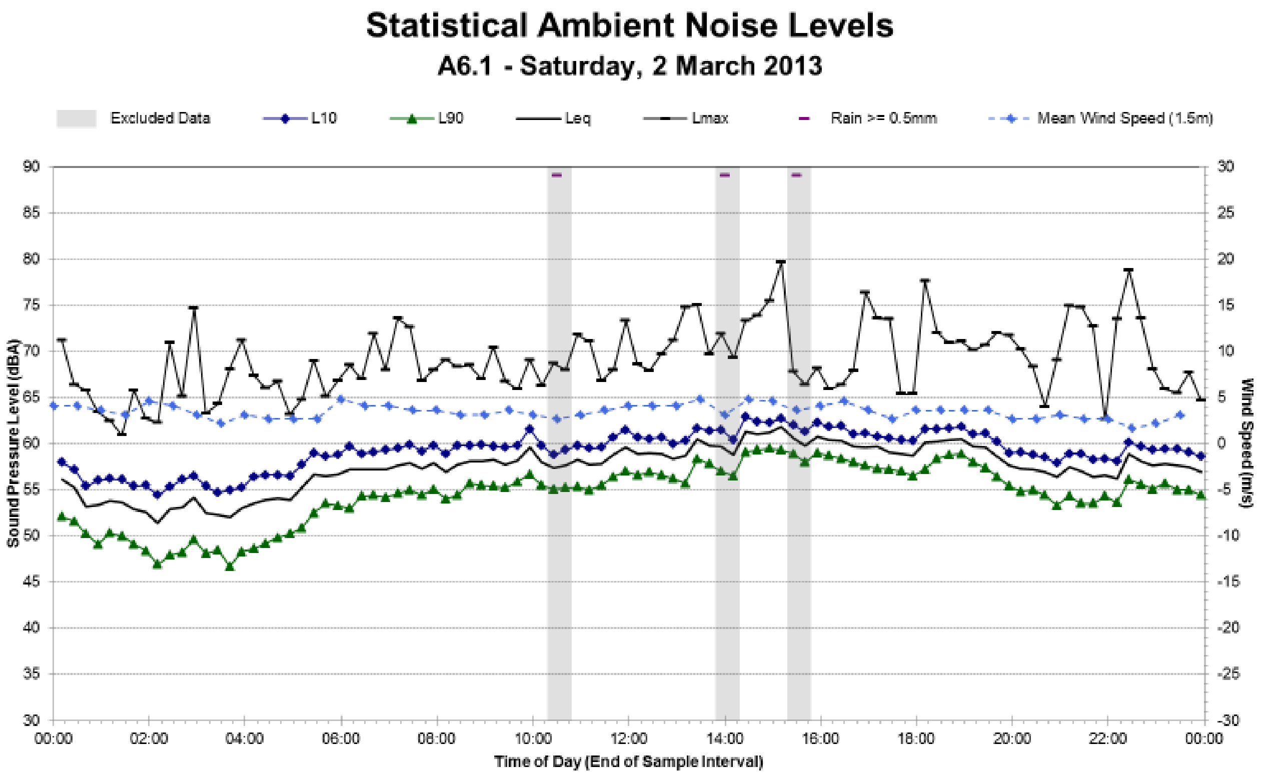
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
12/03/2013	09:01	52	56	70

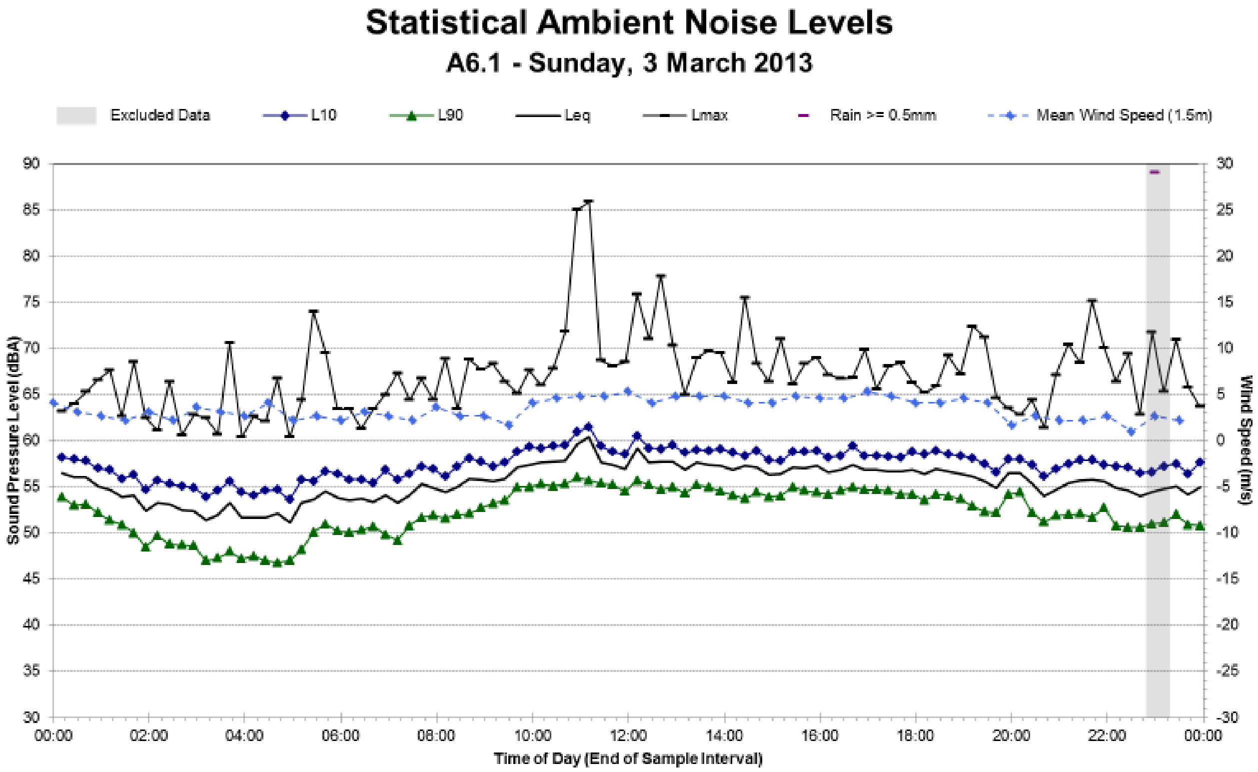
Photo of Noise Monitoring Location

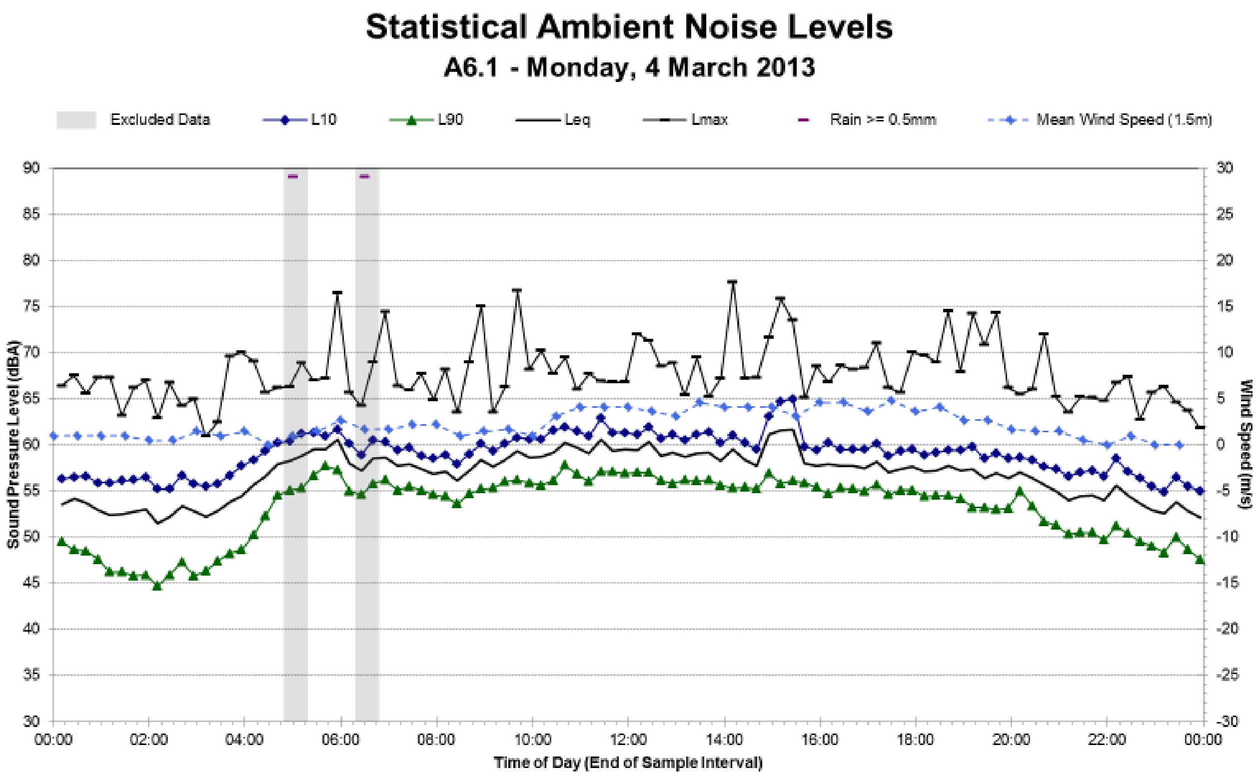
A6 Ambient Noise Monitoring Results



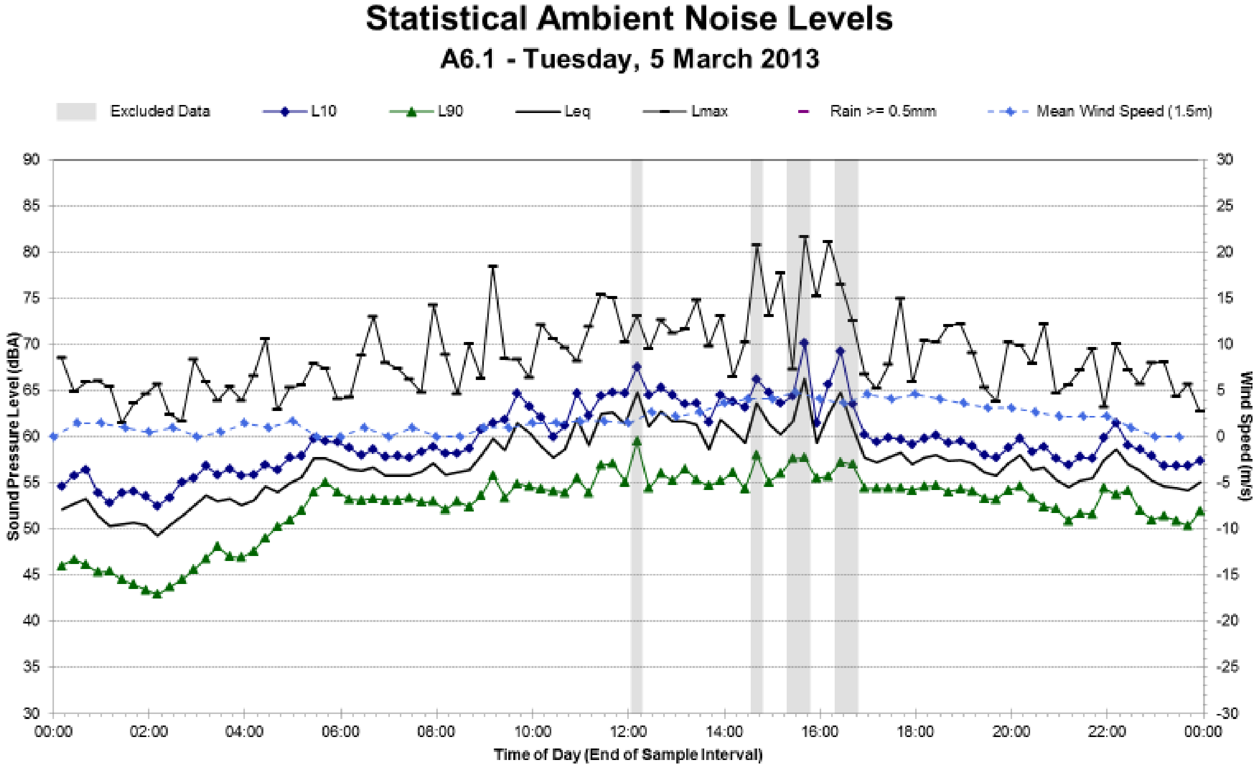


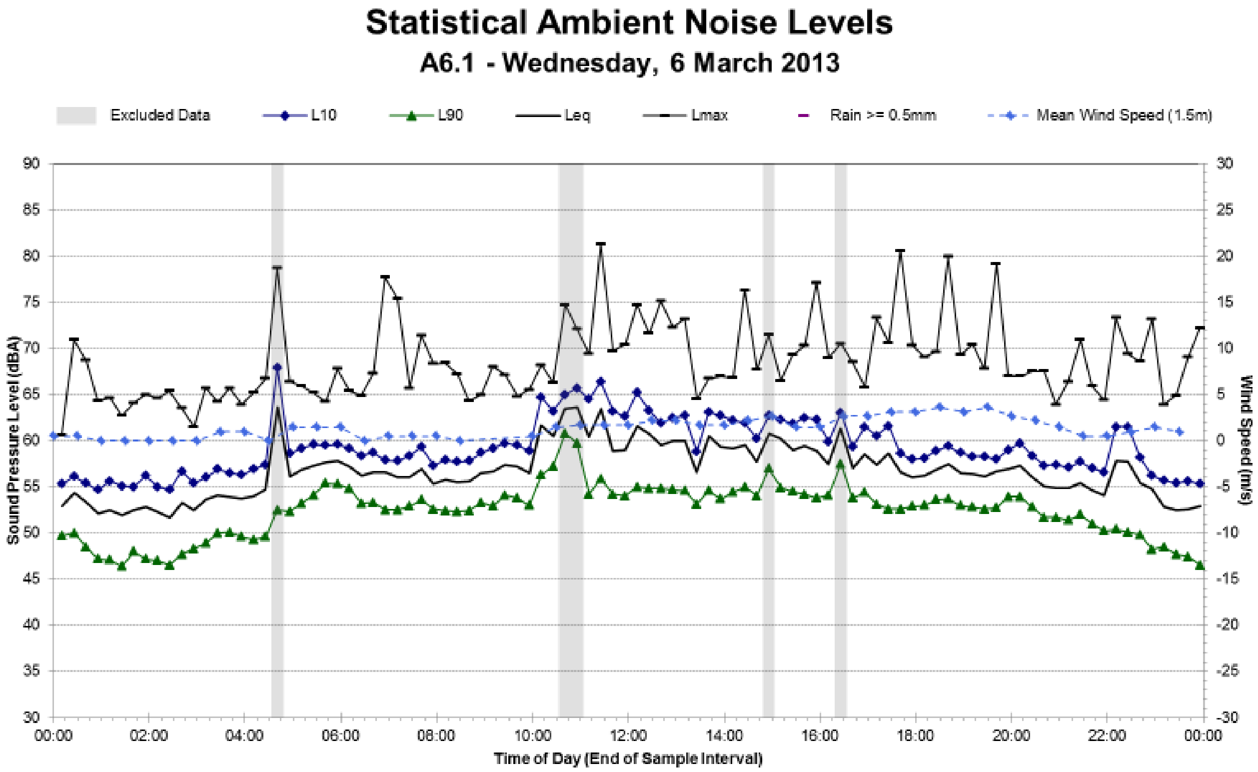
A6 Ambient Noise Monitoring Results



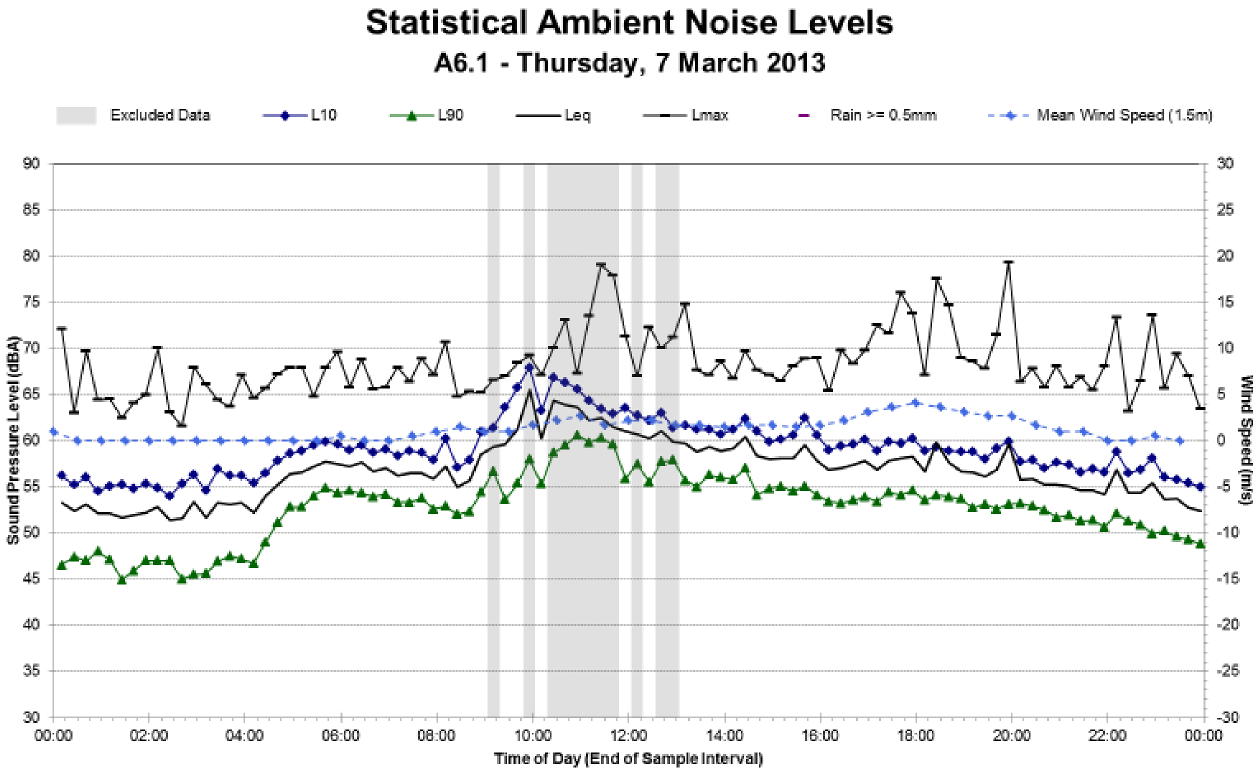


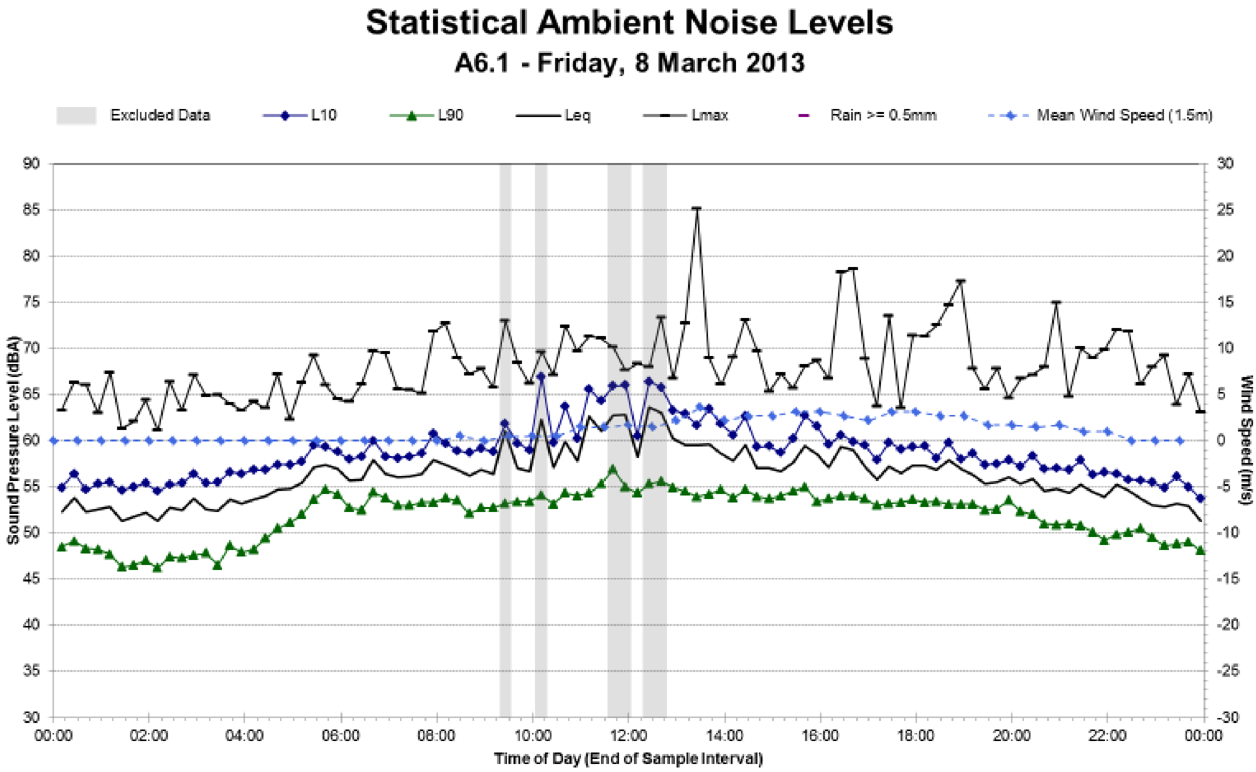
A6 Ambient Noise Monitoring Results



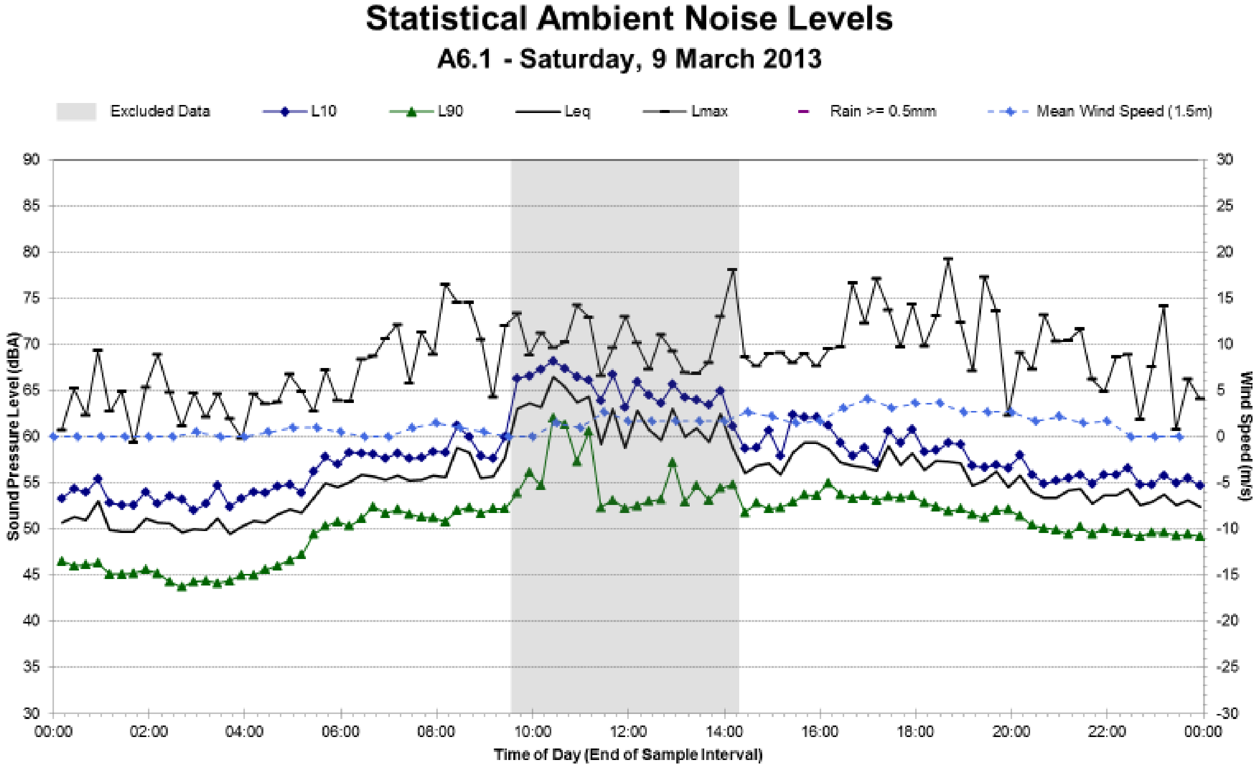


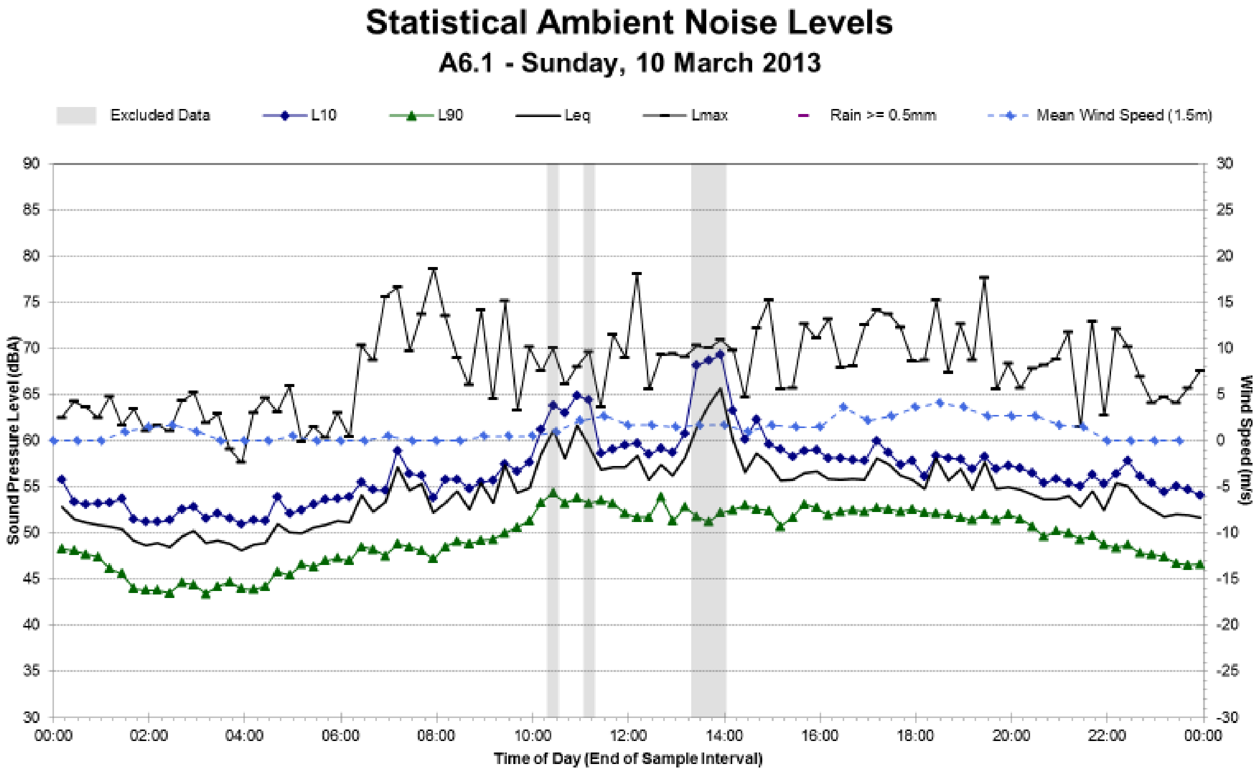
A6 Ambient Noise Monitoring Results



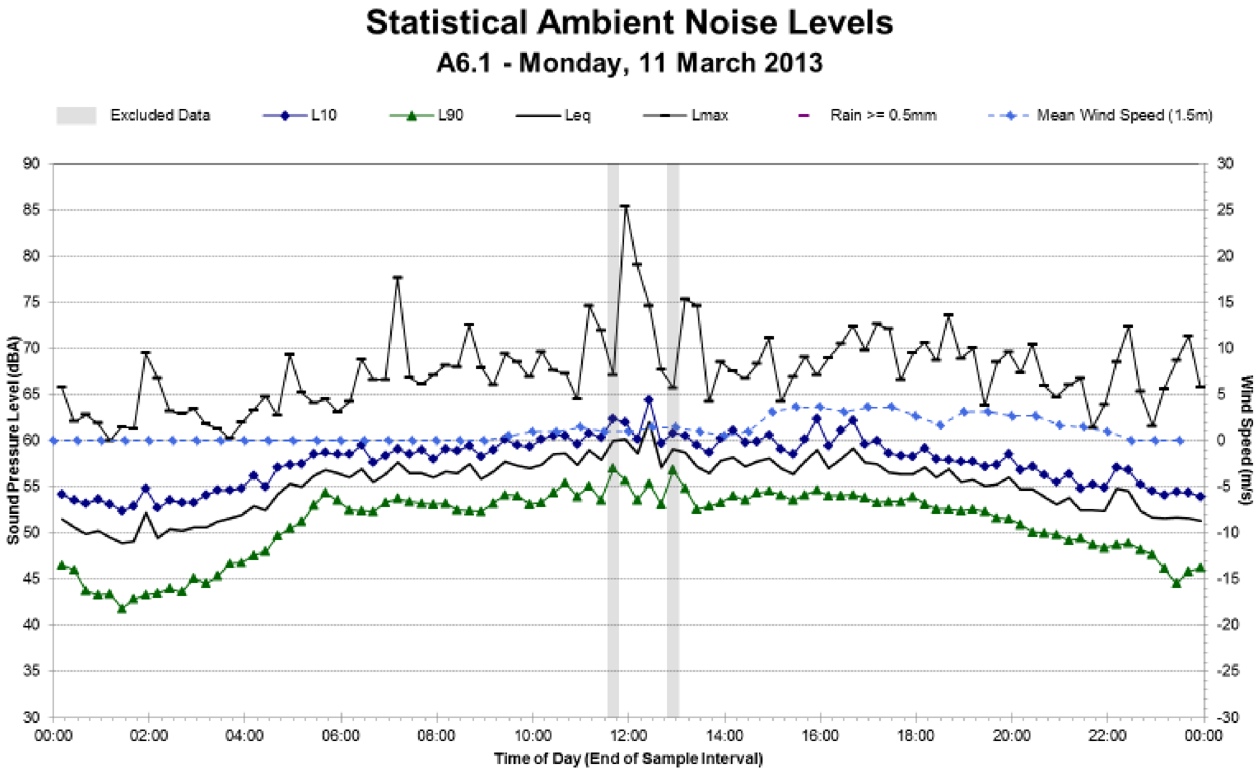


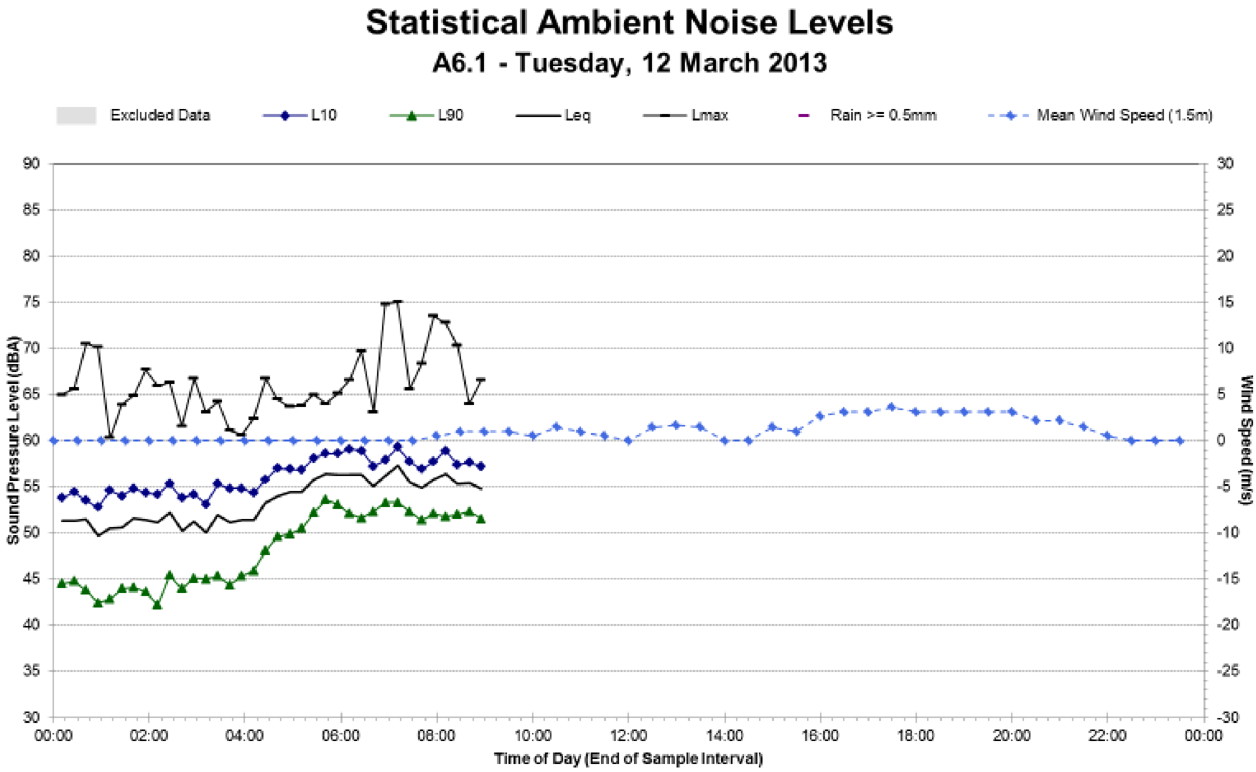
A6 Ambient Noise Monitoring Results





A6 Ambient Noise Monitoring Results





Noise Monitoring Location:	**A6.2**
Noise Monitoring Address:	**29 Carolyn St, Greystanes**

Logger Device Type: Svantek 957
Logger Serial No: 23245

Ambient noise logger deployed at rear of residential address 29 Carolyn St, Greystanes.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 and insect noise during the daytime. Constant tyre-pavement noise from light-vehicle traffic on the M4 can be heard at this location with discrete traffic noise level peaks from heavy vehicle movements occurring frequently. Heavy vehicle noise is predominantly of engine/exhaust origin.

Recorded Noise Levels (LAmax):
M4 Heavy-vehicle road traffic: 64-68 dBA, M4 Light-vehicle road traffic: ~50-52 dBA, Insects: 54 – 63 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	54	61	63	67
Evening	52	58	60	64
Night-time	46	55	57	63

Ambient Noise Logging Results – RNP Defined Time Periods

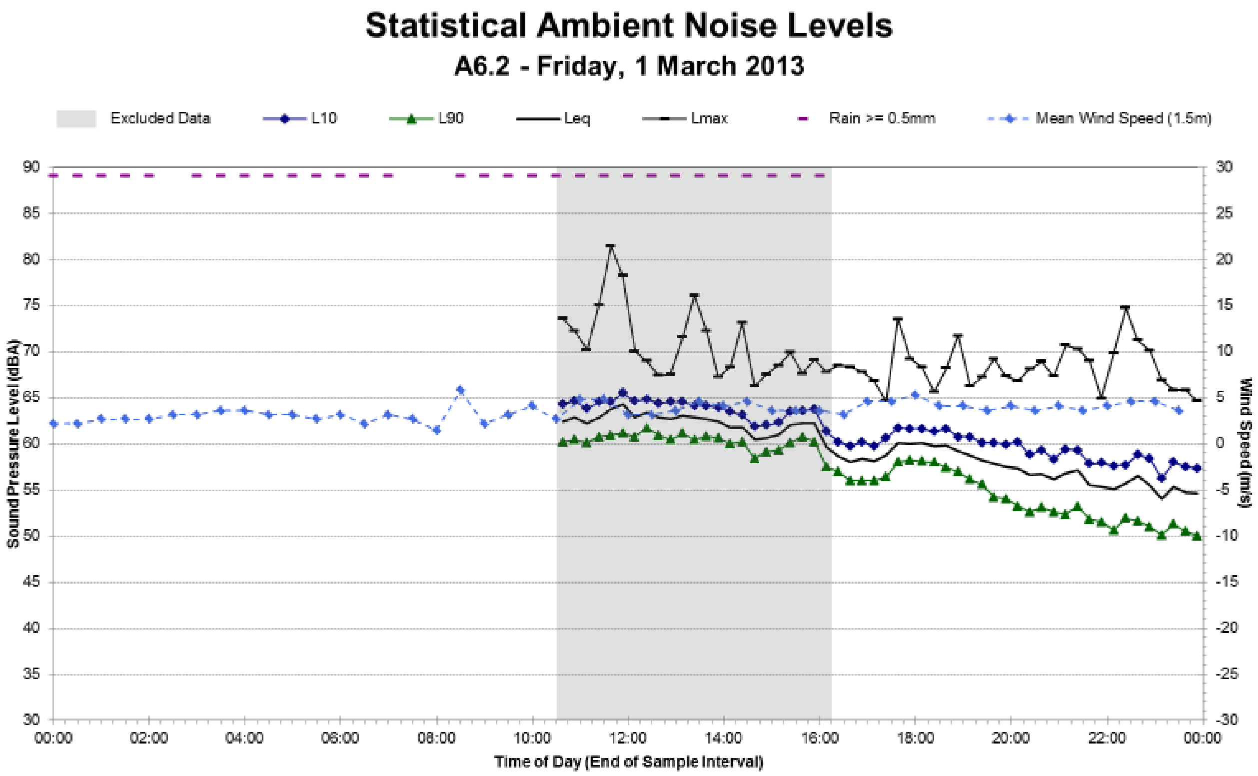
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	5	4	N/A (7 Day Average)
Daytime (7am-10pm)	61	60	61
Night-time (10pm-7am)	55	55	55

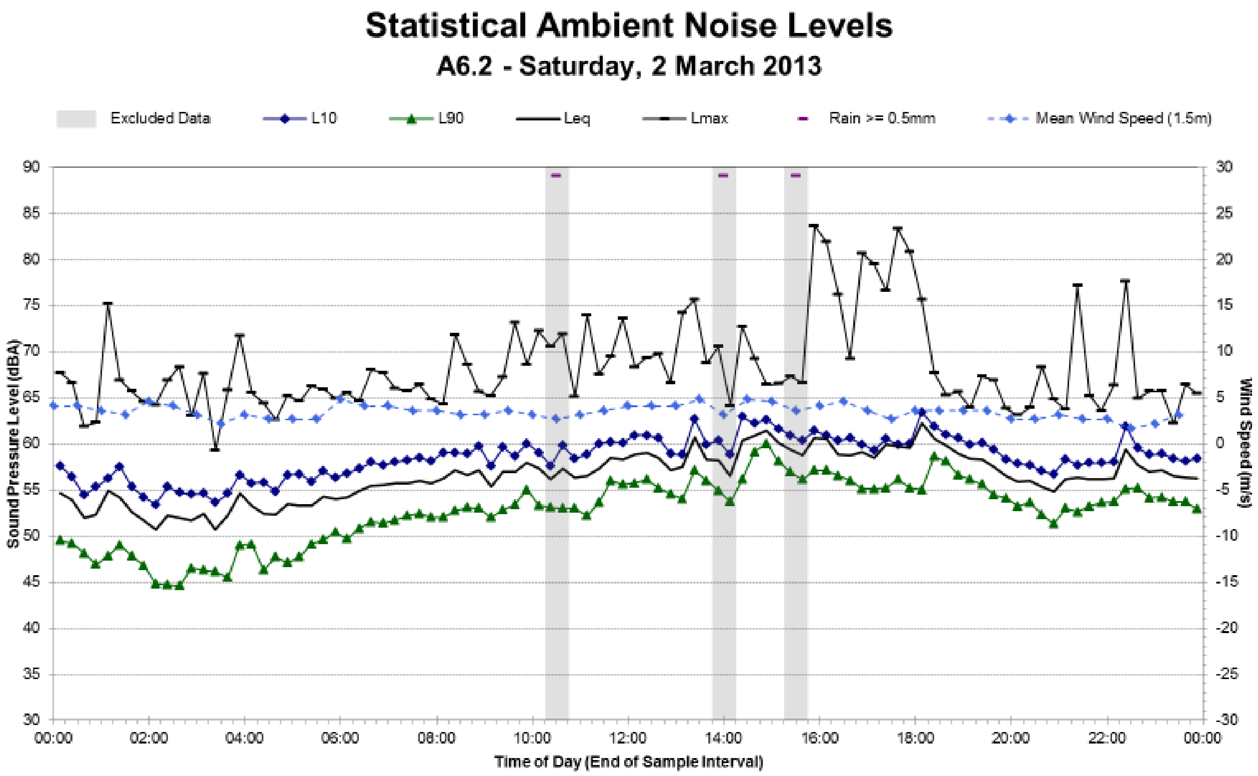
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
13/03/2013	09:37	54	61	68

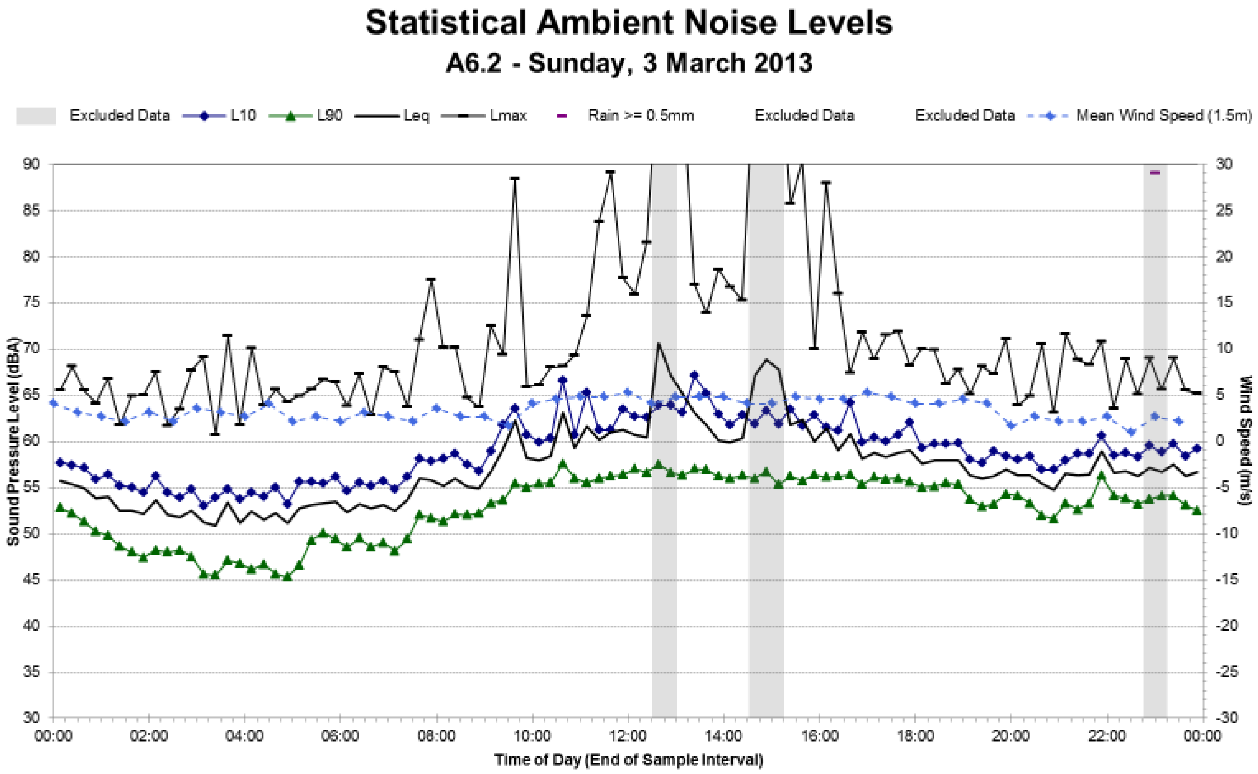
Photo of Noise Monitoring Location

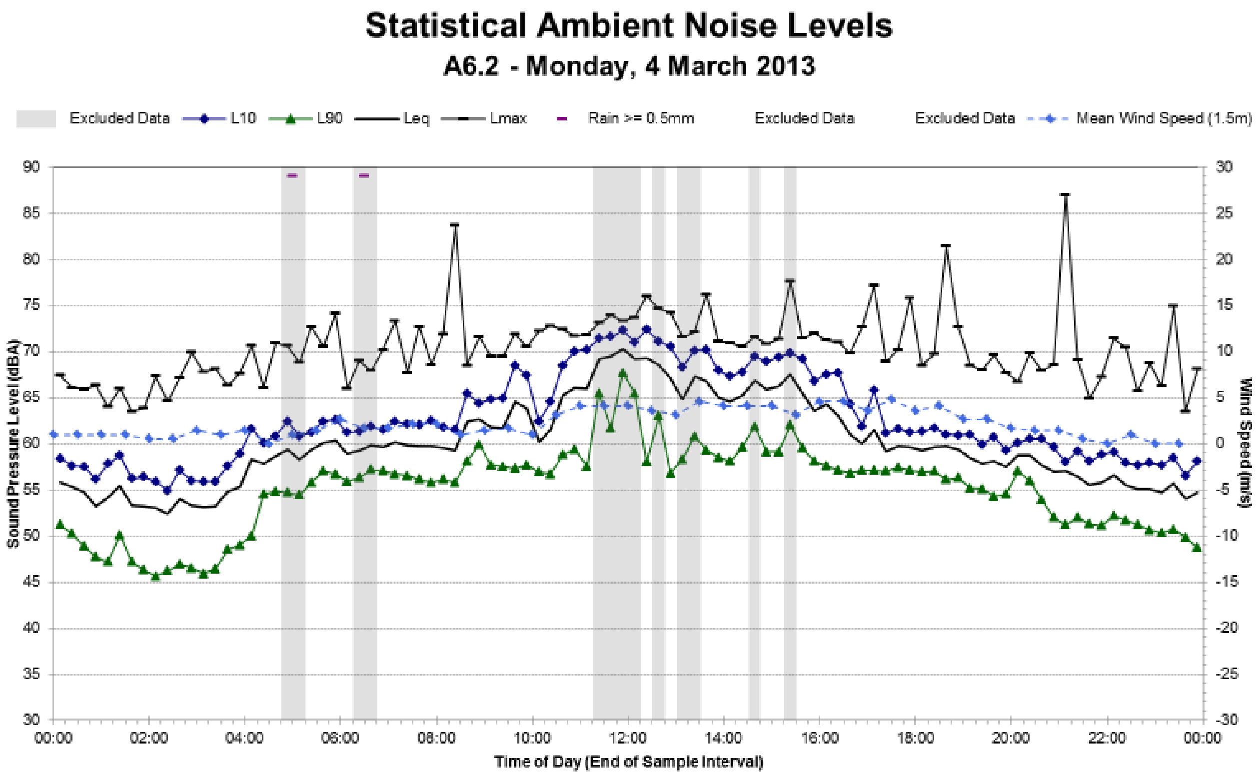
A6 Ambient Noise Monitoring Results



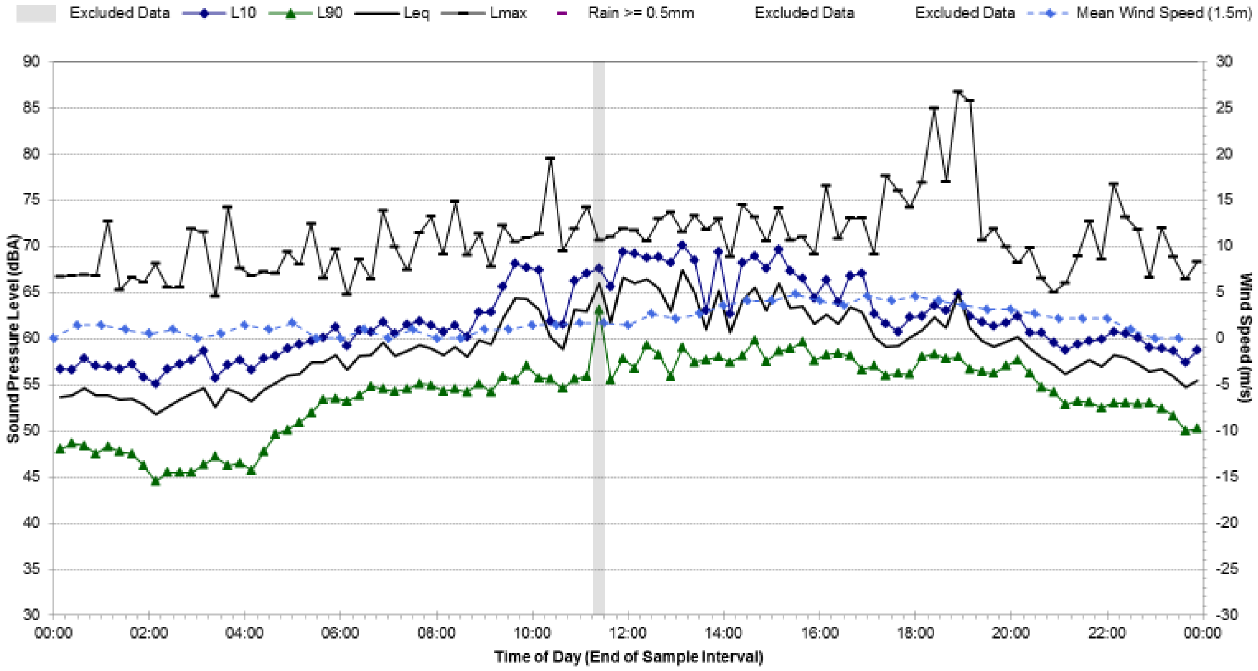


A6 Ambient Noise Monitoring Results

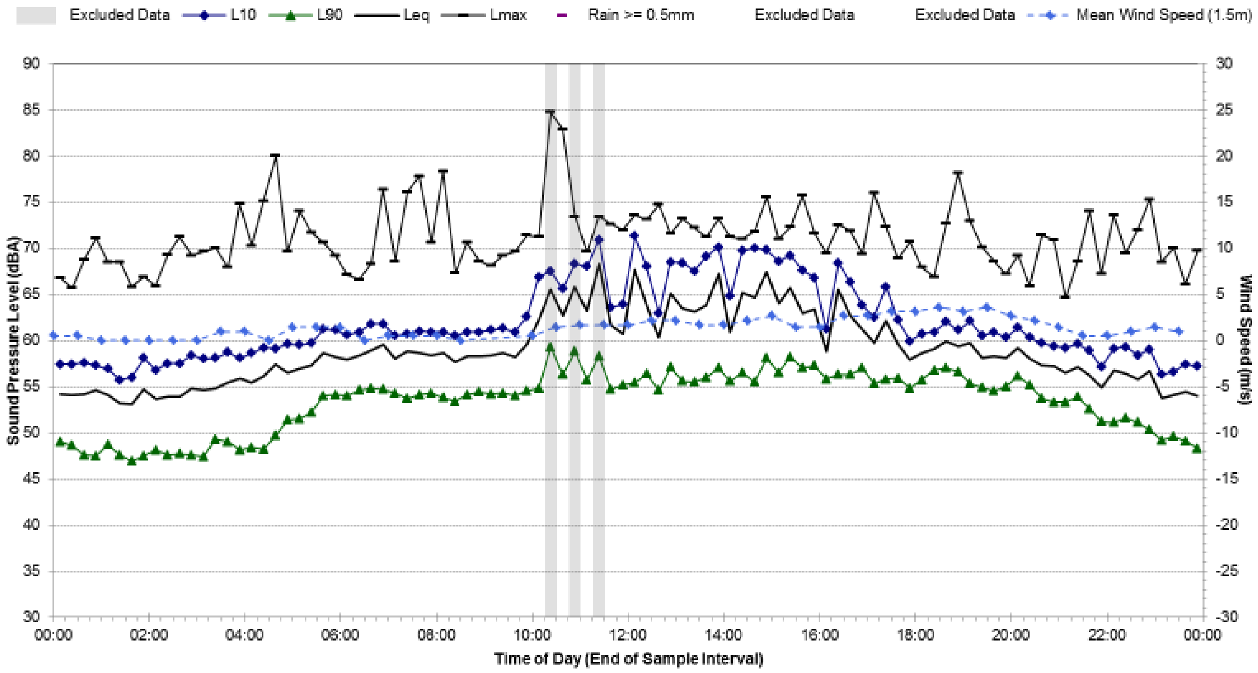


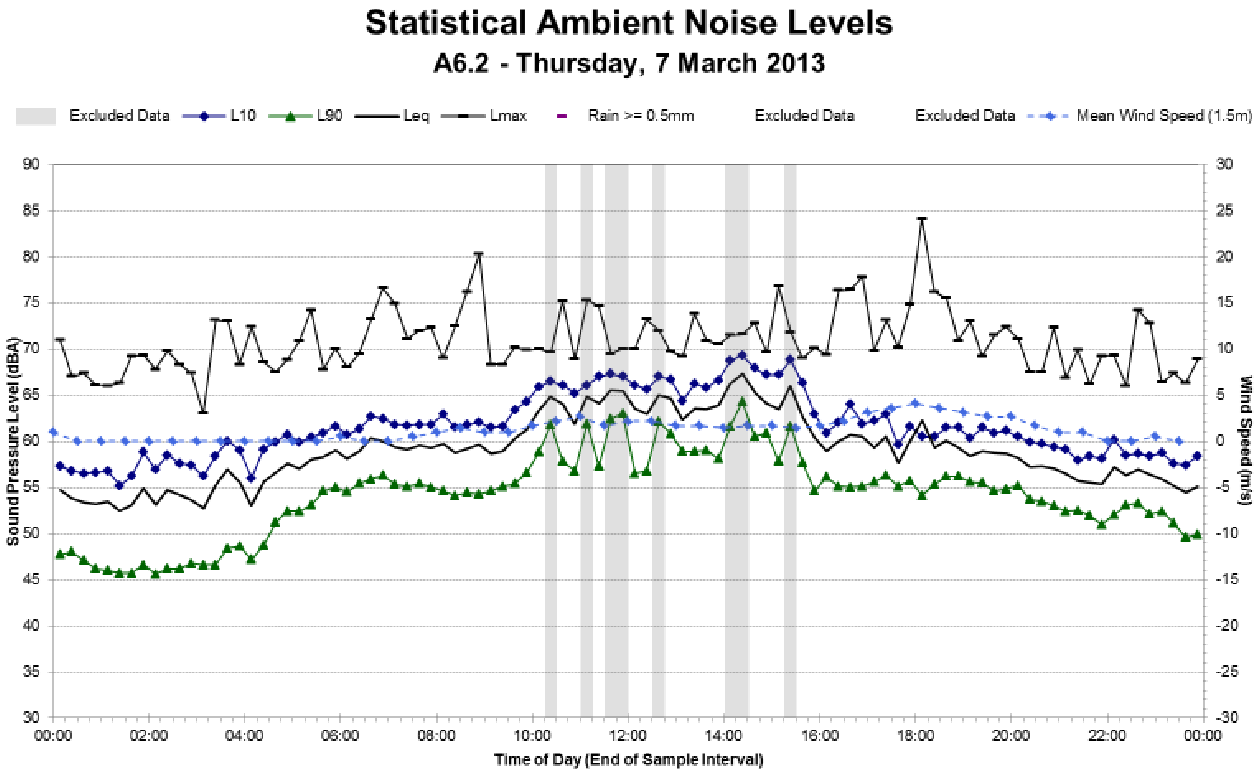


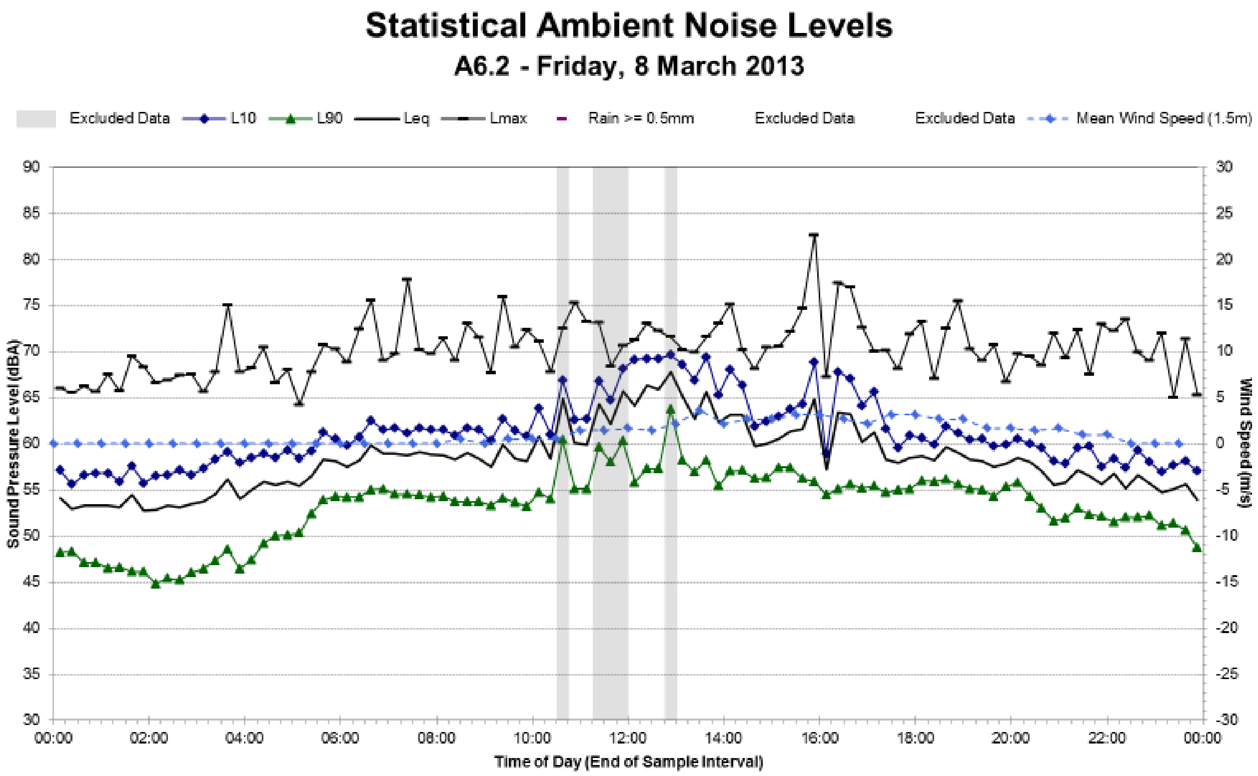
Statistical Ambient Noise Levels
A6.2 - Tuesday, 5 March 2013

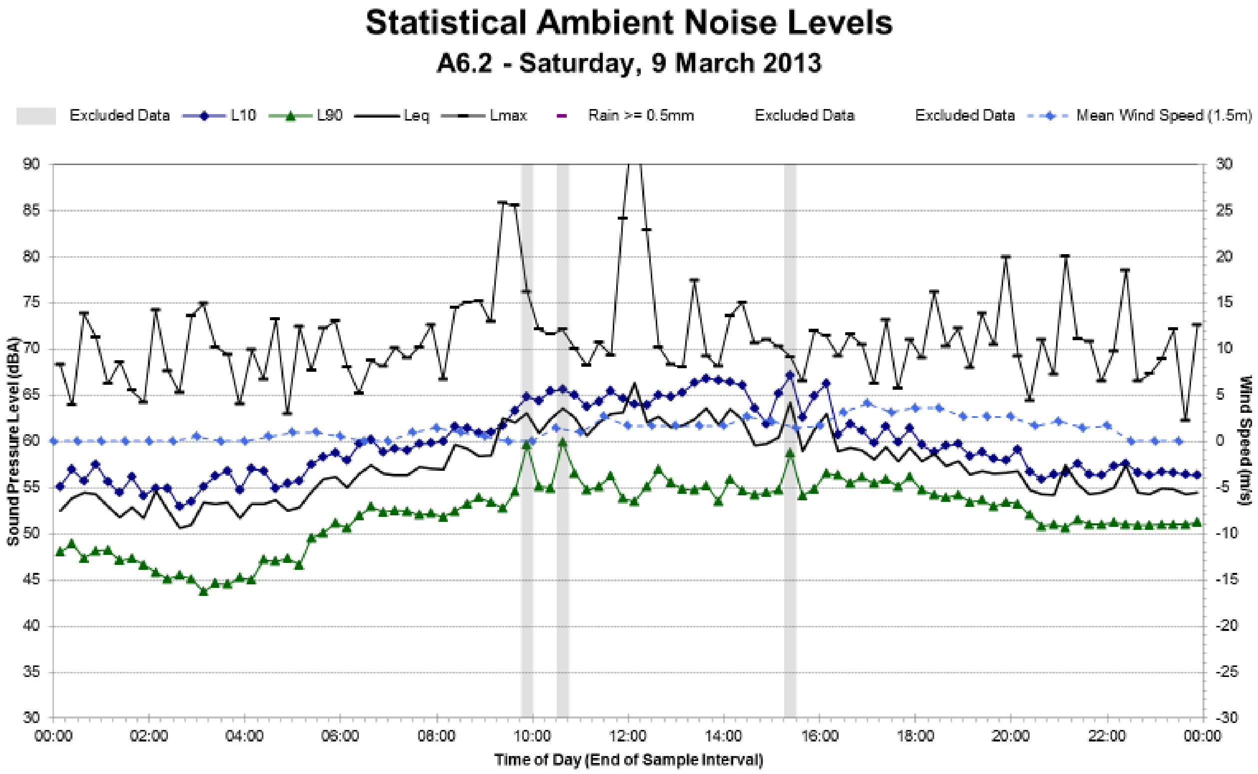


Statistical Ambient Noise Levels
A6.2 - Wednesday, 6 March 2013

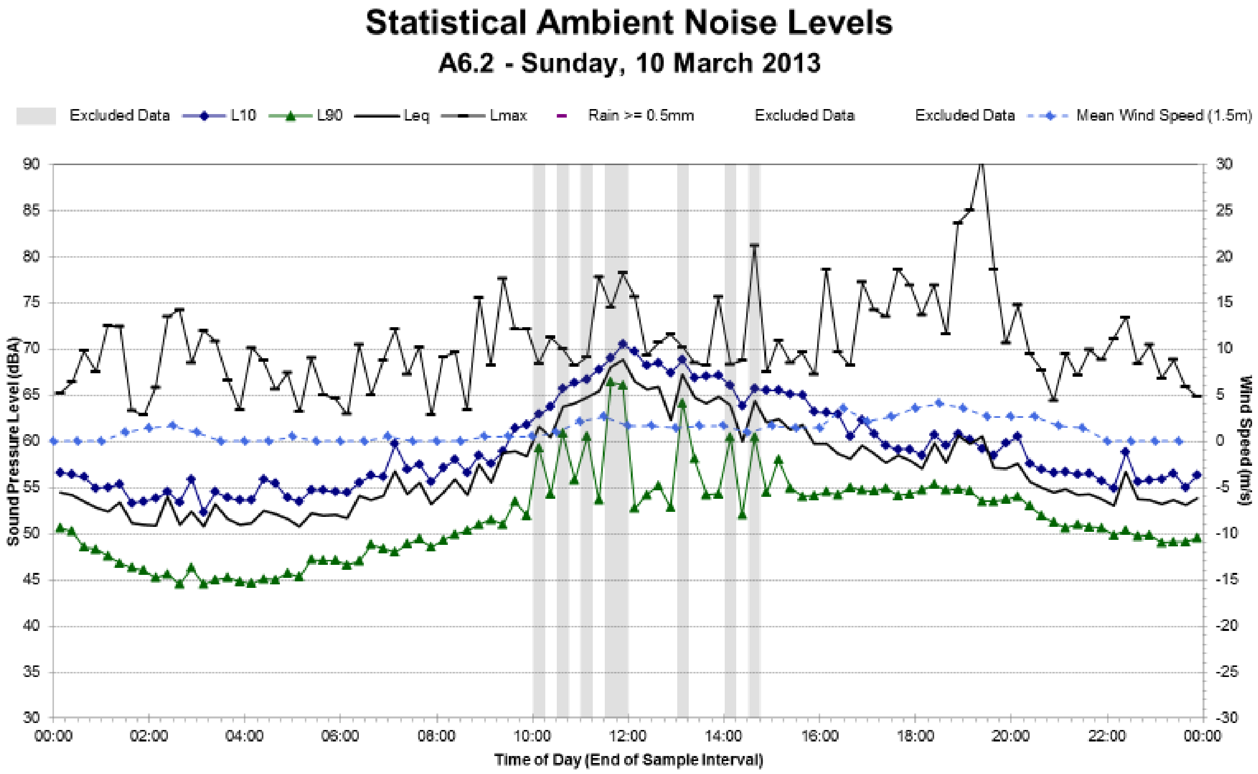



Statistical Ambient Noise Levels
A6.2 - Thursday, 7 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

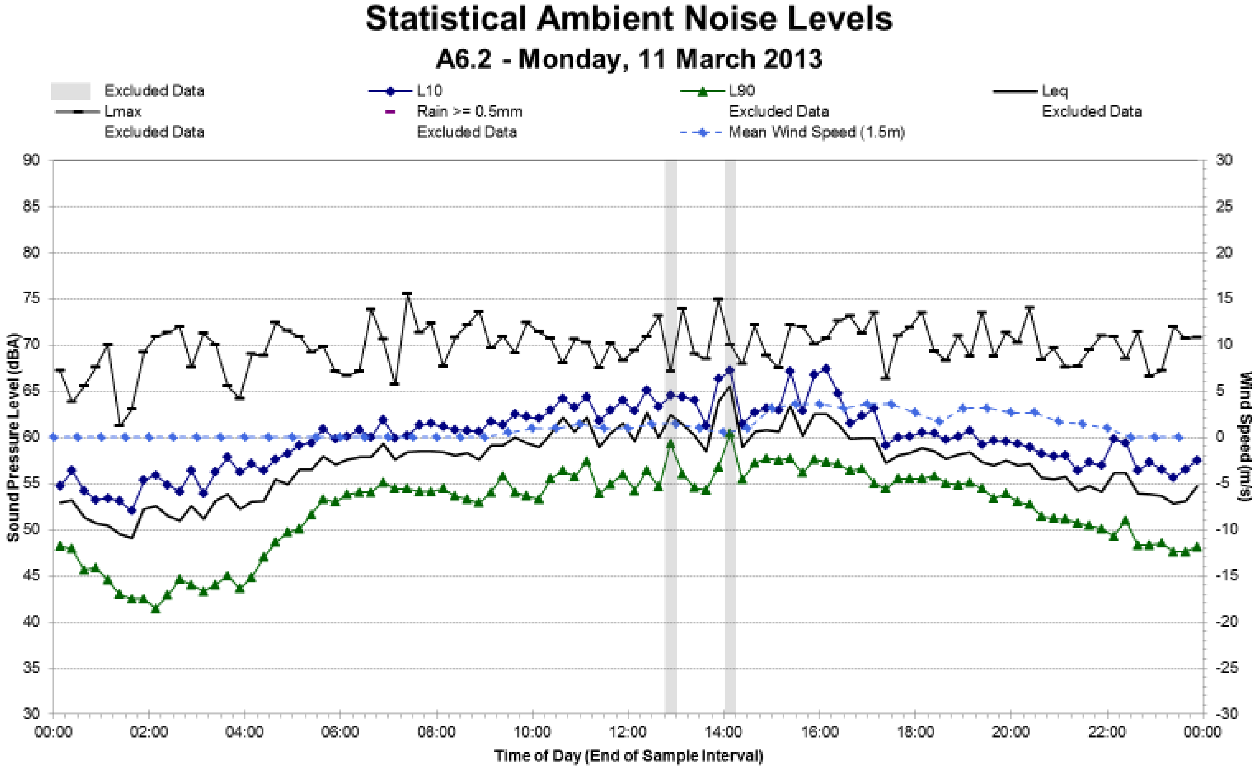

Statistical Ambient Noise Levels
A6.2 - Friday, 8 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

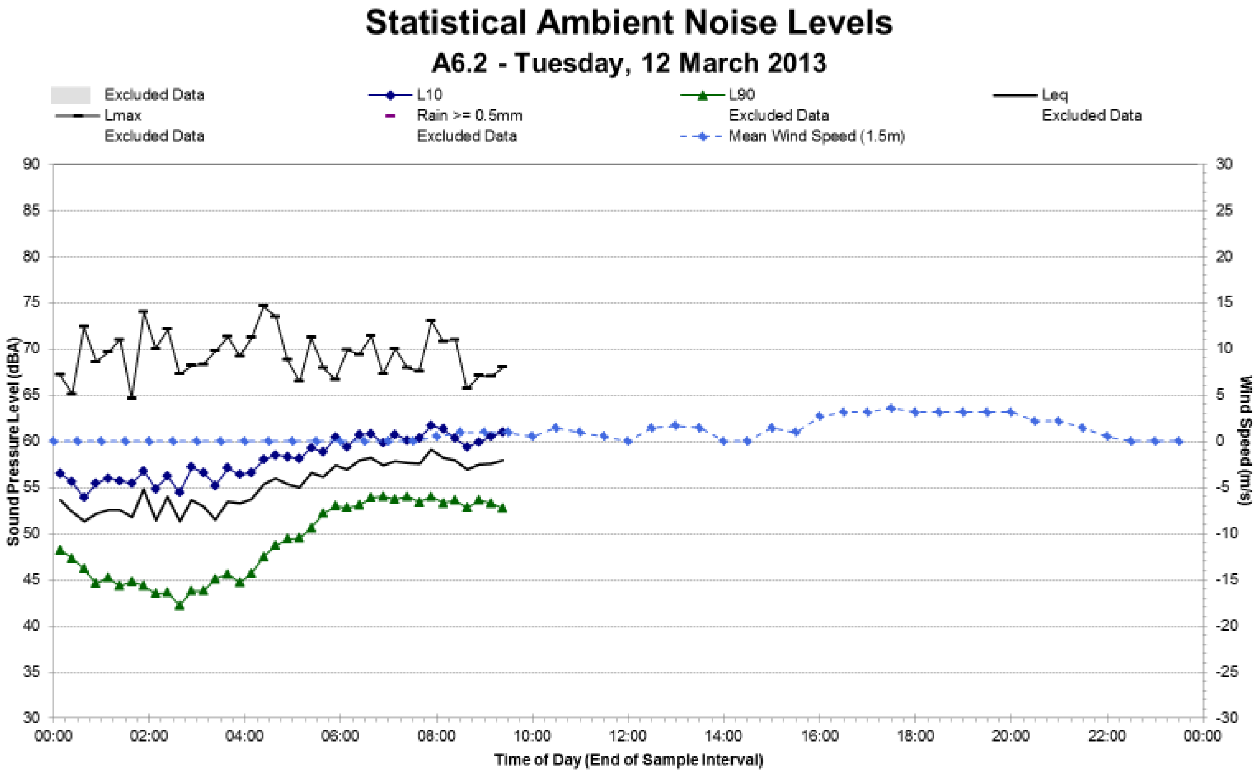


Statistical Ambient Noise Levels
A6.2 - Saturday, 9 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
A6.2 - Sunday, 10 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A6.2 - Monday, 11 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A6.2 - Tuesday, 12 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A7 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A7.1**
Noise Monitoring Address:	**44 Great Western Highway, Prospect**

Logger Device Type: Svantek 957
Logger Serial No: 20673

Ambient noise logger deployed immediately outside residential address 44 Great Western Highway, Prospect. Logger located in front yard on southern property boundary.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Great Western Highway located immediately to the south. Frequent tyre-pavement noise from light-vehicle traffic on Great Western Highway can be heard at this location together with discrete traffic noise level peaks from heavy vehicle movements.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 81-86 dBA, Light-vehicle road traffic: 72-78 dBA, Insects: 53-55 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	54	68	72	77
Evening	52	66	69	75
Night-time	46	65	64	73

Ambient Noise Logging Results – RNP Defined Time Periods

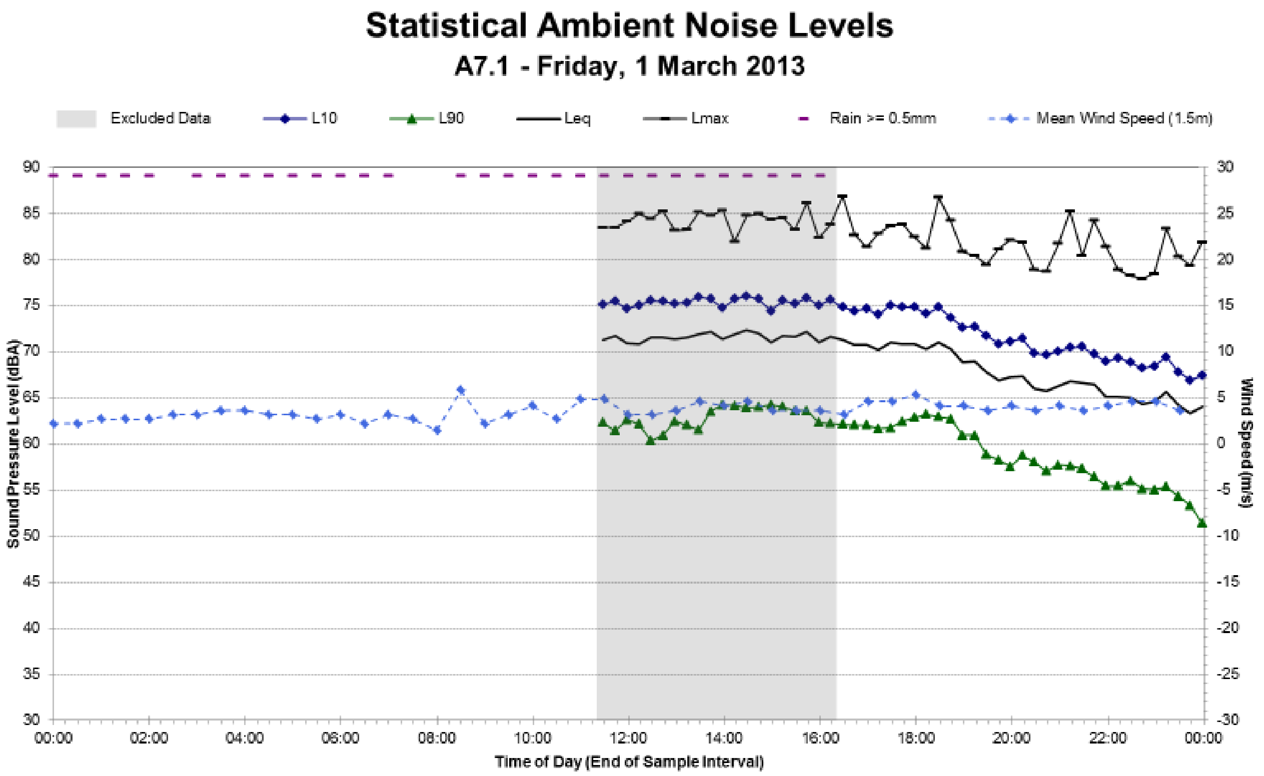
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	3	N/A (7 Day Average)
Daytime (7am-10pm)	68	66	68
Night-time (10pm-7am)	65	63	65

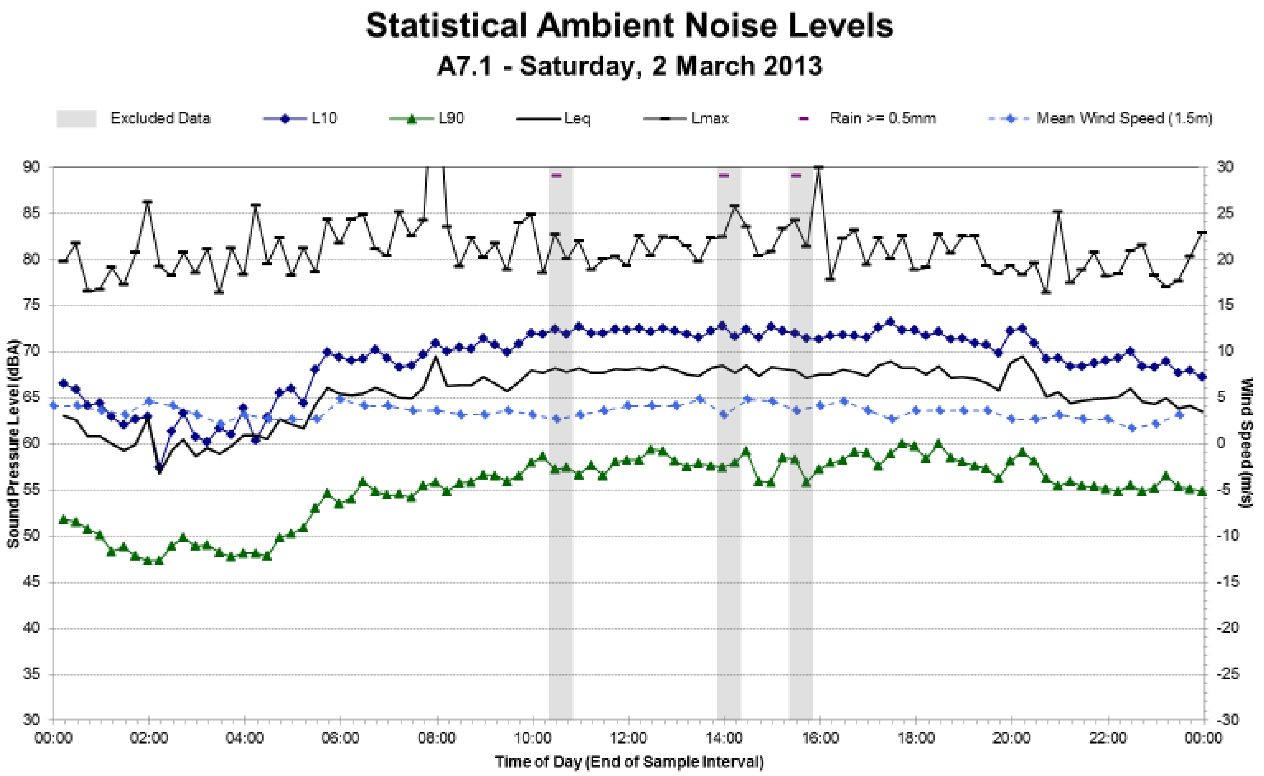
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
12/03/2013	10:14	56	69	86

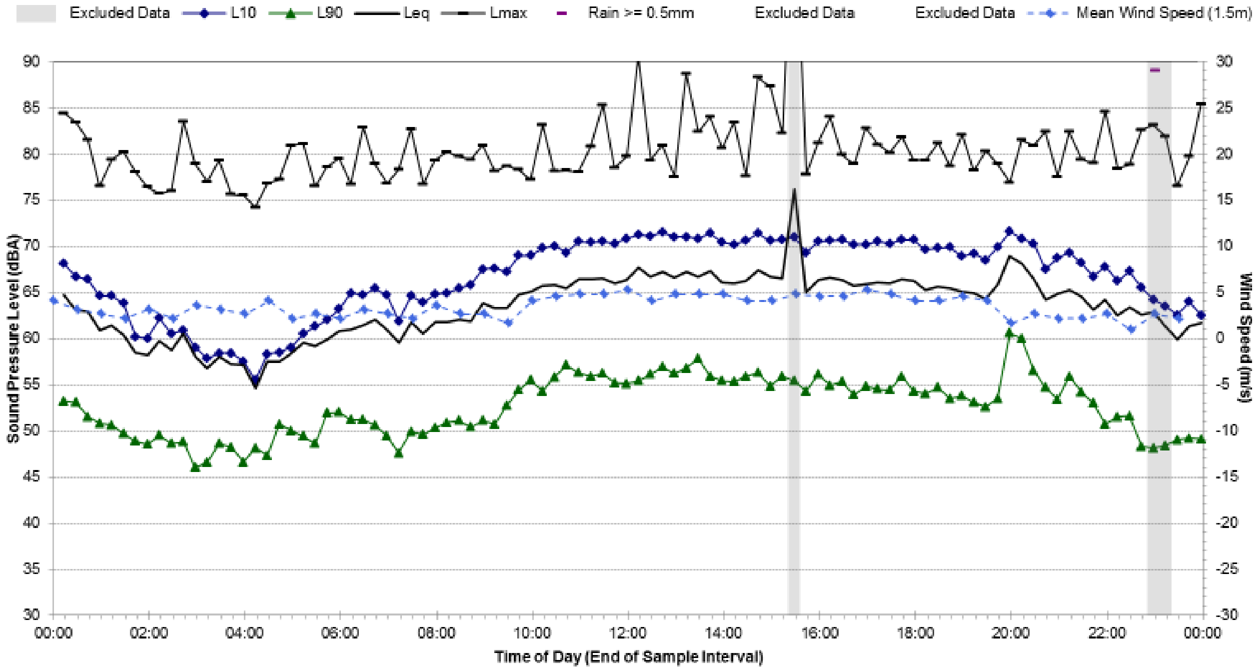
Photo of Noise Monitoring Location

A7 Ambient Noise Monitoring Results

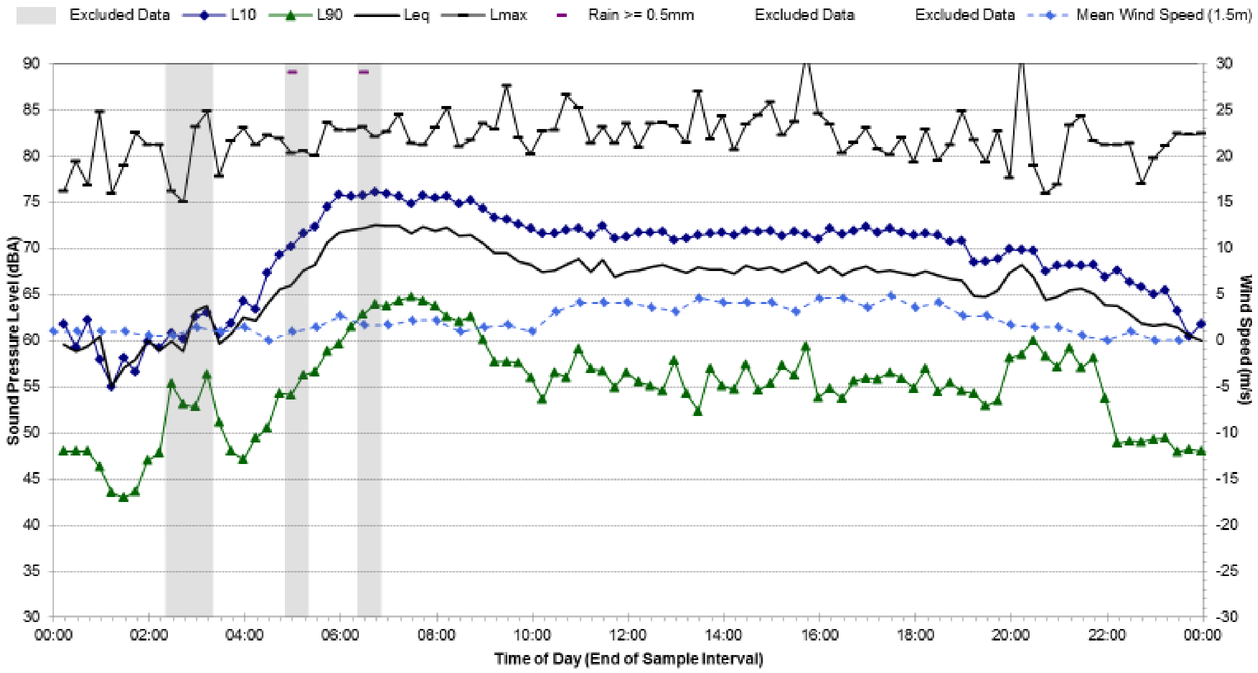


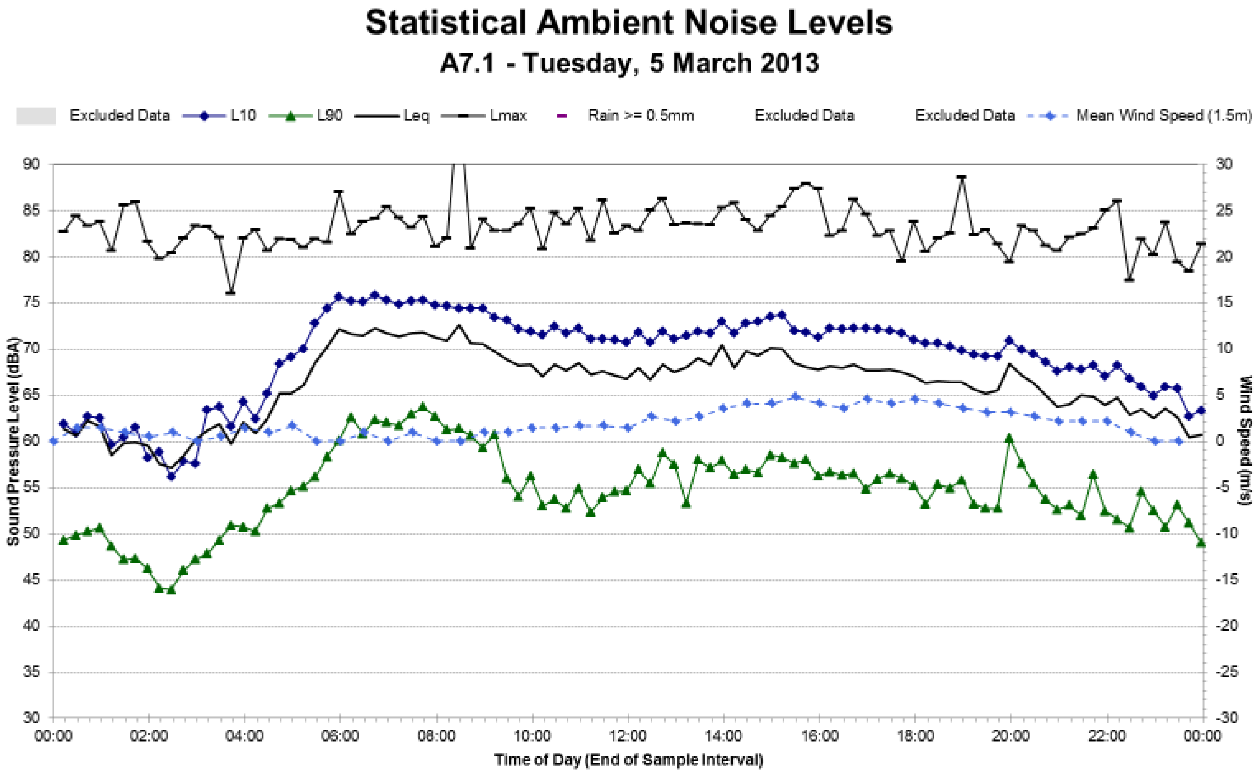


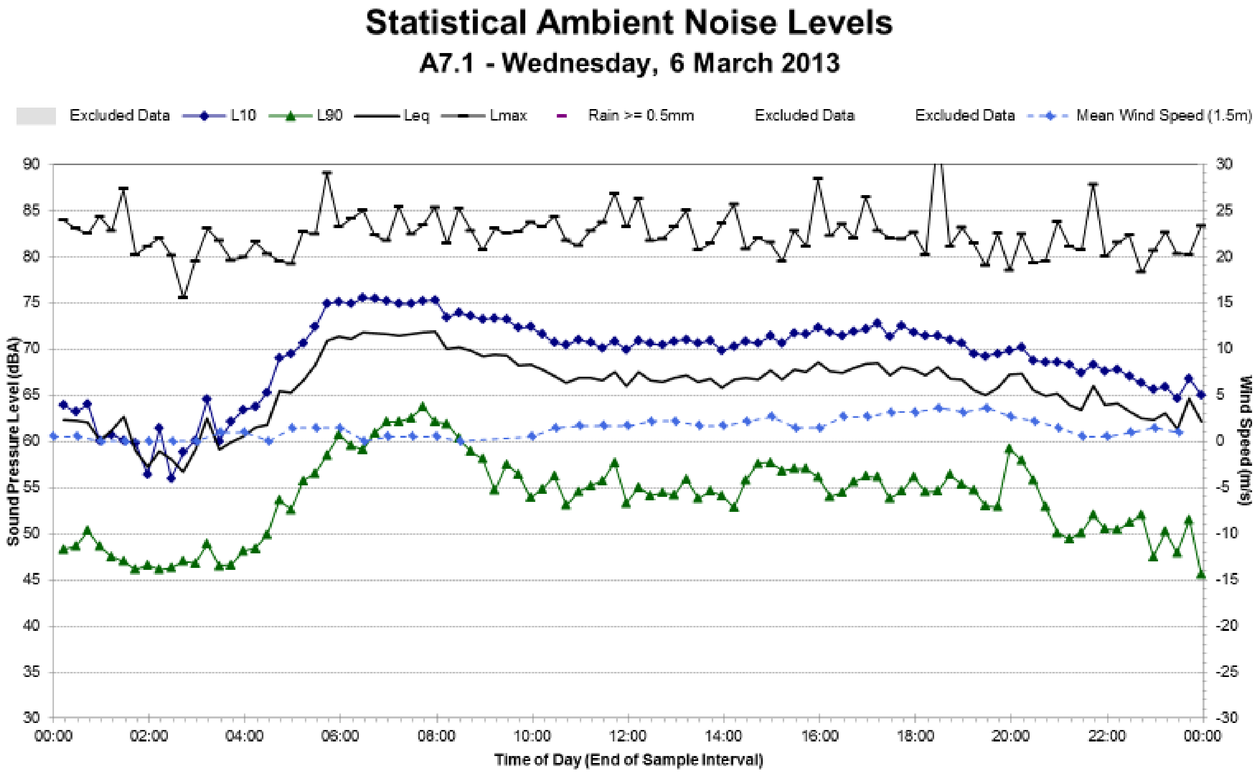
Statistical Ambient Noise Levels
A7.1 - Sunday, 3 March 2013



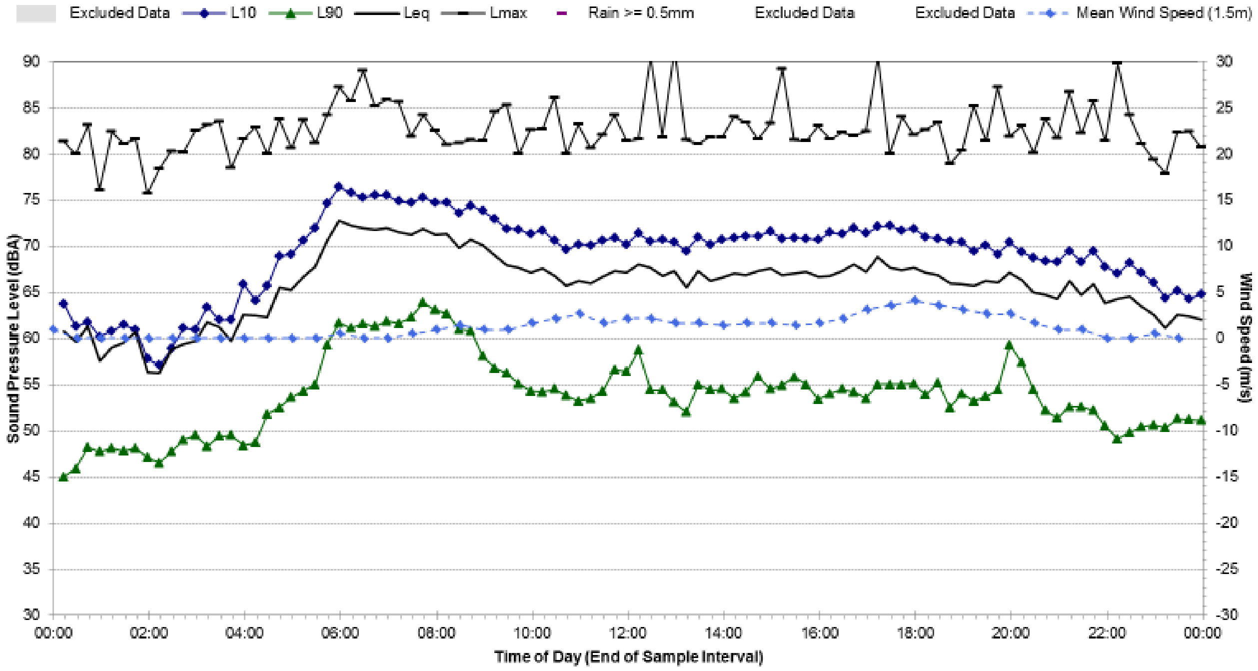
Statistical Ambient Noise Levels
A7.1 - Monday, 4 March 2013



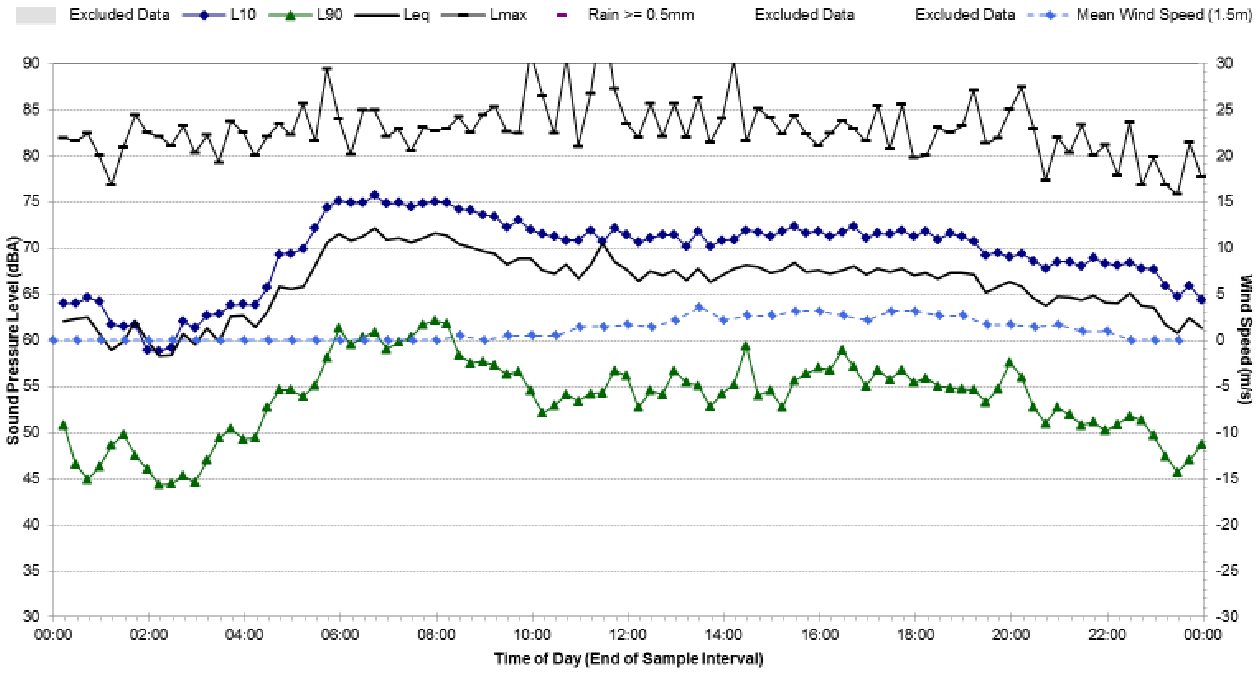

Statistical Ambient Noise Levels
A7.1 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A7.1 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

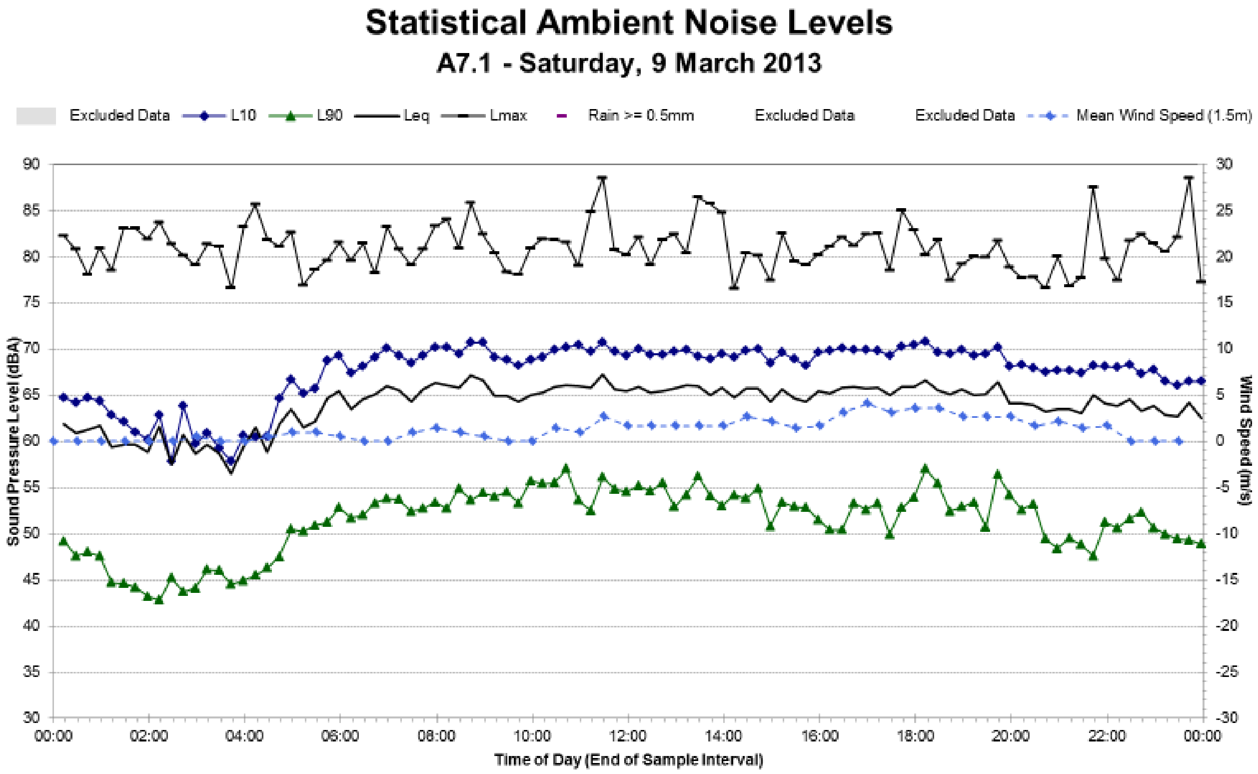
Statistical Ambient Noise Levels
A7.1 - Thursday, 7 March 2013

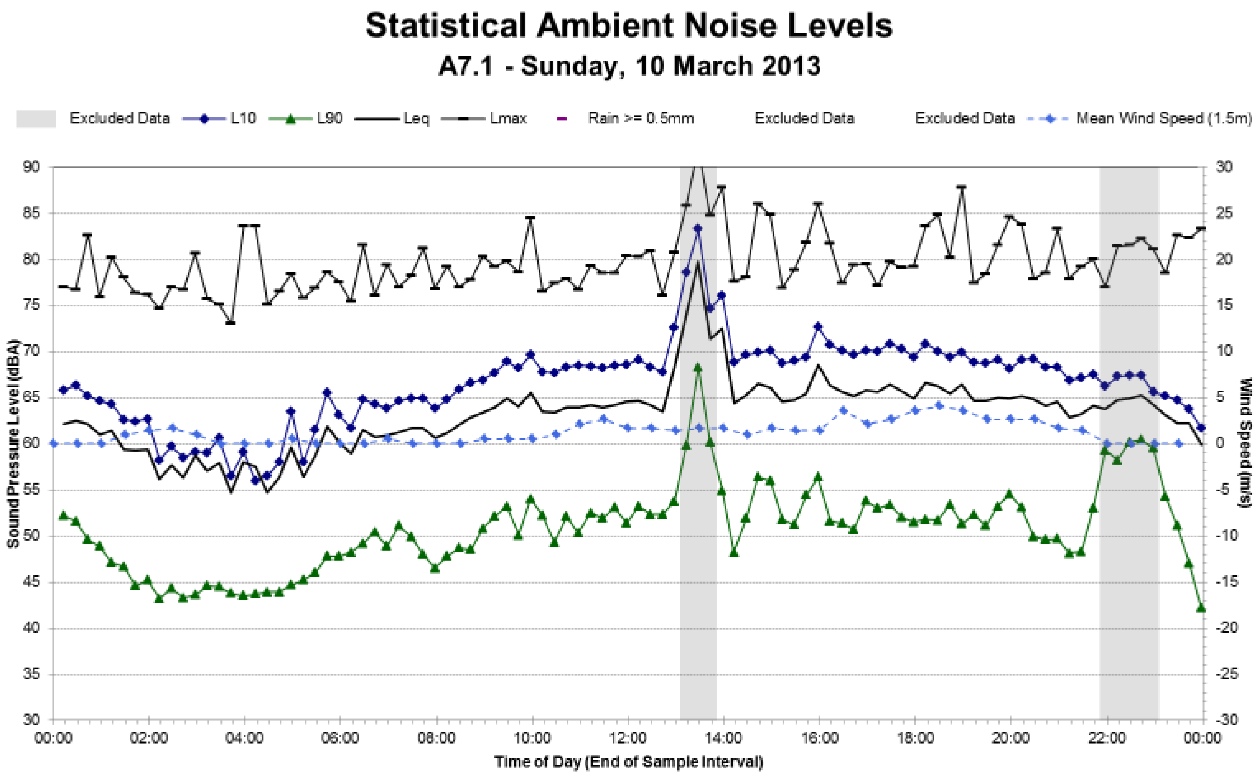


Statistical Ambient Noise Levels
A7.1 - Friday, 8 March 2013



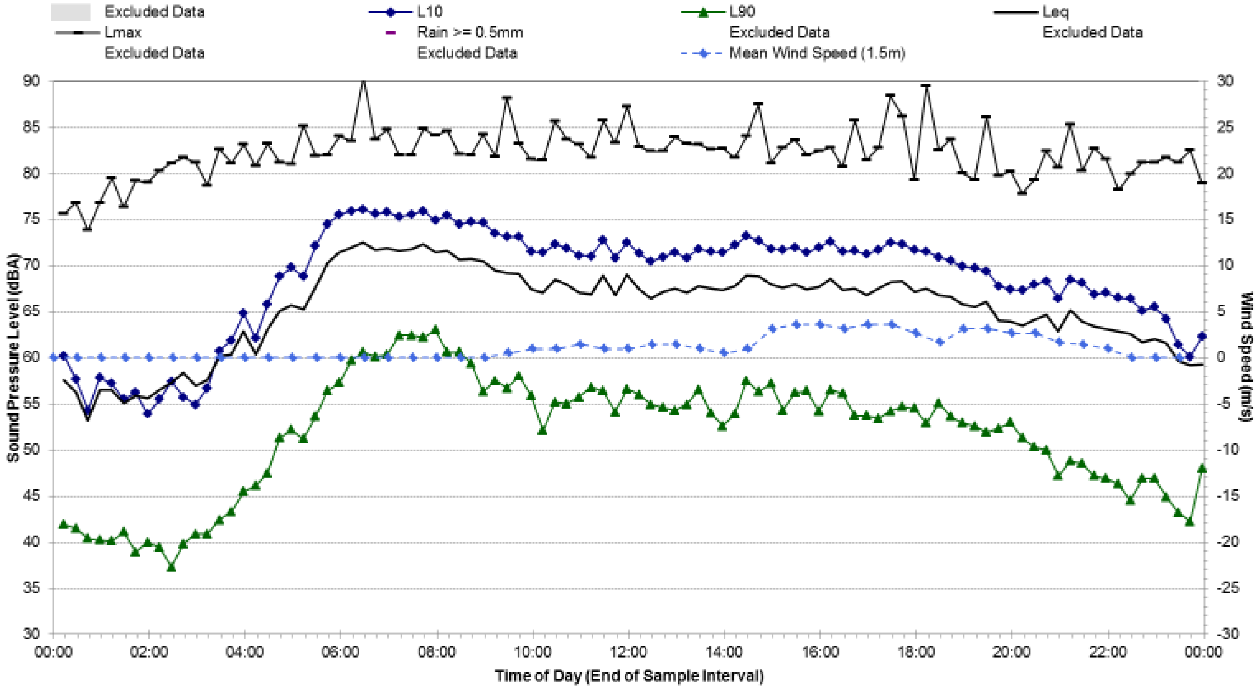
A7 Ambient Noise Monitoring Results





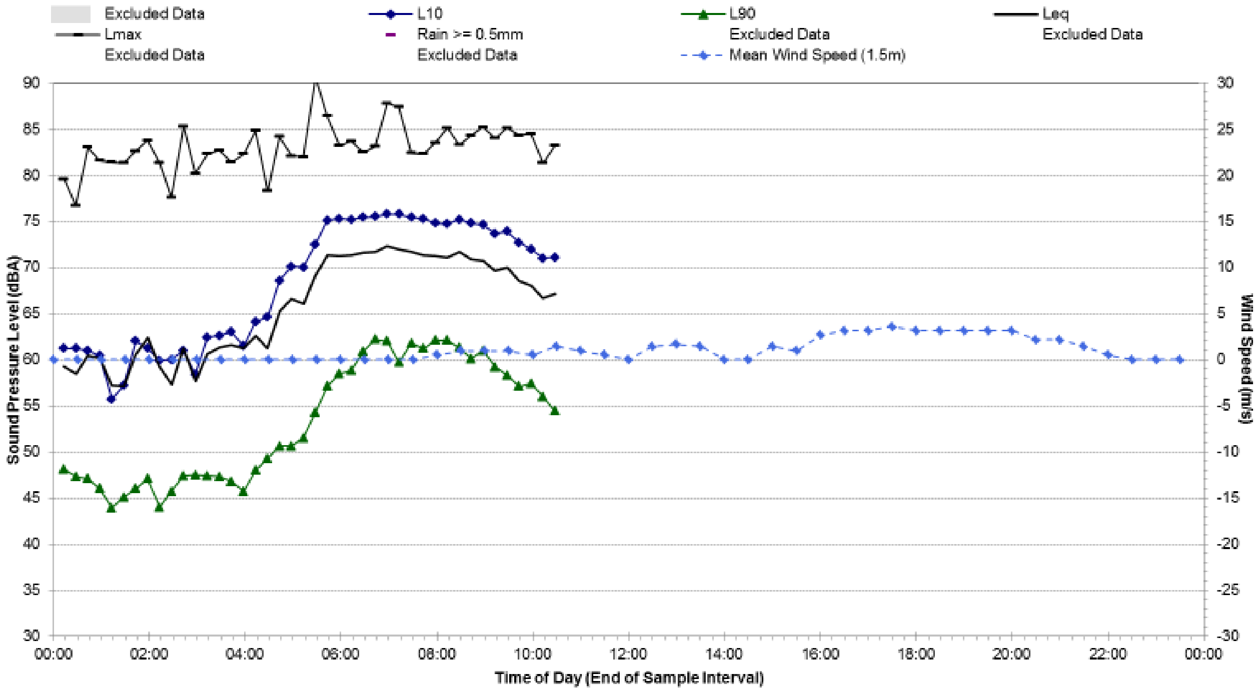
Statistical Ambient Noise Levels

A7.1 - Monday, 11 March 2013



Statistical Ambient Noise Levels

A7.1 - Tuesday, 12 March 2013



Noise Monitoring Location:	**A7.2**
Noise Monitoring Address:	**24 Watch House Road, Prospect**

Logger Device Type: Svantek 957
Logger Serial No: 23241

Ambient noise logger deployed approximately 15 m from the most potentially affected facade of residential address 24 Watch House Road, Prospect.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 westbound on-ramp located north-east of measurement position. Frequent tyre-pavement noise from light-vehicle traffic on M4 ramp can also be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are apparent and are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 61-77 dBA, Light-vehicle road traffic: 50-54 dBA, Insects: 51-54 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	52	59	62	66
Evening	51	57	59	64
Night-time	46	53	53	60

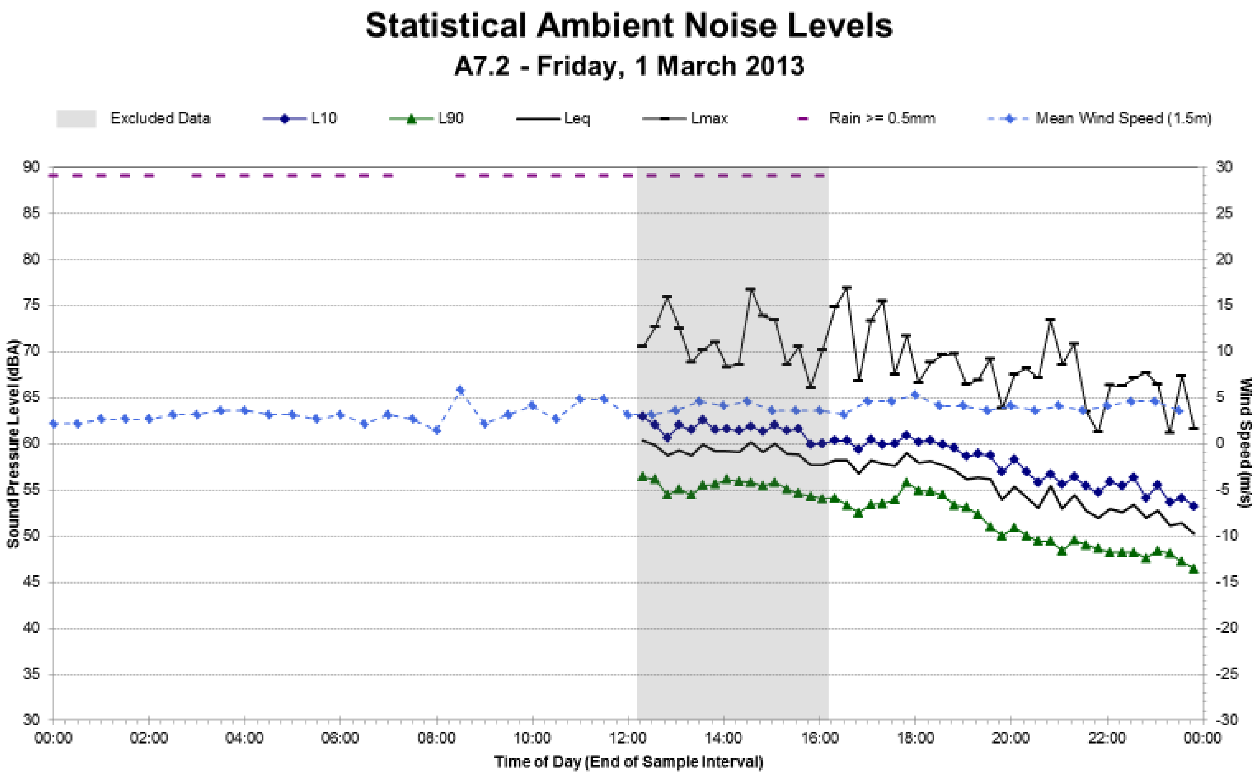
Ambient Noise Logging Results – RNP Defined Time Periods

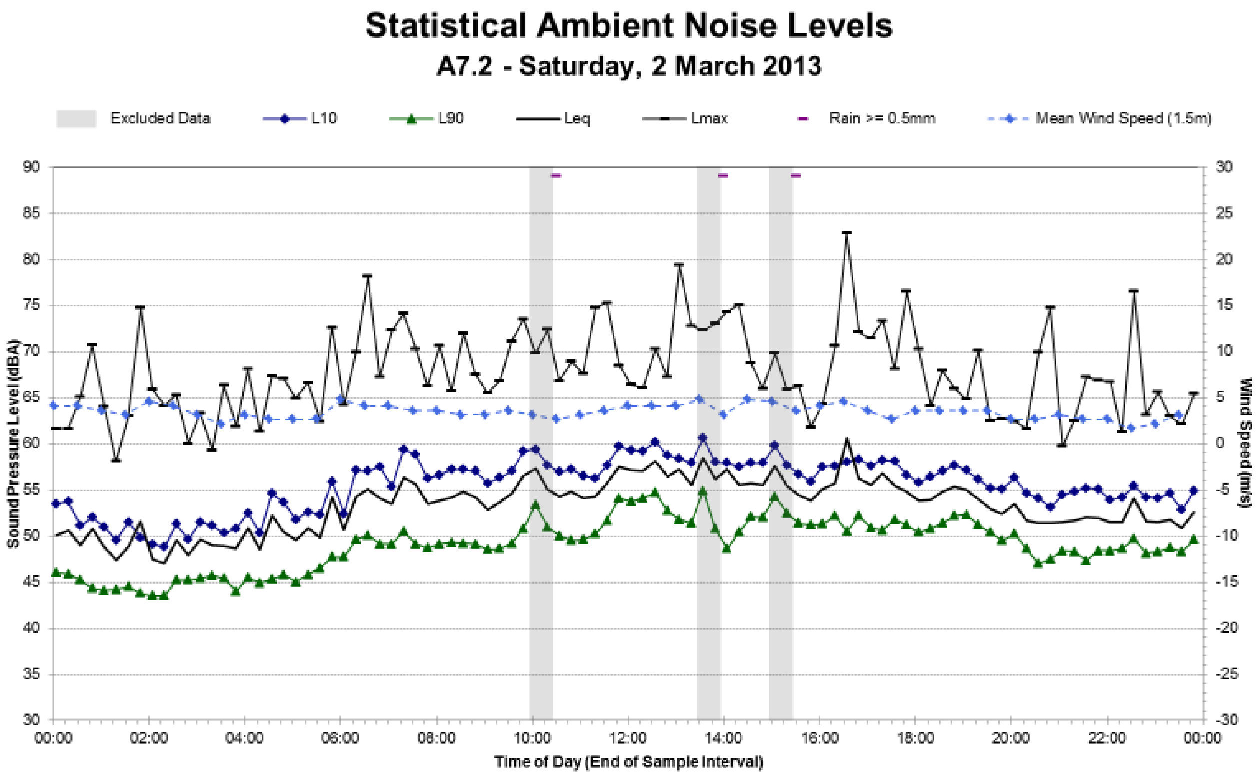
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	4	N/A (7 Day Average)
Daytime (7am-10pm)	59	57	59
Night-time (10pm-7am)	53	53	53

Attended Noise Measurement Results

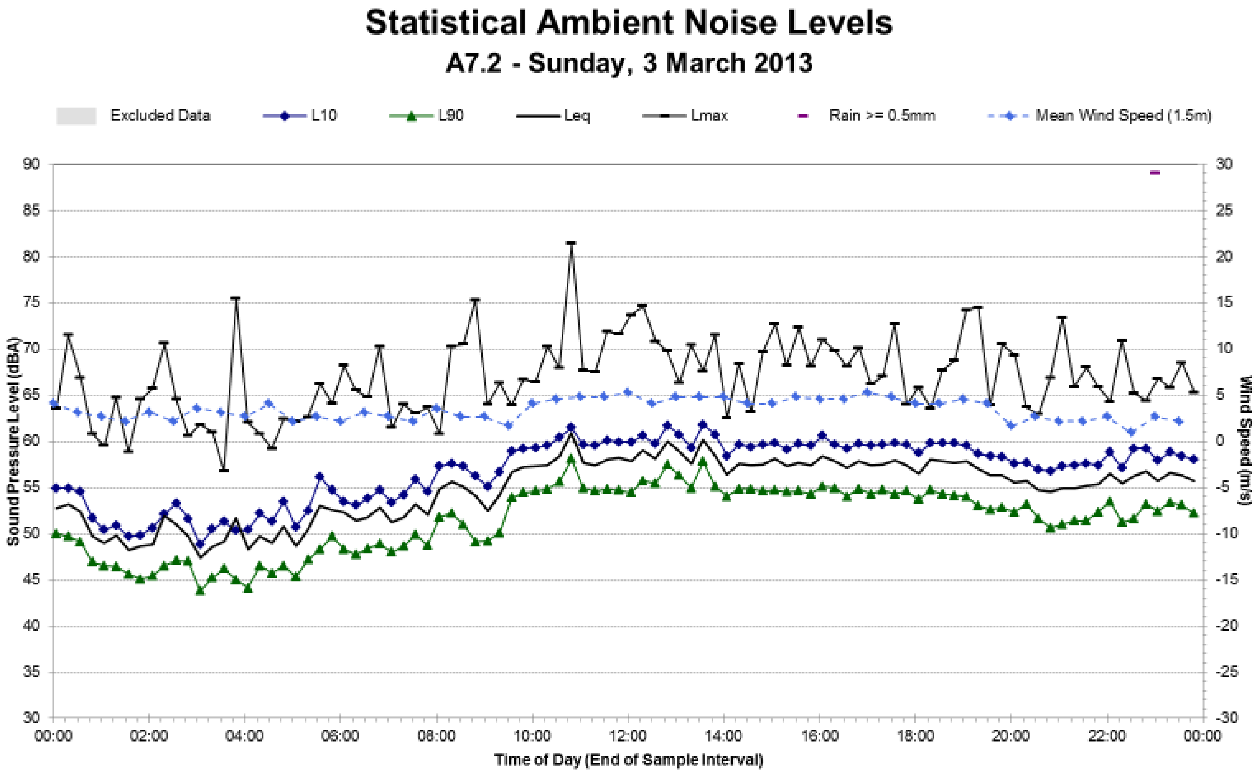
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
12/03/2013	10:56	51	58	77

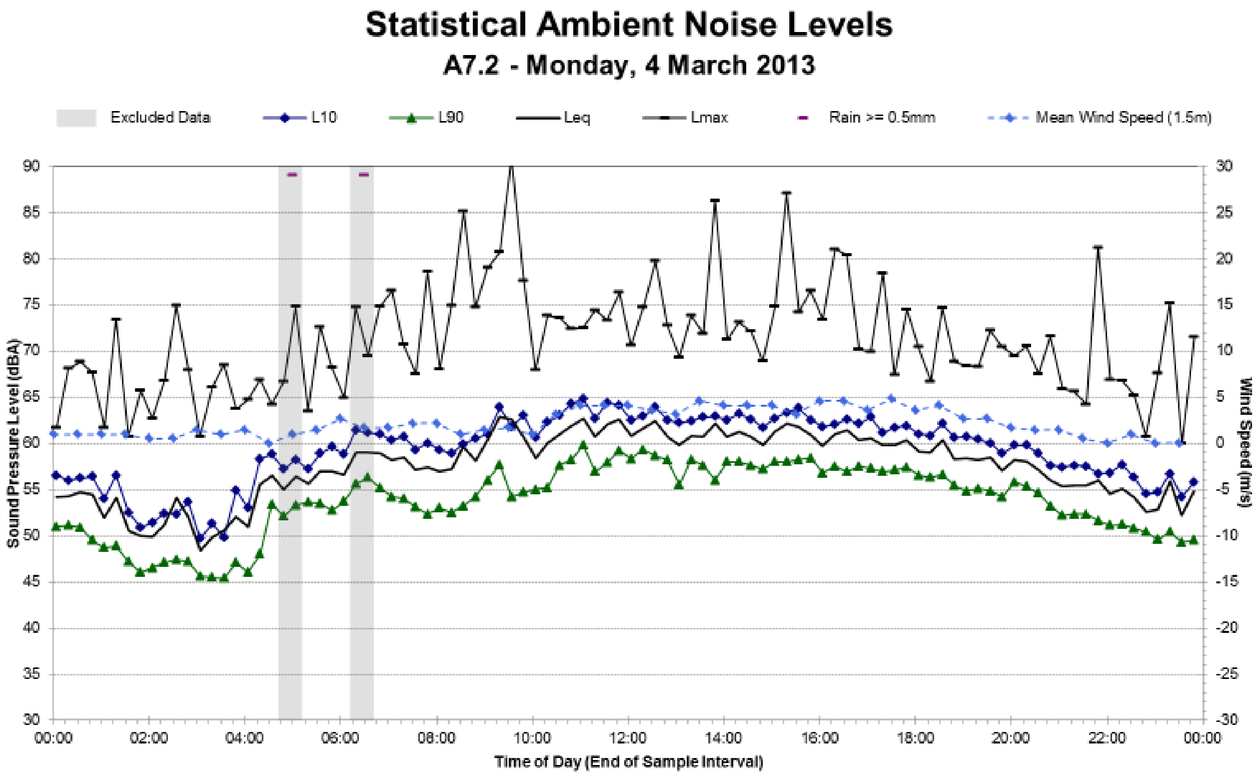
Photo of Noise Monitoring Location

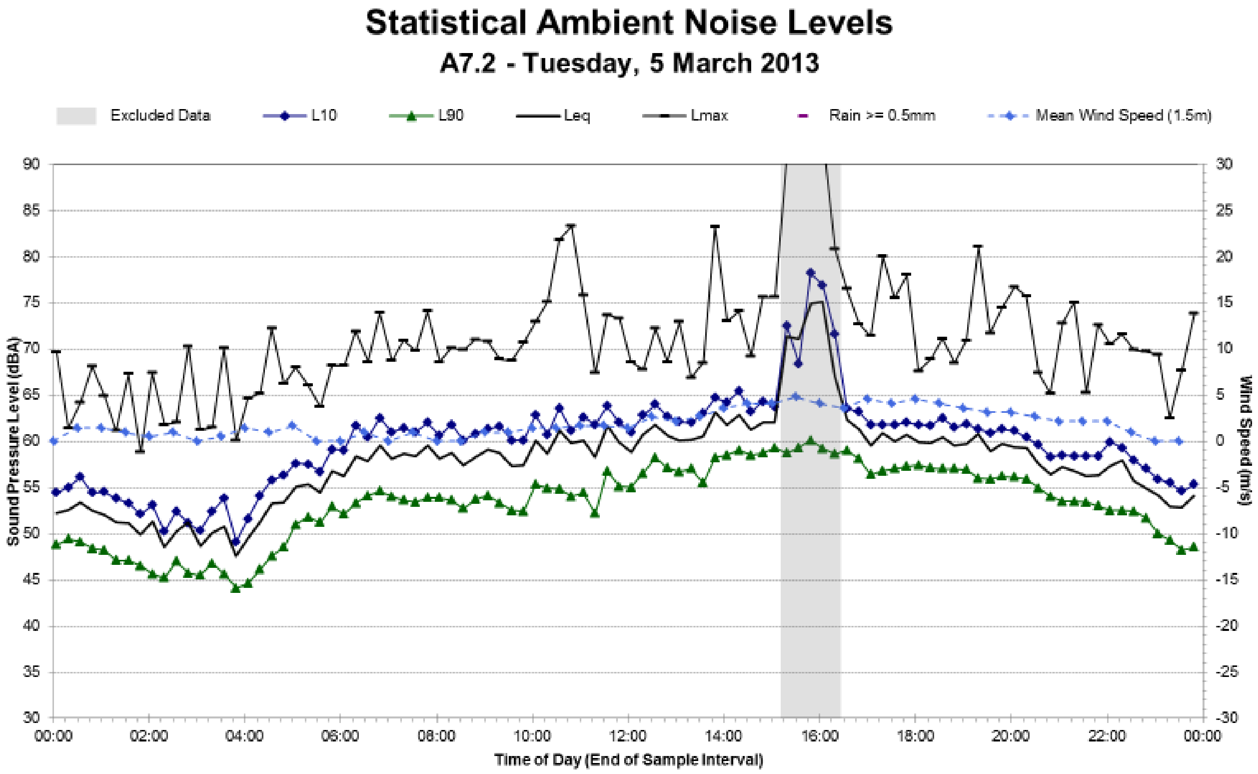

Statistical Ambient Noise Levels
A7.2 - Friday, 1 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

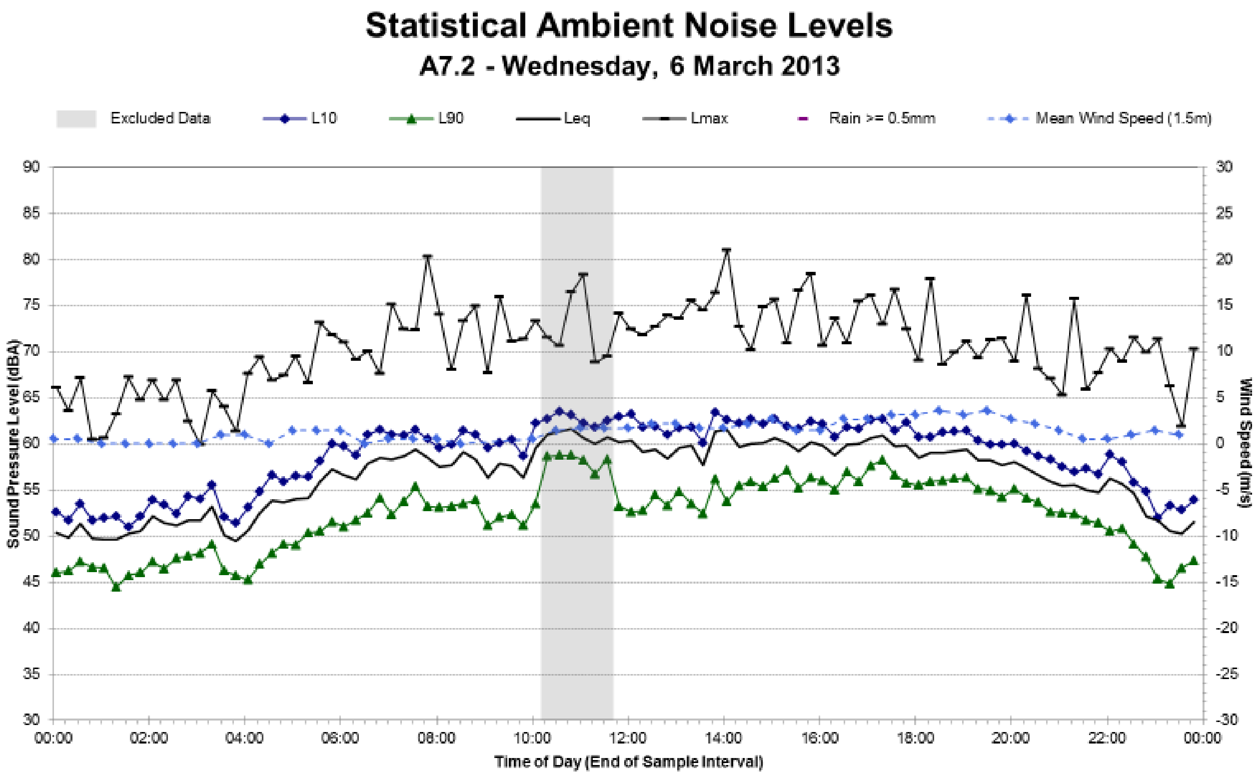

Statistical Ambient Noise Levels
A7.2 - Saturday, 2 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A7 Ambient Noise Monitoring Results

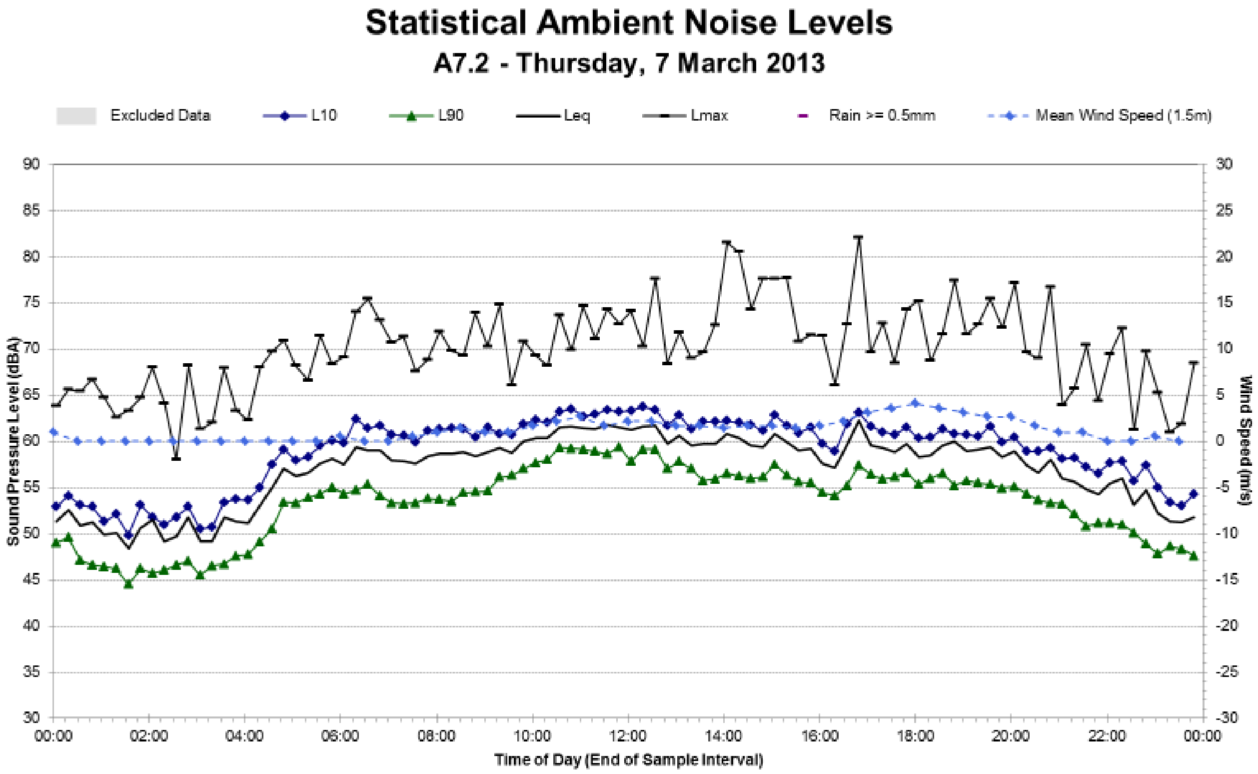


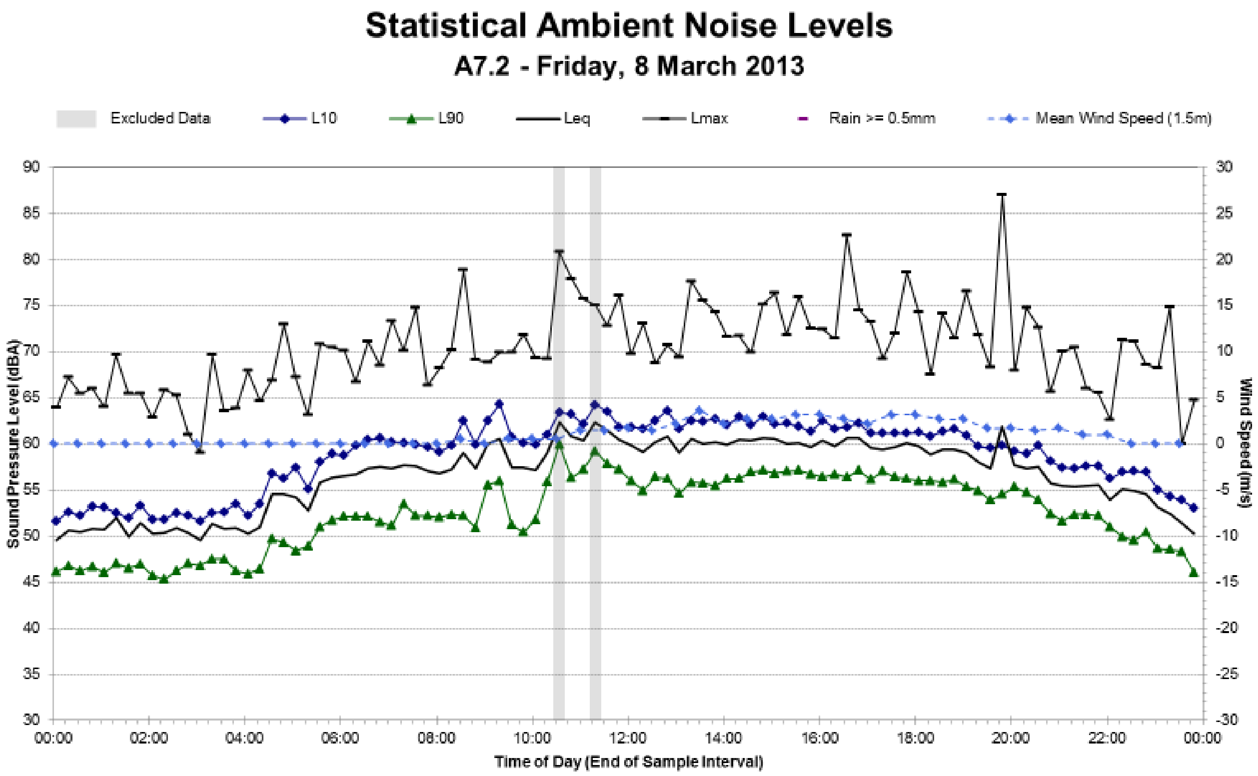


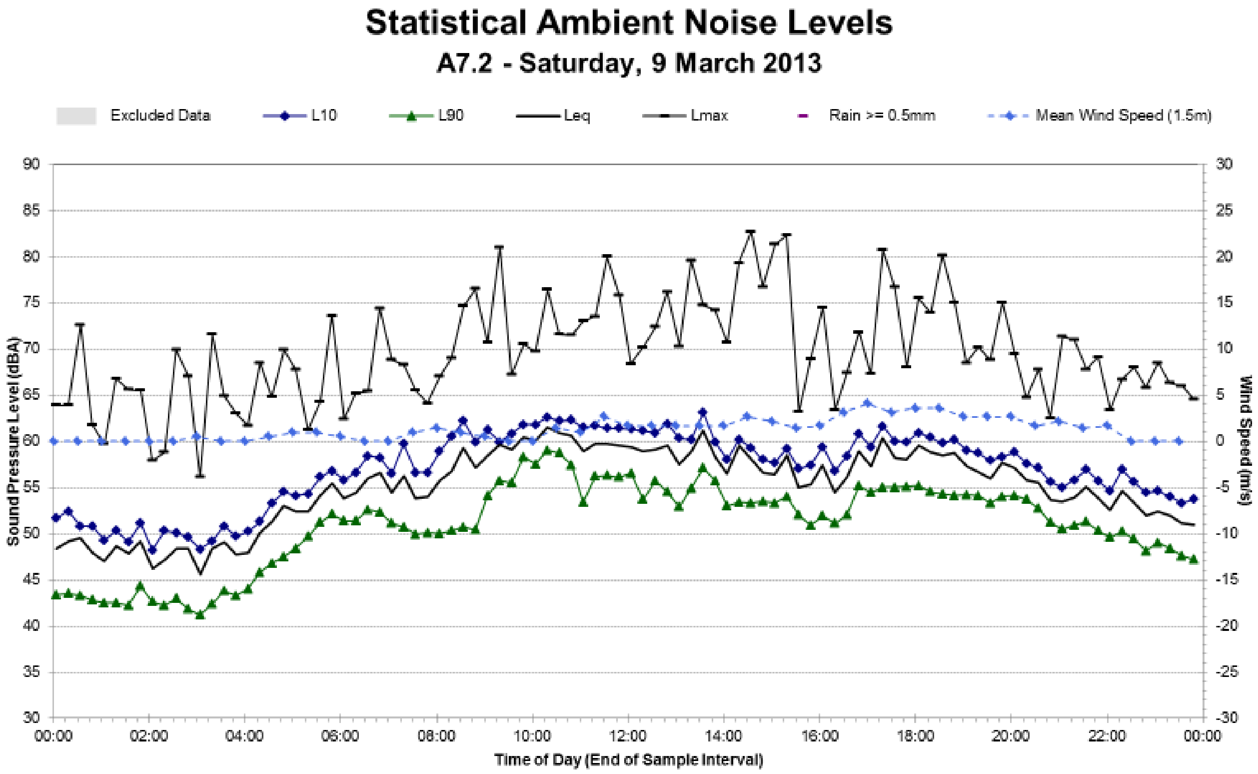

Statistical Ambient Noise Levels
A7.2 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A7.2 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A7 Ambient Noise Monitoring Results






Statistical Ambient Noise Levels
A7.2 - Saturday, 9 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
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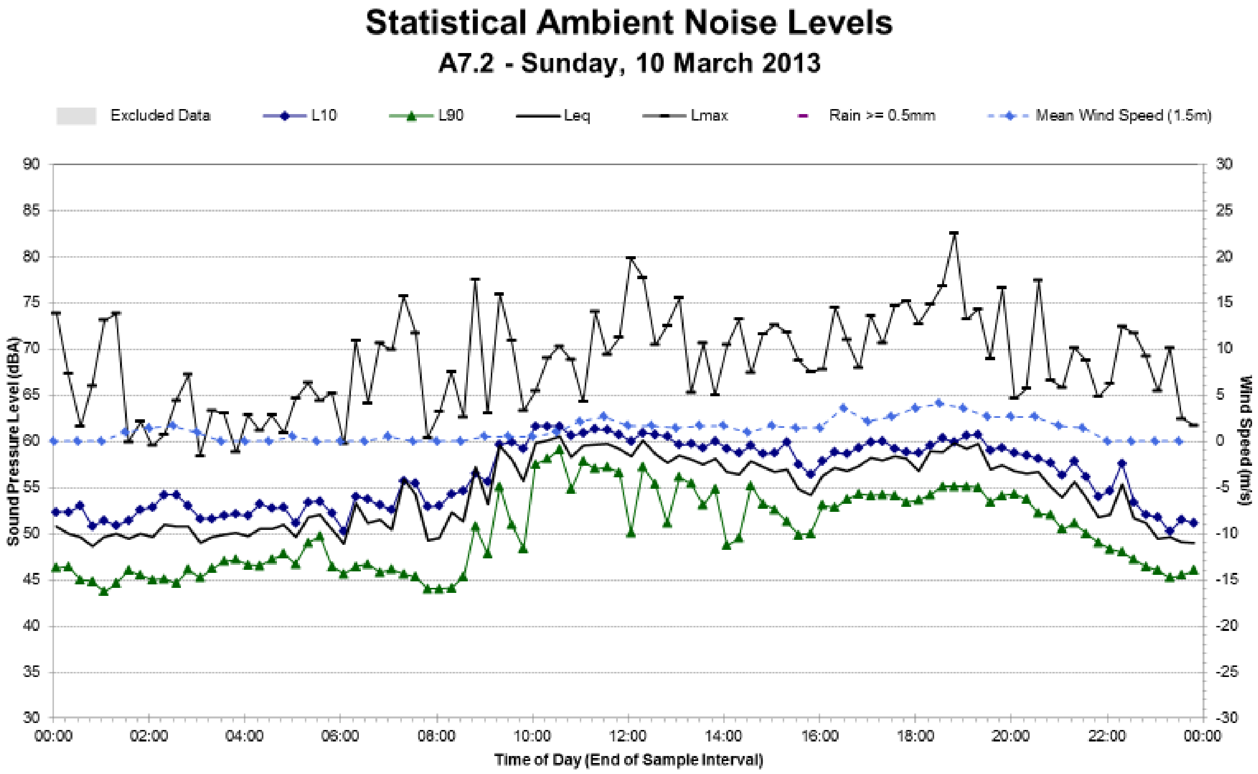
20:00
22:00
00:00


Statistical Ambient Noise Levels
A7.2 - Sunday, 10 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
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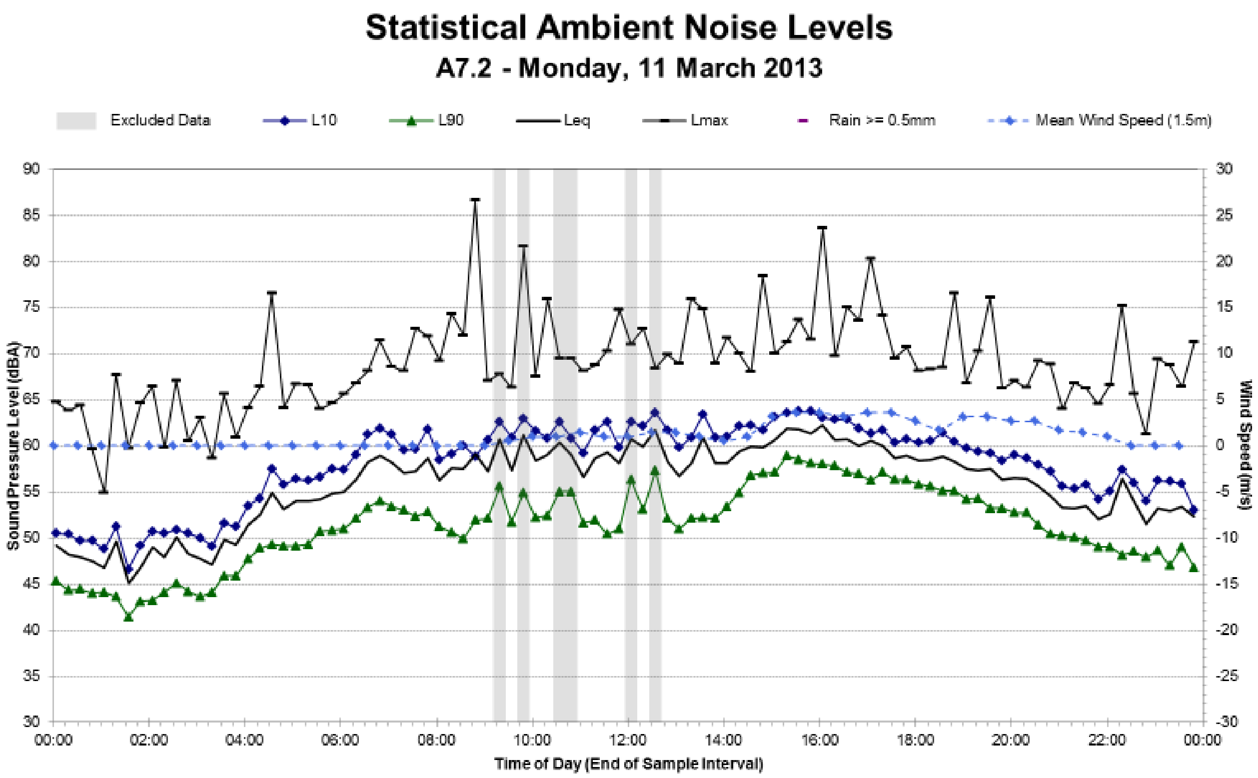
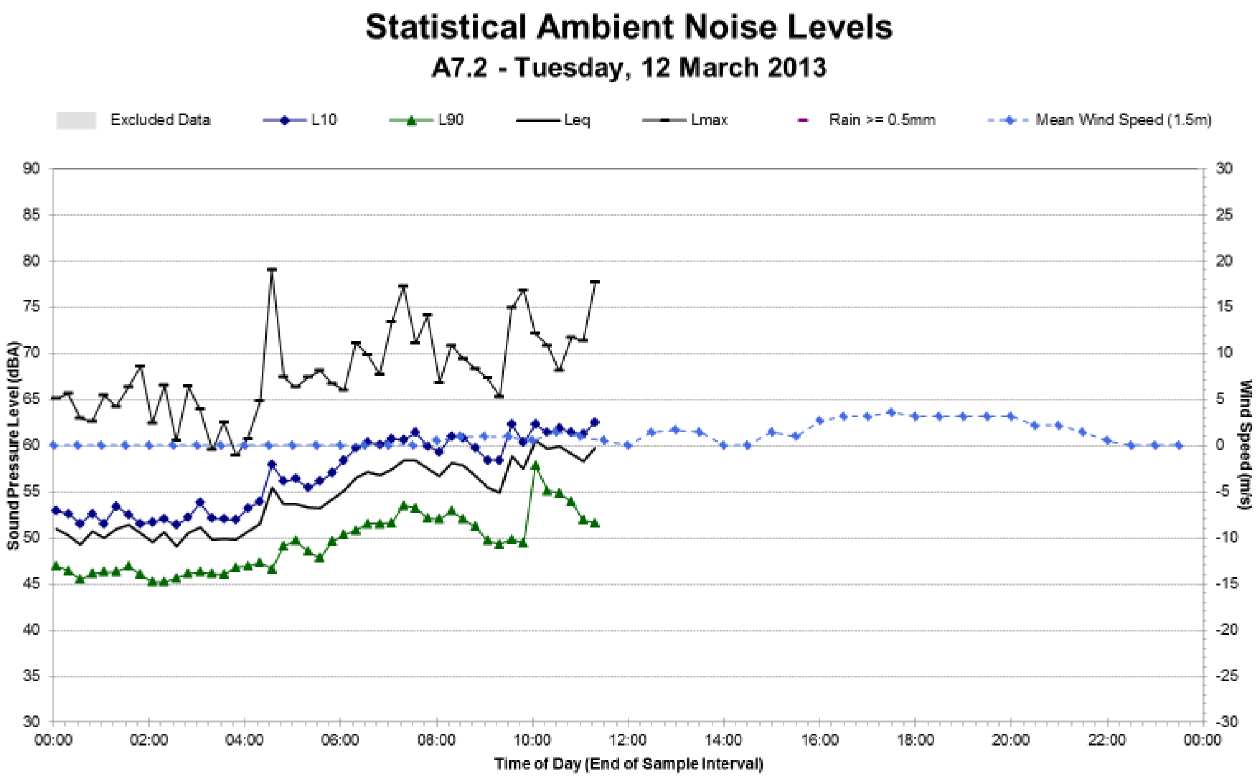

Statistical Ambient Noise Levels
A7.2 - Monday, 11 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A7.2 - Tuesday, 12 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A8 Ambient Noise Monitoring Results

Noise Monitoring Location:	A8.1
Noise Monitoring Address:	**2 Yallock Place, Prospect**

Logger Device Type: Svantek 957
Logger Serial No: 27523

Ambient noise logger deployed on RMS land approximately 40 m west of residential address 2 Yallock Place, Prospect.

Attended noise measurements indicate the ambient noise environment at this location is dominated by heavy vehicle road traffic noise on M4. Frequent tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are apparent and are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 59-64 dBA, Air traffic: 55-70 dBA, Birds: 66-67 dBA, Insects: ~57 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	**LAeq**	**L10**	**L1**
Daytime	52	57	59	63
Evening	52	56	57	61
Night-time	48	54	55	59

Ambient Noise Logging Results – RNP Defined Time Periods

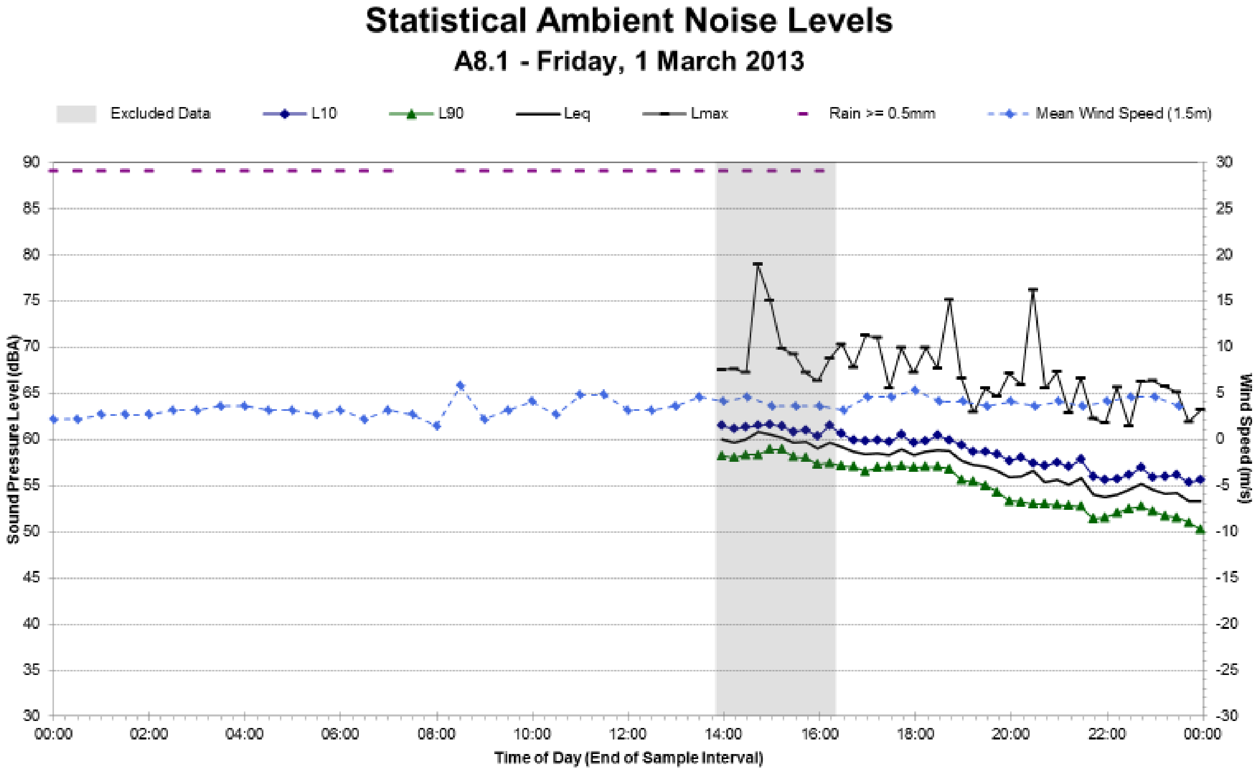
Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	2	N/A (7 Day Average)
Daytime (7am-10pm)	58	55	57
Night-time (10pm-7am)	54	53	54

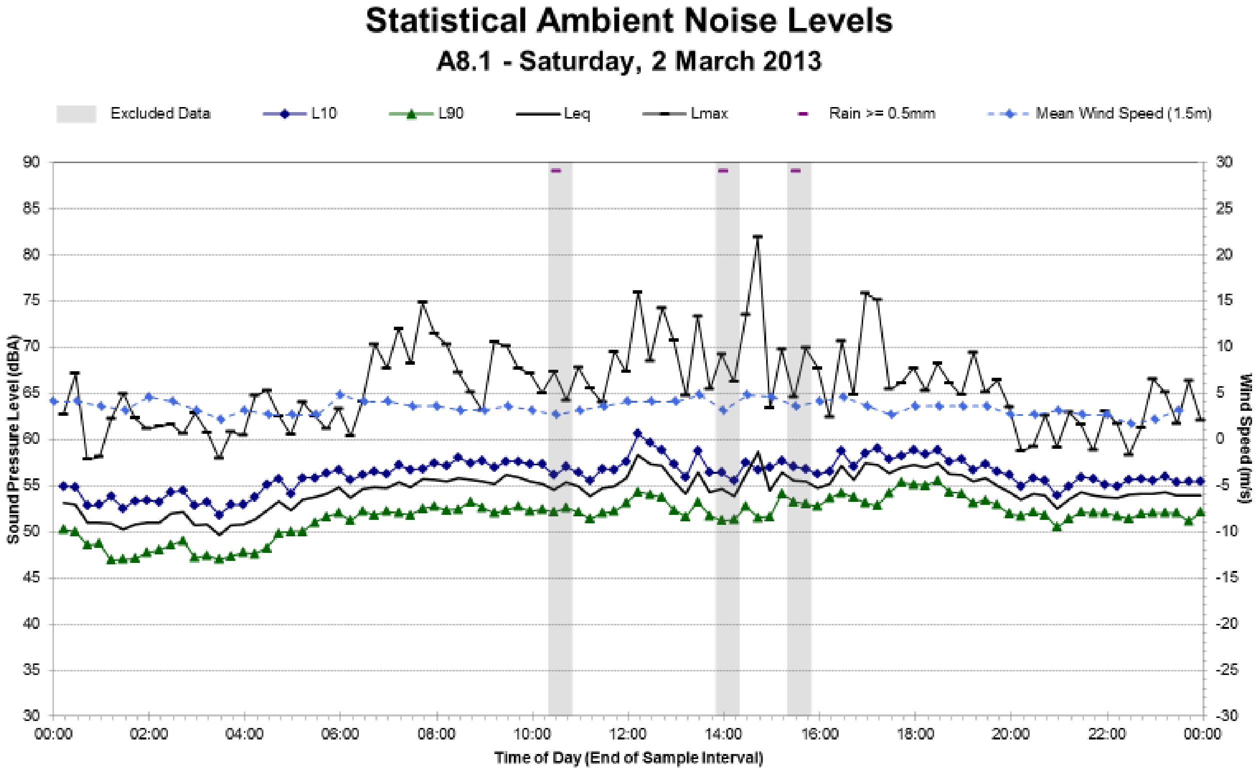
Attended Noise Measurement Results

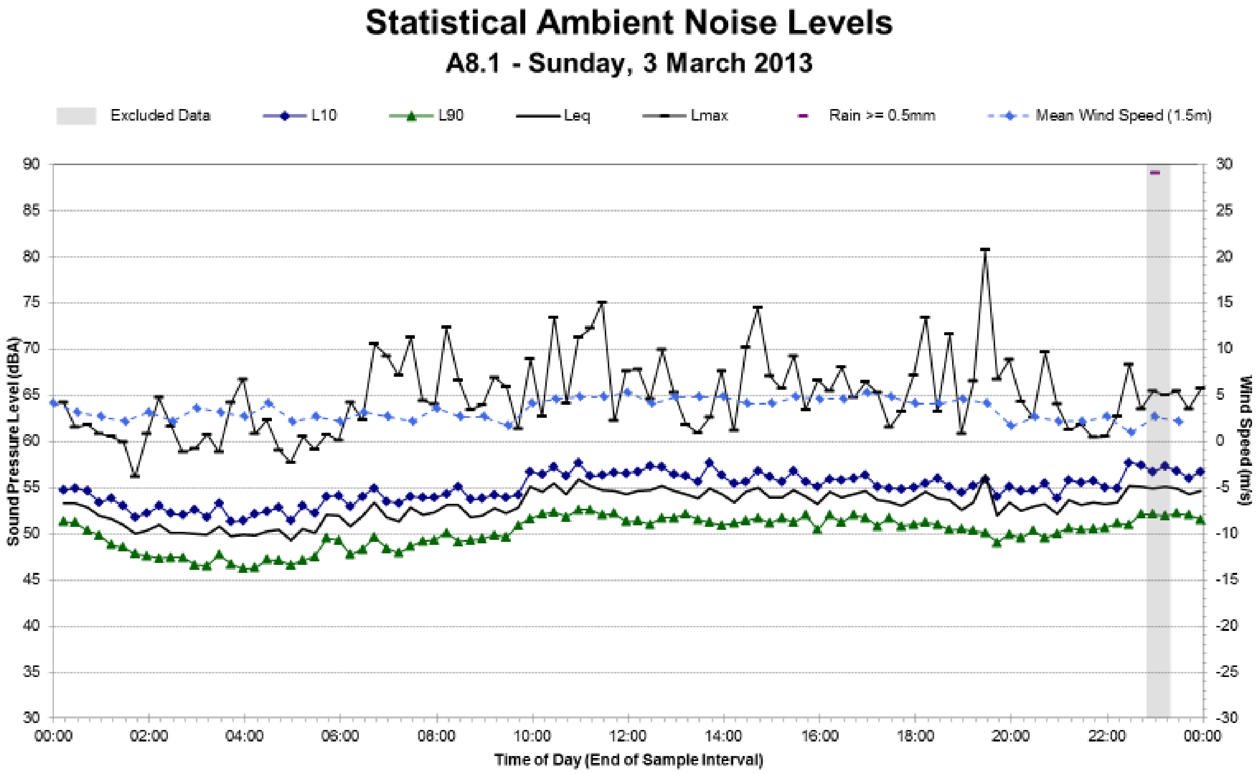
Date	Start Time	Measured Noise Level (dBA)		
		LA90	**LAeq**	**LAmax**
12/03/2013	11:30	55	58	70

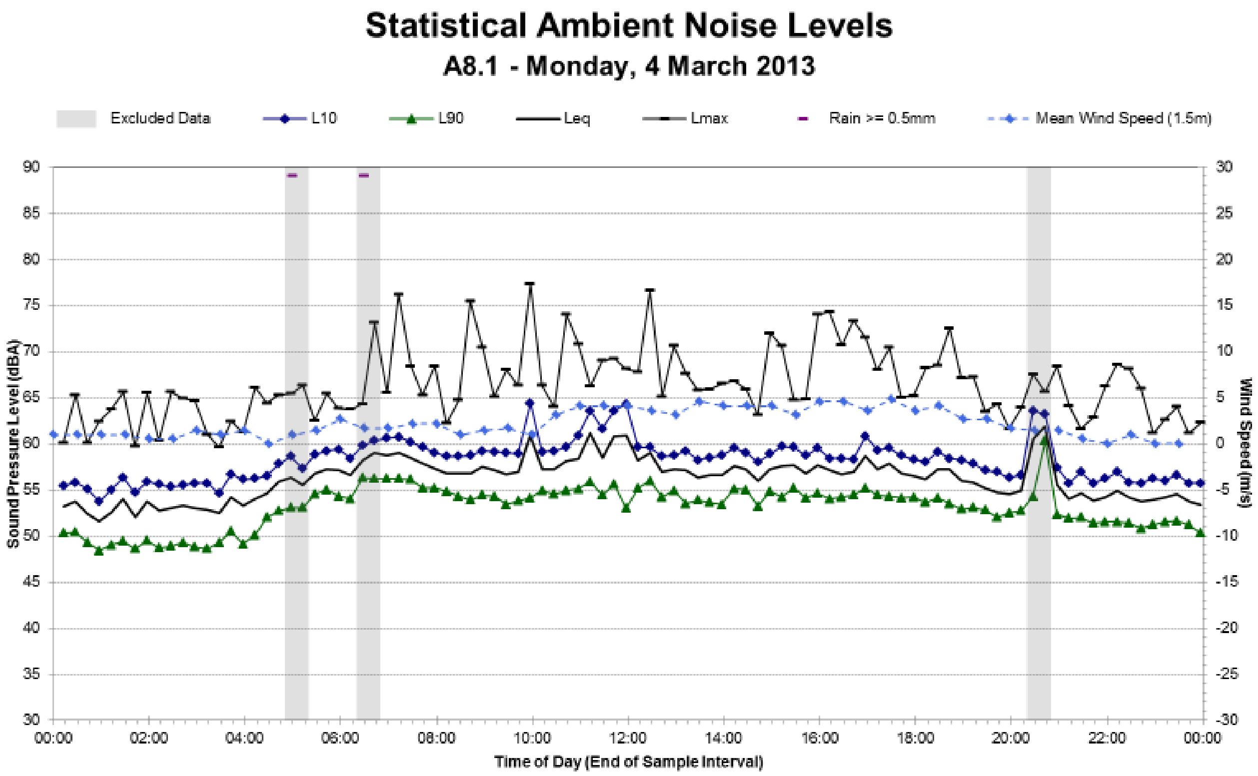
Photo of Noise Monitoring Location

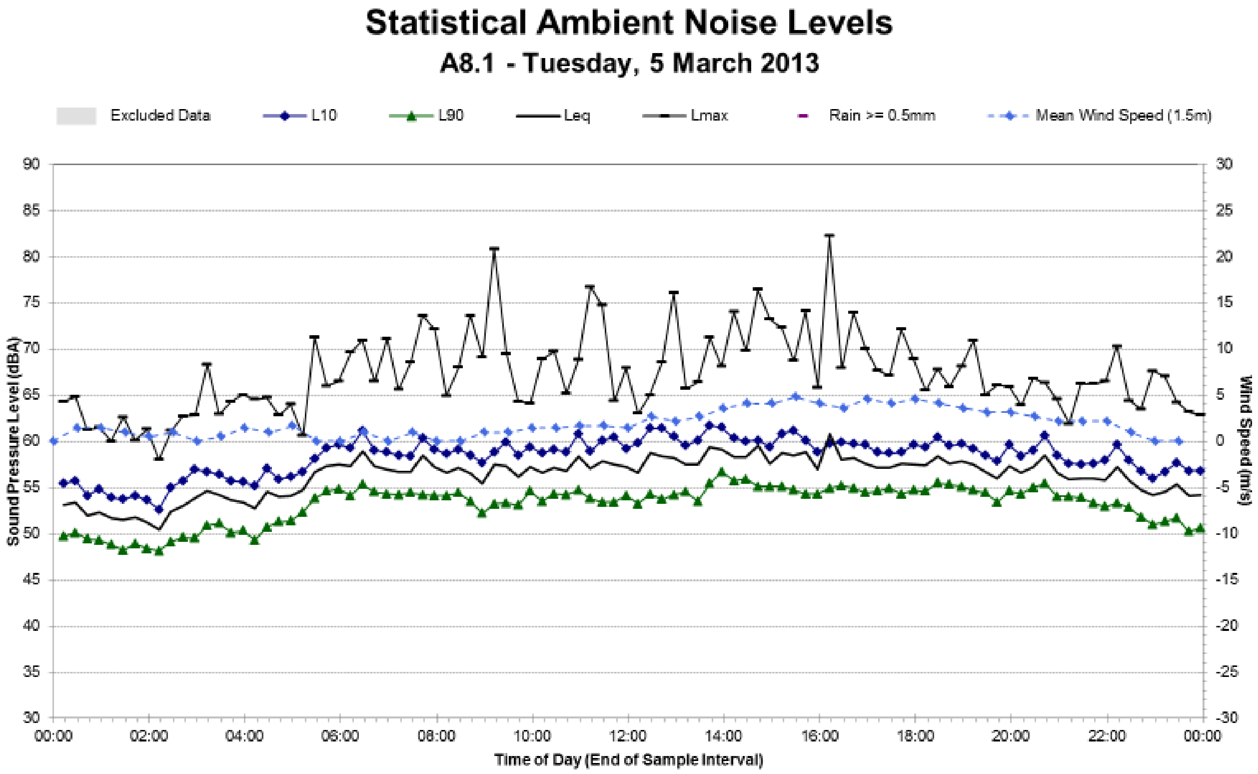
A8 Ambient Noise Monitoring Results






Statistical Ambient Noise Levels
A8.1 - Sunday, 3 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A8.1 - Monday, 4 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A8.1 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
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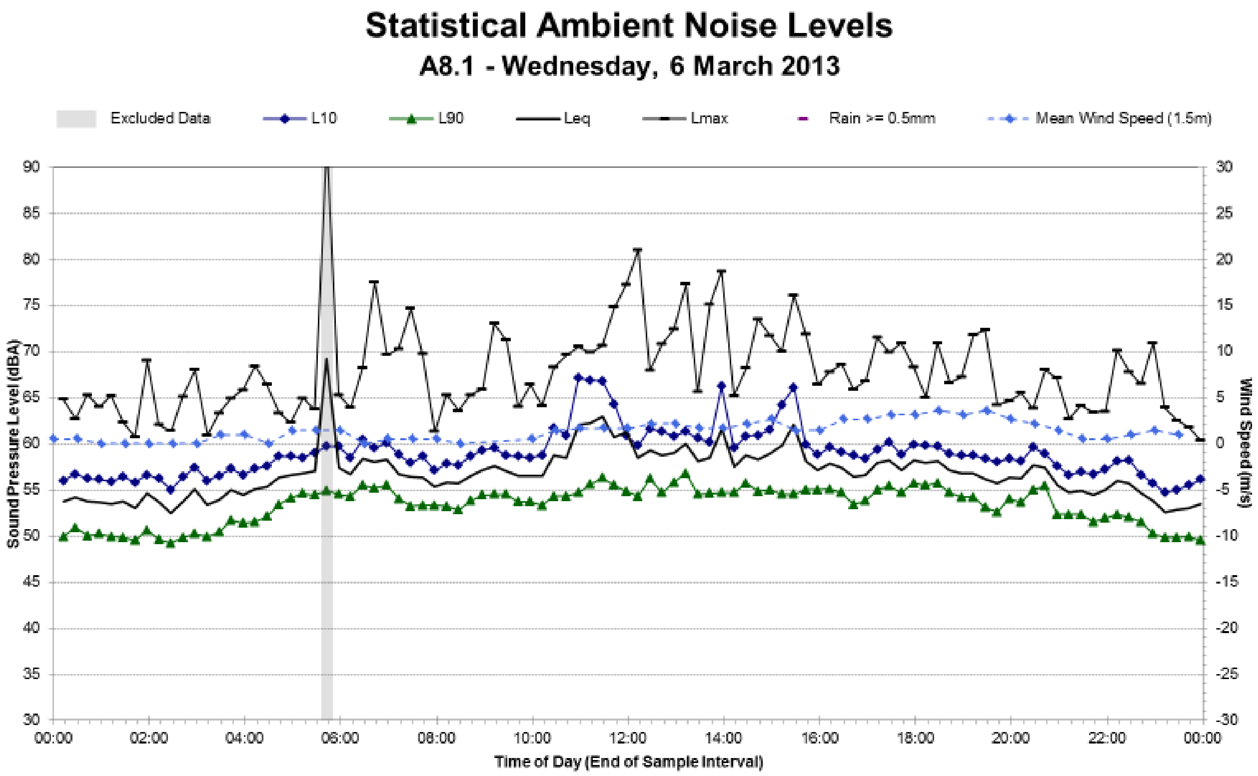
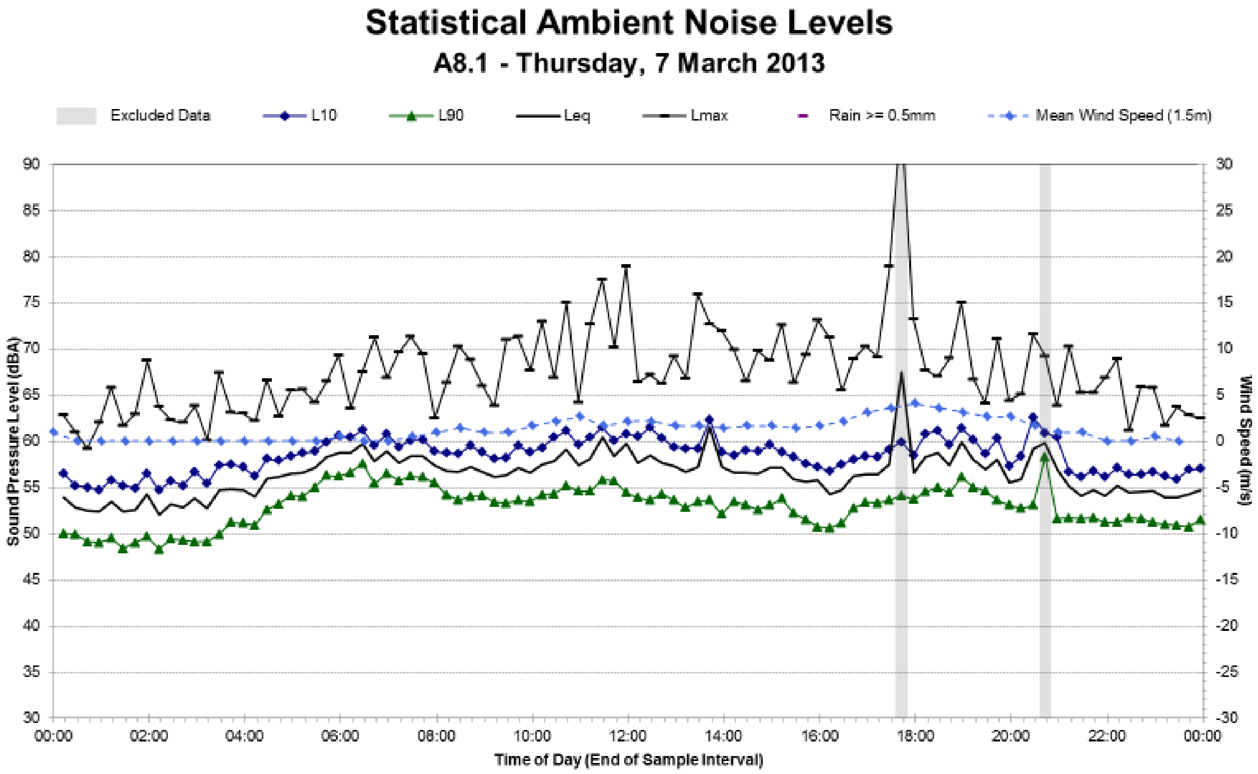
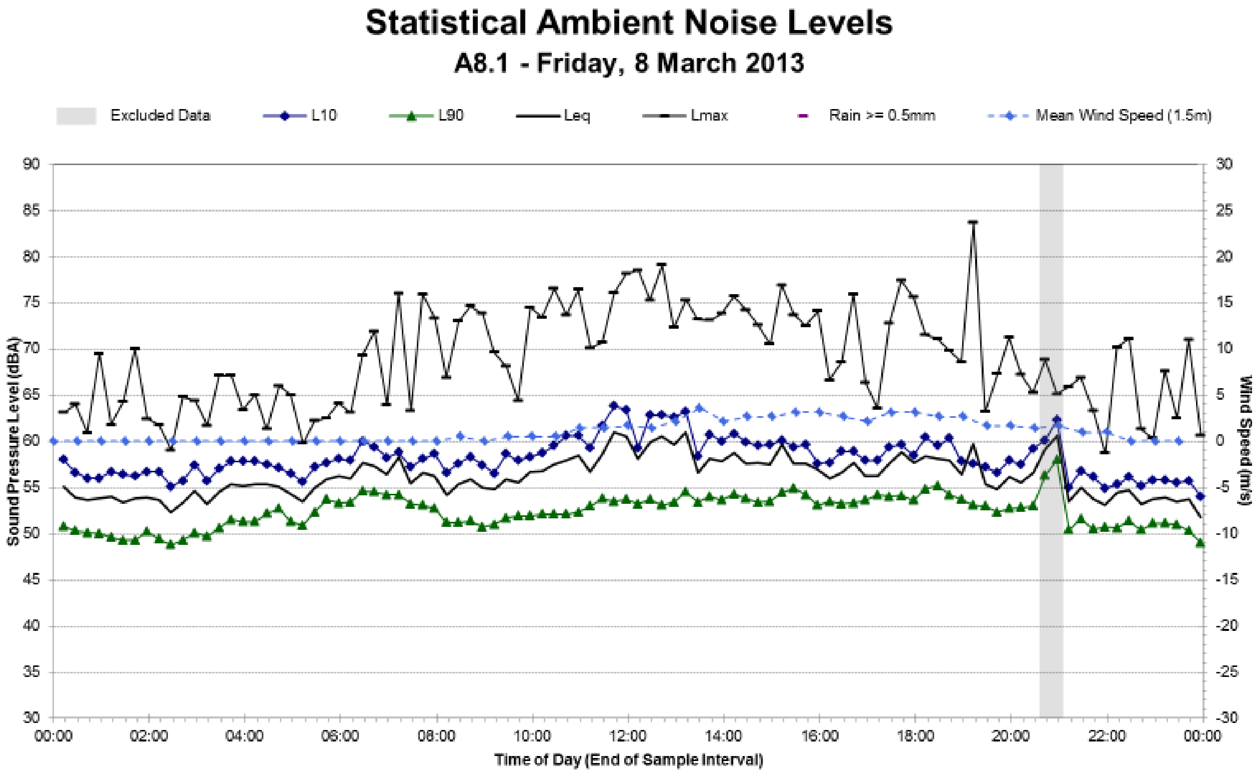
16:00
18:00
20:00
22:00
00:00

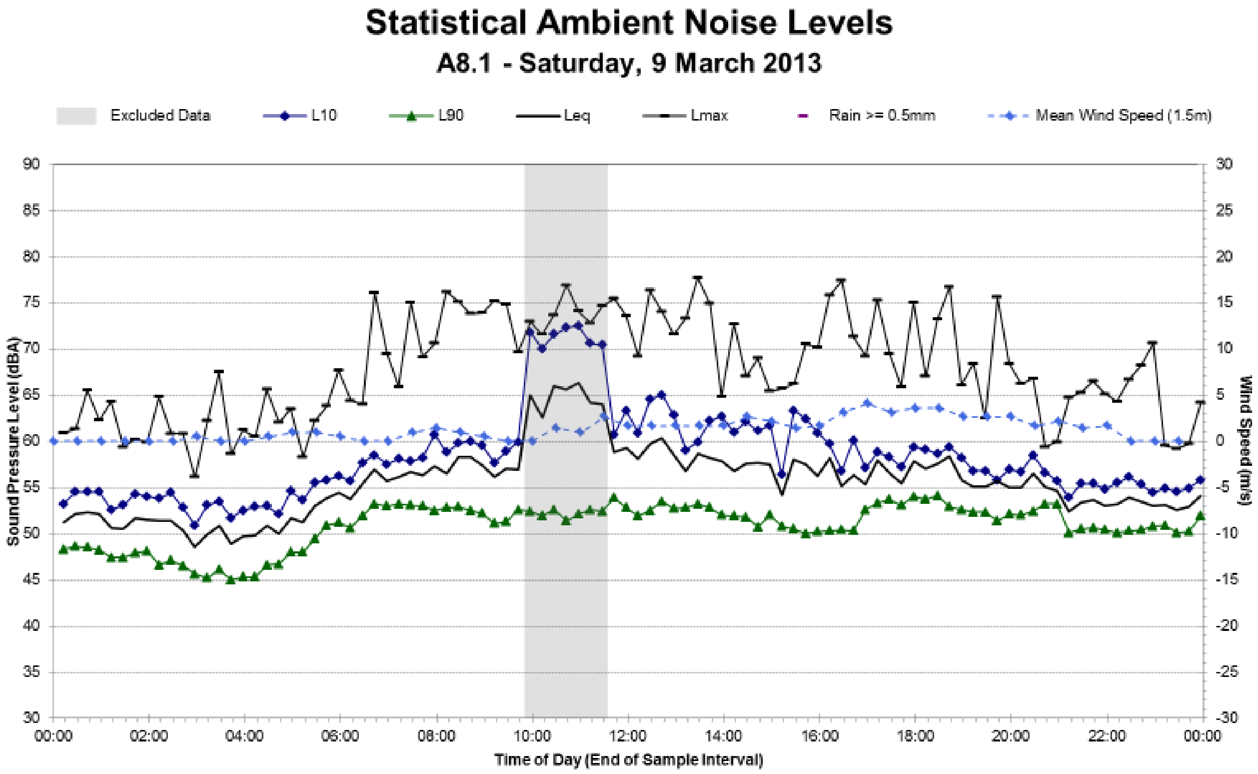

Statistical Ambient Noise Levels
A8.1 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

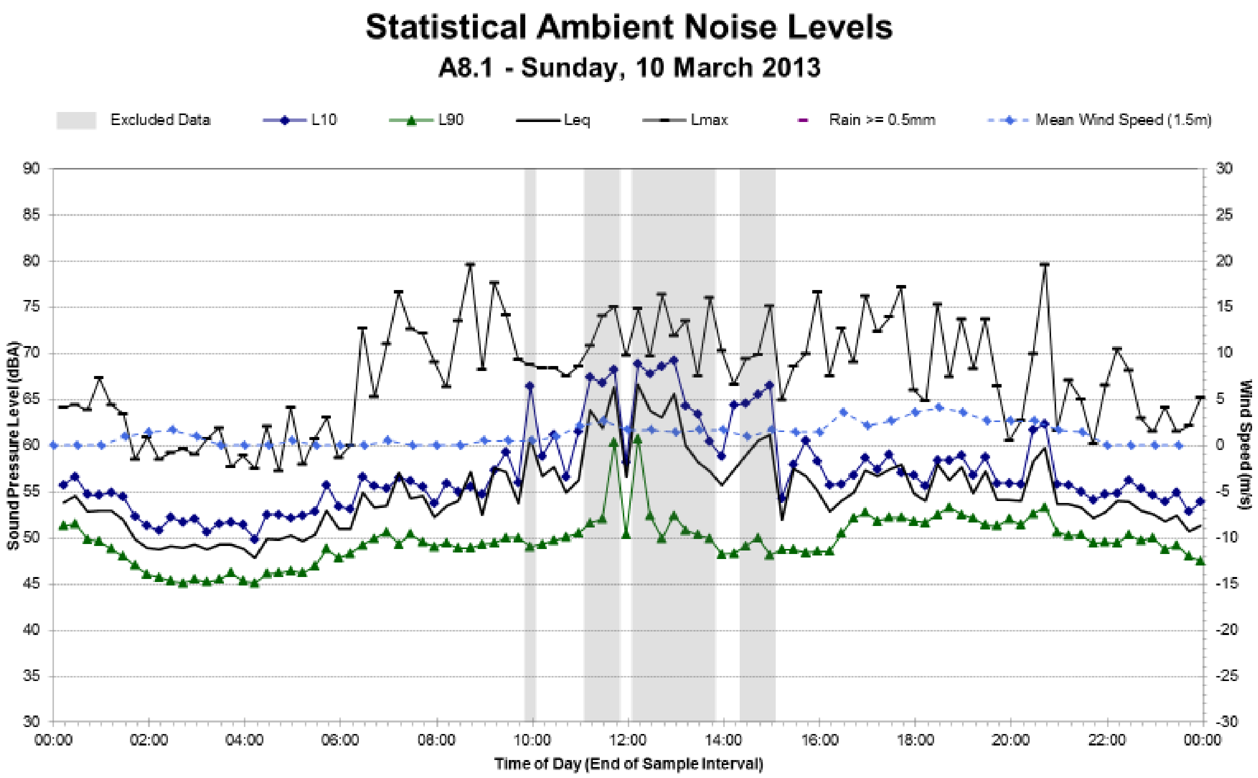
A8 Ambient Noise Monitoring Results



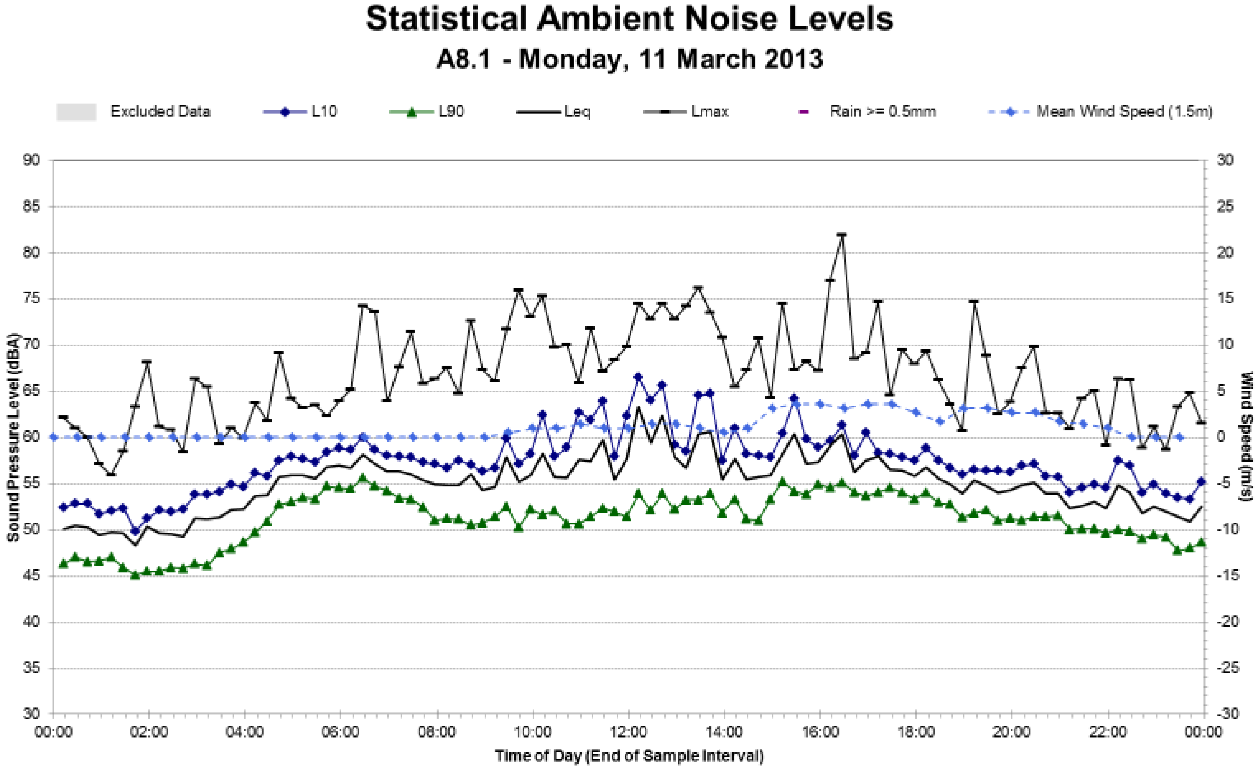


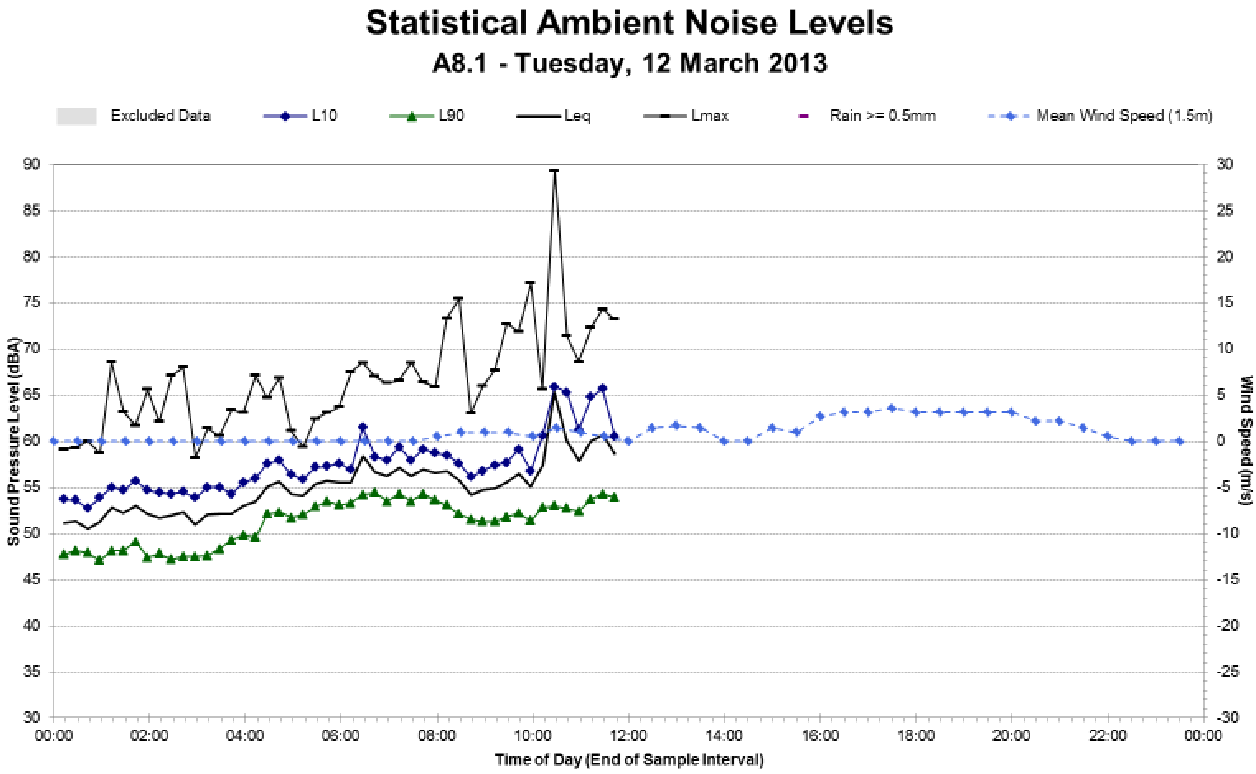
A8 Ambient Noise Monitoring Results





A8 Ambient Noise Monitoring Results





A8 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A8.2**
Noise Monitoring Address:	**63B 179 Reservoir Rd, Blacktown**

Logger Device Type: Svantek 957
Logger Serial No: 20669

Ambient noise logger deployed immediately outside residential address 63B 179 Reservoir Rd, Blacktown. Logger located in front of south facing facade facing Great Western Highway and Reservoir Road junction.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Great Western Highway located immediately to the south. Frequent tyre-pavement noise from light-vehicle traffic on nearby roads can be heard at this location together with heavy-vehicle and motorcycle movements.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 62-75 dBA, Light-vehicle road traffic: 54-77 dBA, Motorcycles: 85 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	56	64	67	72
Evening	53	62	64	69
Night-time	47	61	61	69

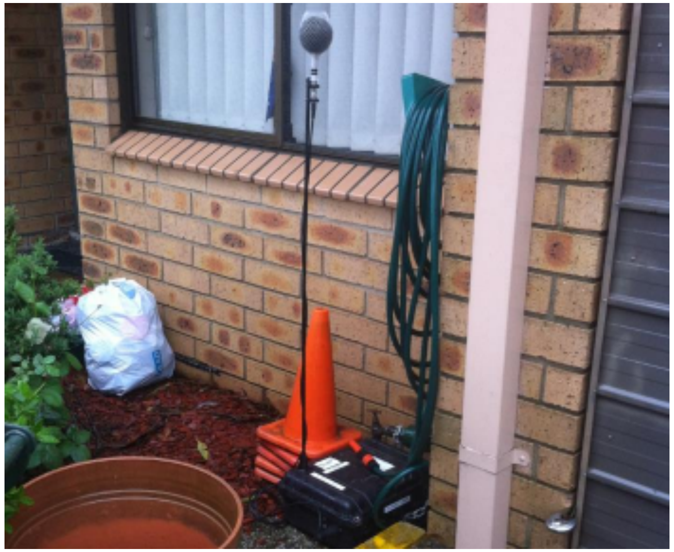
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	4	N/A (7 Day Average)
Daytime (7am-10pm)	64	62	63
Night-time (10pm-7am)	61	61	61

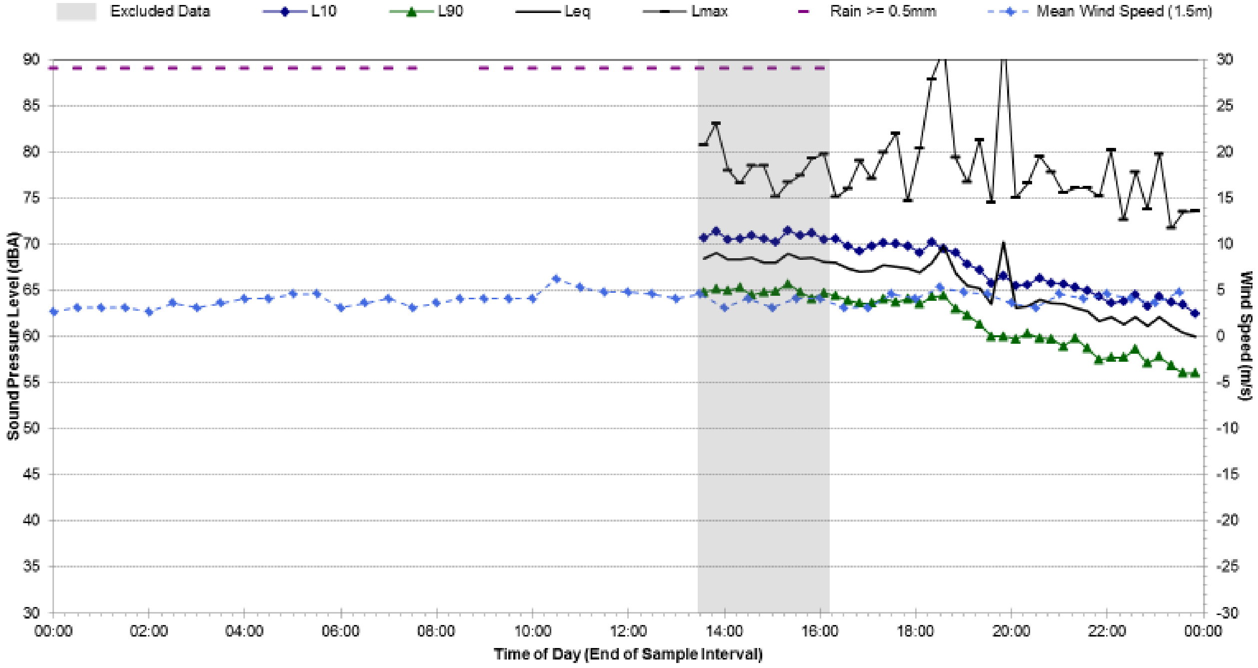
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
12/03/2013	12:05	55	62	85

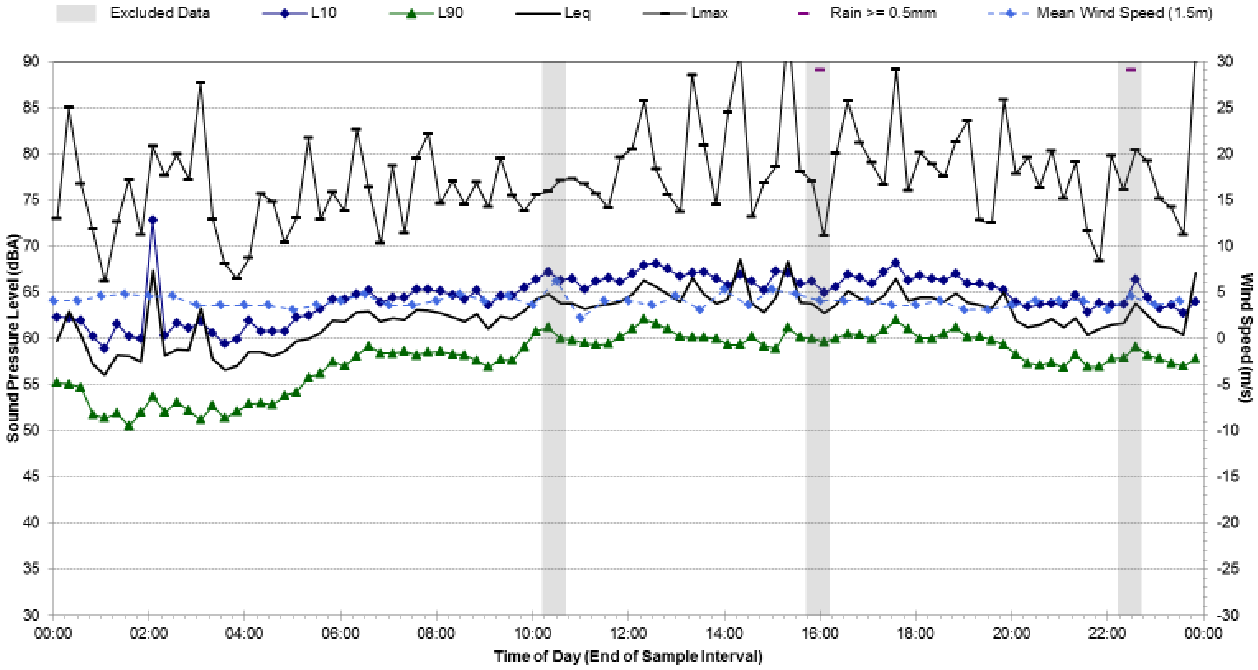
Photo of Noise Monitoring Location

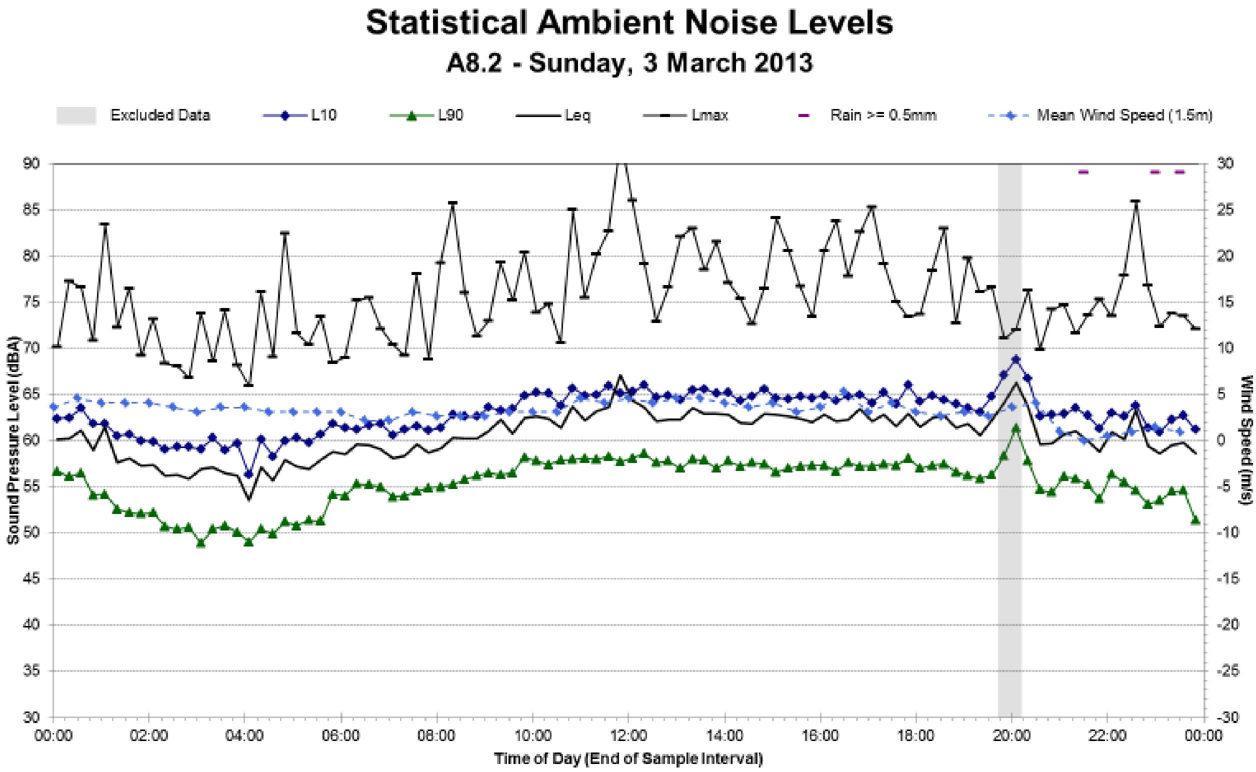


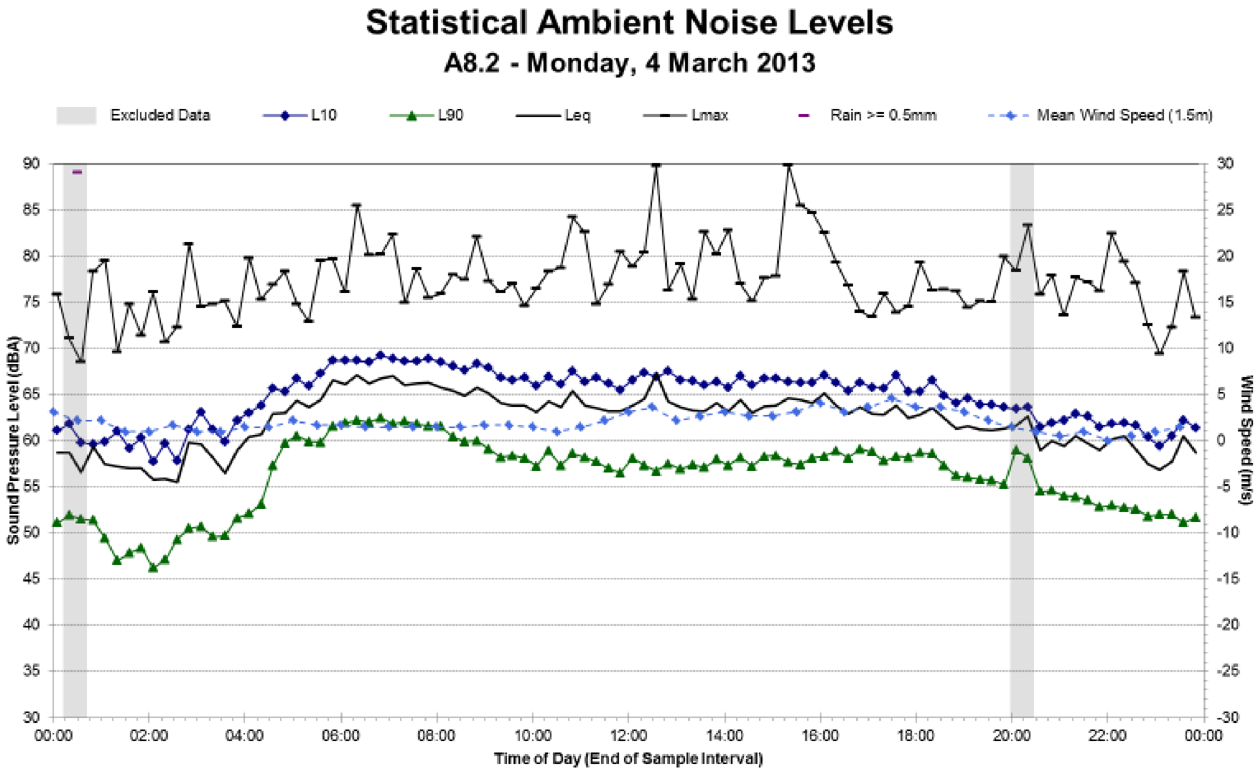
Statistical Ambient Noise Levels
A8.2 - Friday, 1 March 2013



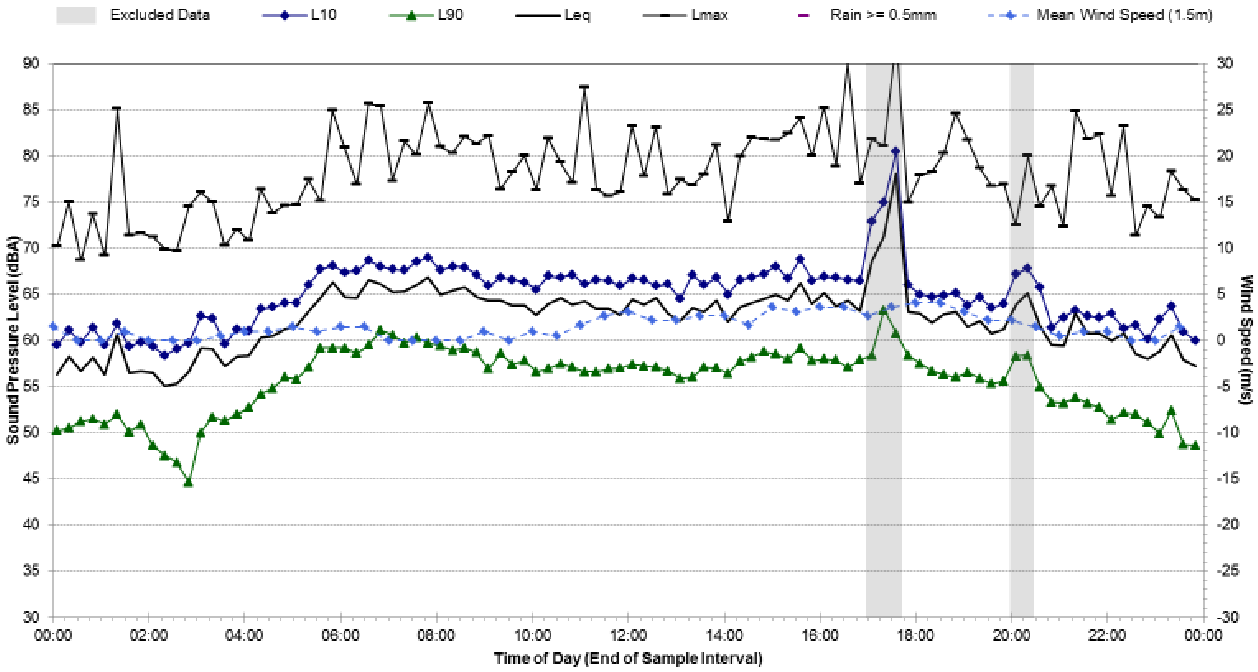
Statistical Ambient Noise Levels
A8.2 - Saturday, 2 March 2013



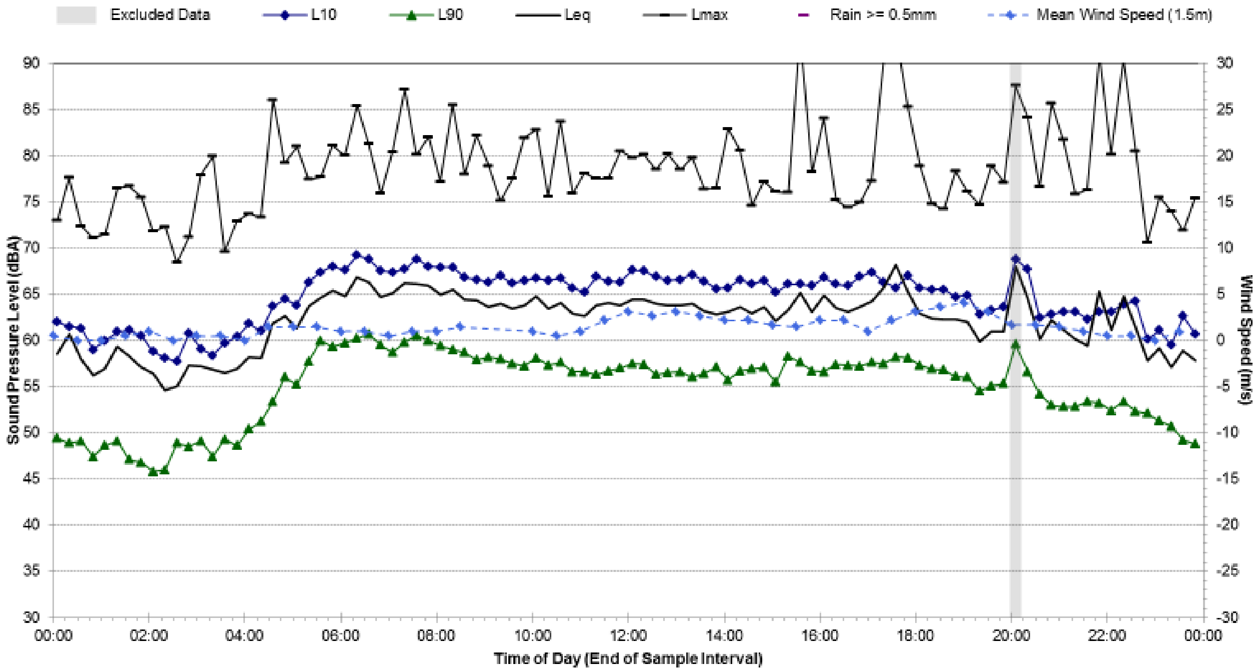

Statistical Ambient Noise Levels
A8.2 - Sunday, 3 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

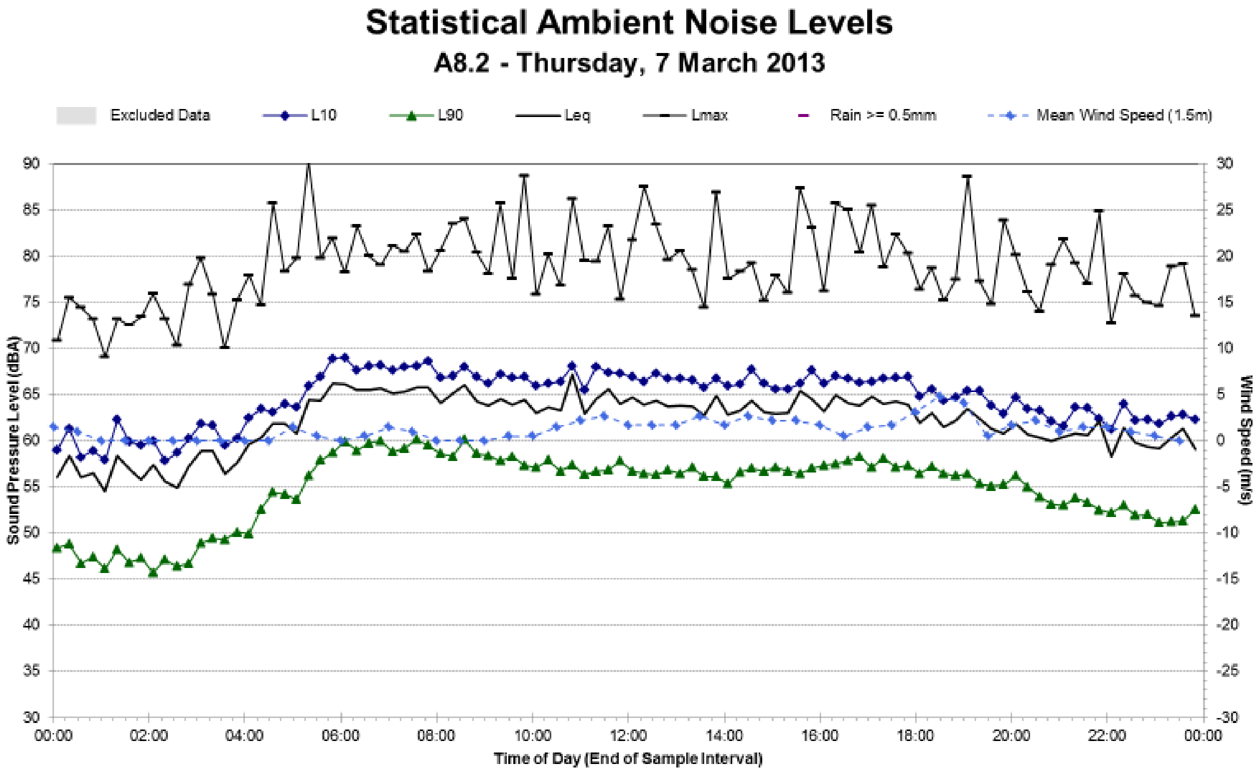

Statistical Ambient Noise Levels
A8.2 - Monday, 4 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

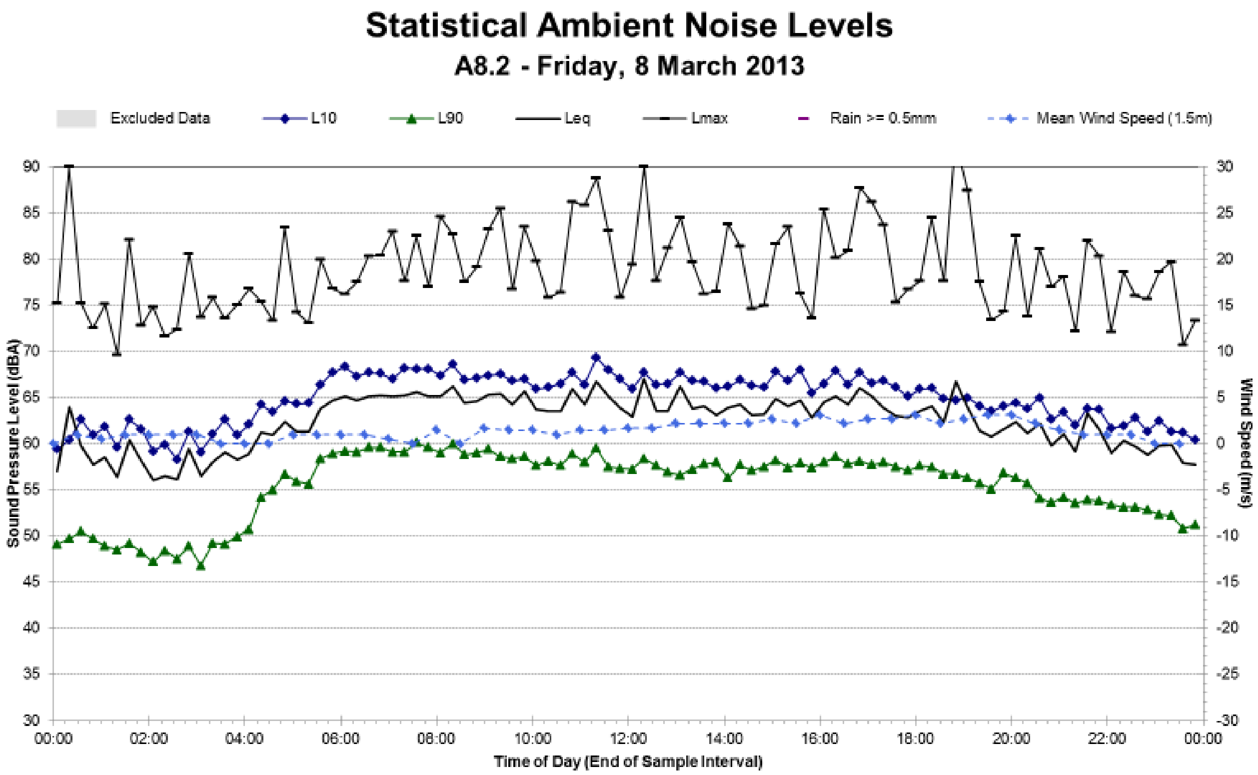
Statistical Ambient Noise Levels
A8.2 - Tuesday, 5 March 2013

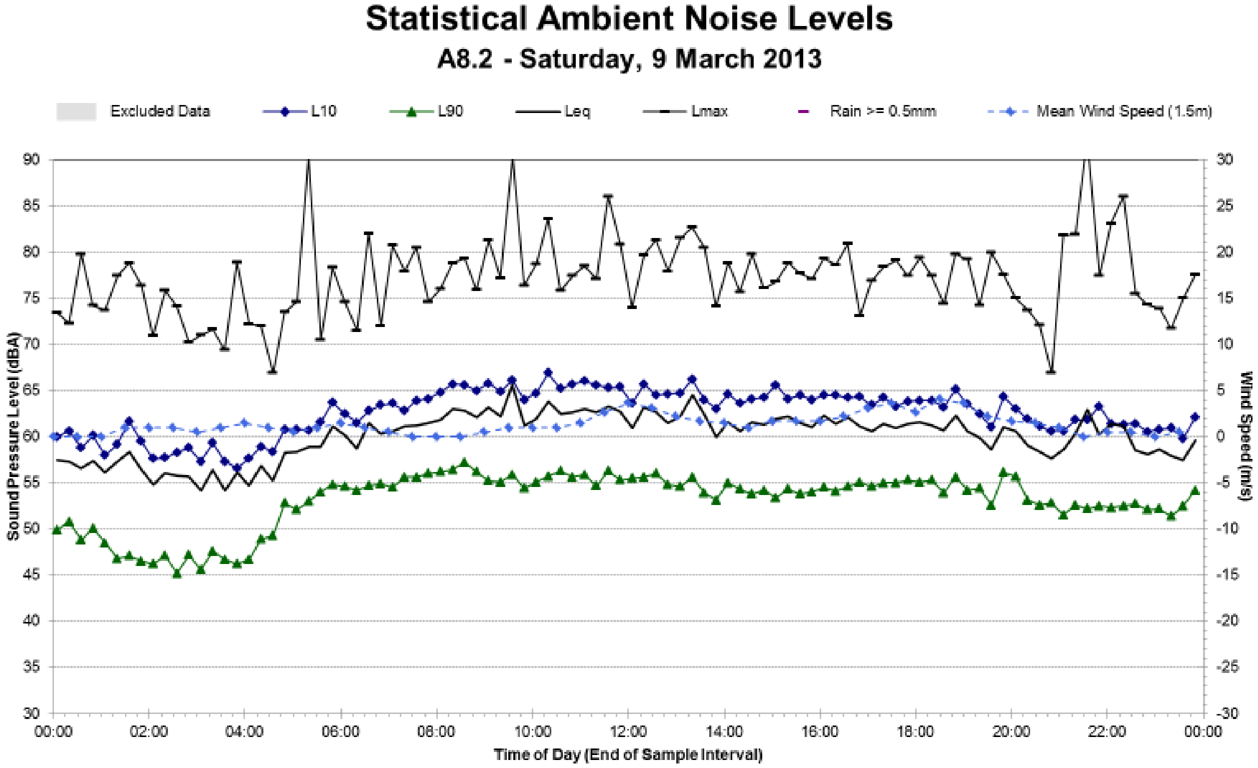


Statistical Ambient Noise Levels
A8.2 - Wednesday, 6 March 2013




Statistical Ambient Noise Levels
A8.2 - Thursday, 7 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A8.2 - Friday, 8 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A8.2 - Saturday, 9 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
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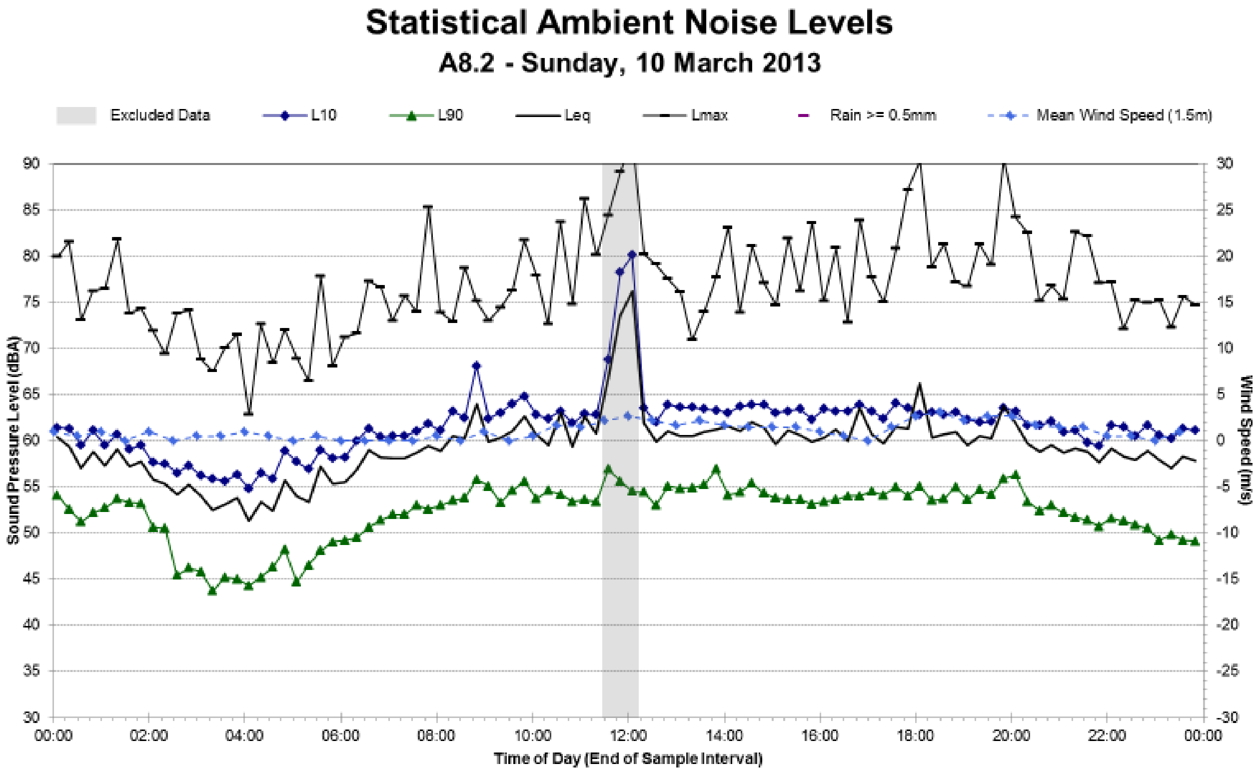
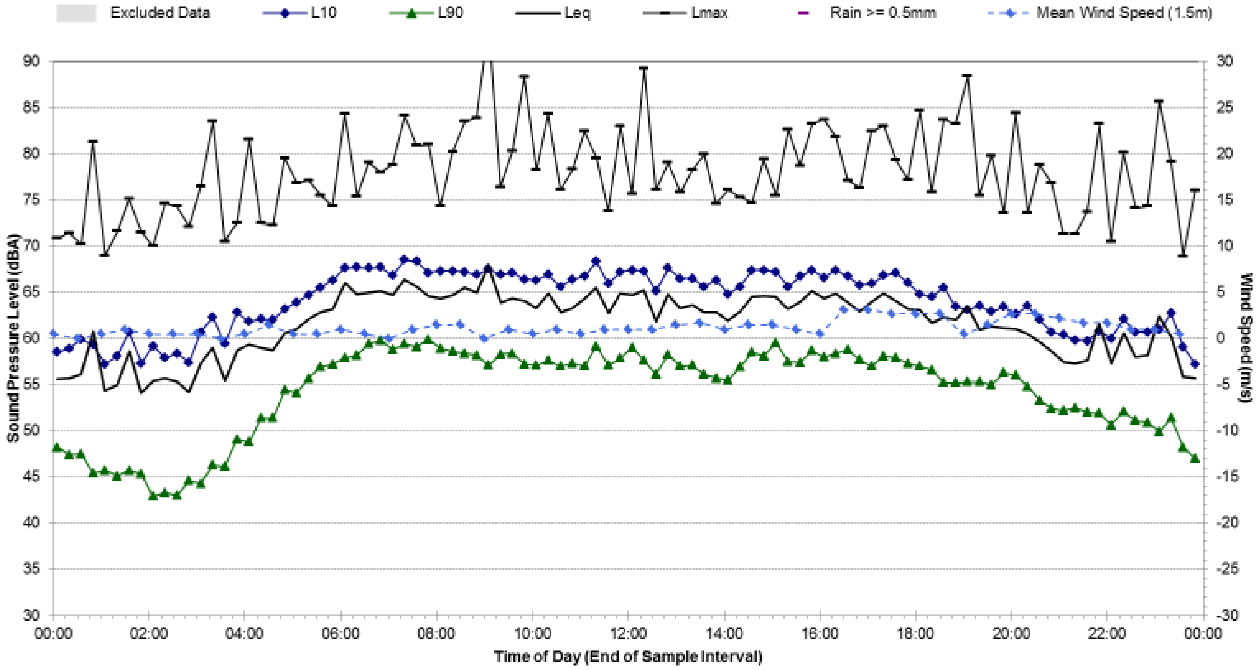
20:00
22:00
00:00

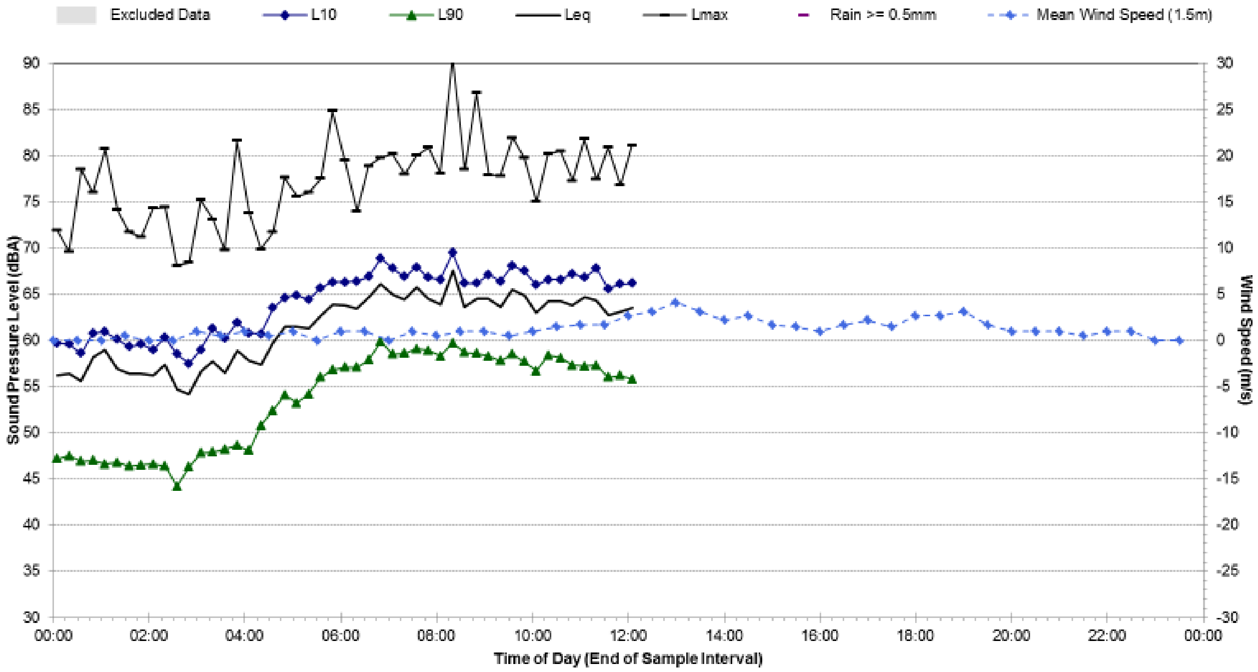

Statistical Ambient Noise Levels
A8.2 - Sunday, 10 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

A8 Ambient Noise Monitoring Results

Statistical Ambient Noise Levels
A8.2 - Monday, 11 March 2013



Statistical Ambient Noise Levels
A8.2 - Tuesday, 12 March 2013



A9 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A9.2**
Noise Monitoring Address:	**41 Pikes Ln, Eastern Creek**

Logger Device Type: Svantek 957
Logger Serial No: 20668

Ambient noise logger deployed at residential address 41 Pikes Ln, Eastern Creek.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 55-61 dBA, Light-vehicle road traffic: ~54 dBA, Motorcycle: 59-60 dBA, Air traffic: 55-57 dBA, Birds: 55-57 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	50	58	59	62
Evening	49	56	55	59
Night-time	48	56	56	59

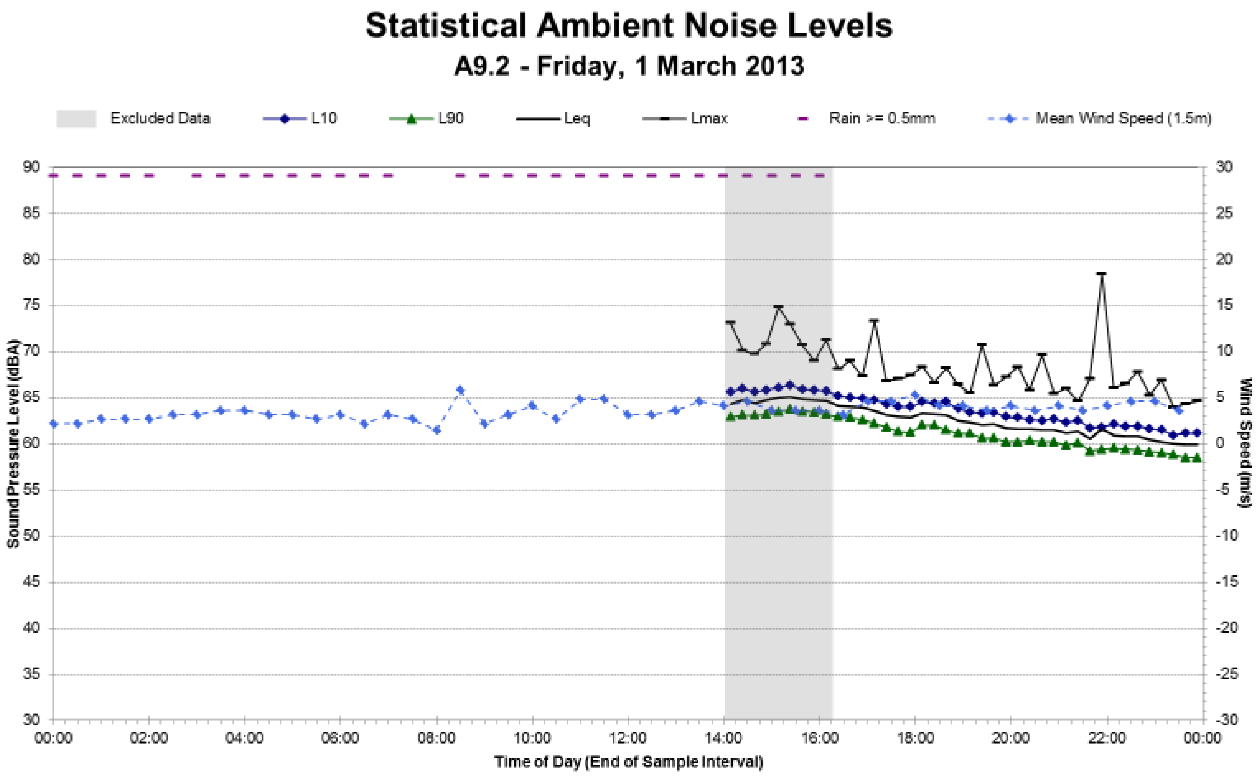
Ambient Noise Logging Results – RNP Defined Time Periods

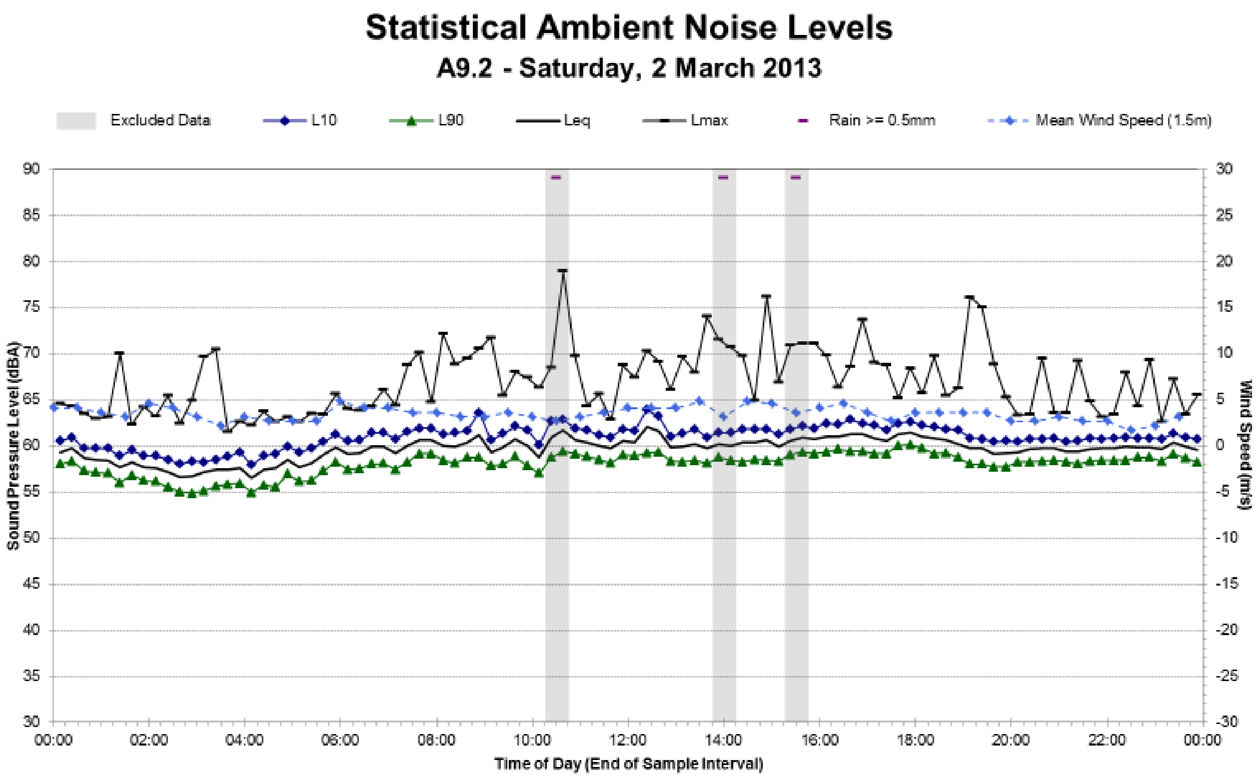
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	3	N/A (7 Day Average)
Daytime (7am-10pm)	56	58	57
Night-time (10pm-7am)	56	55	56

Attended Noise Measurement Results

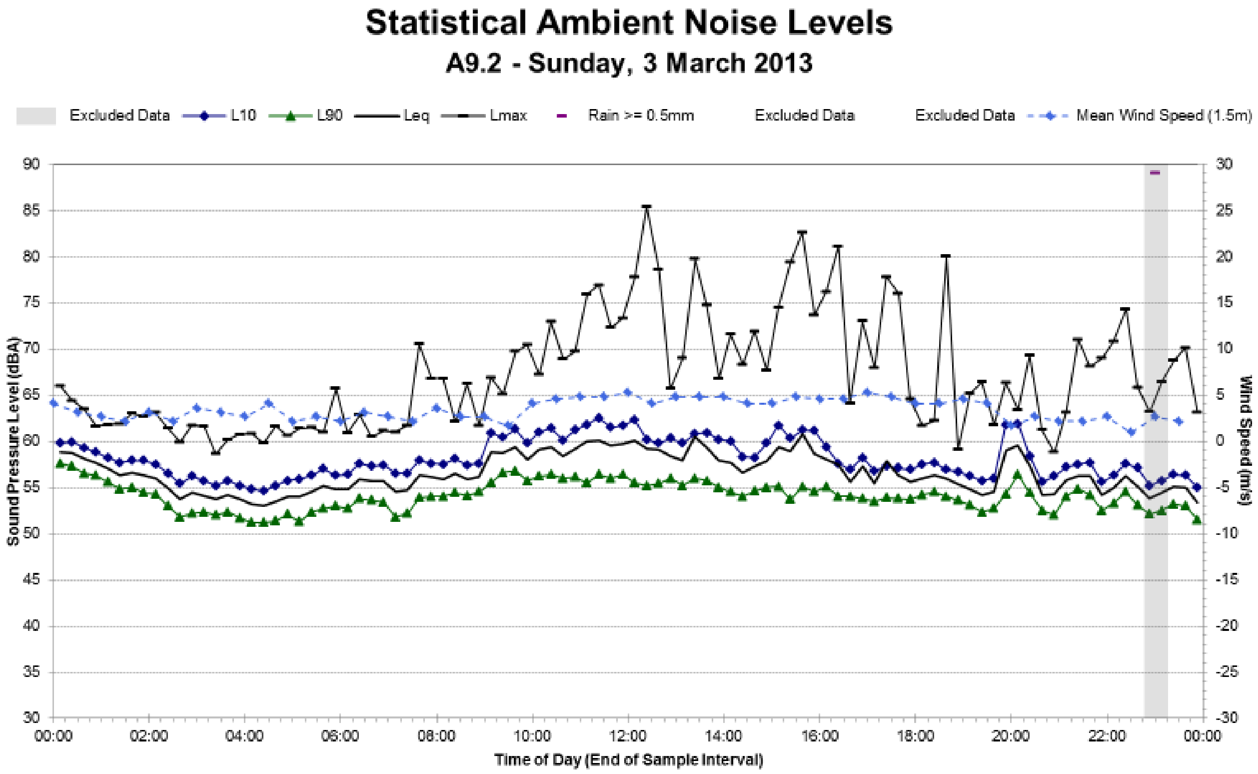
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
12/03/2013	12:33	53	56	66

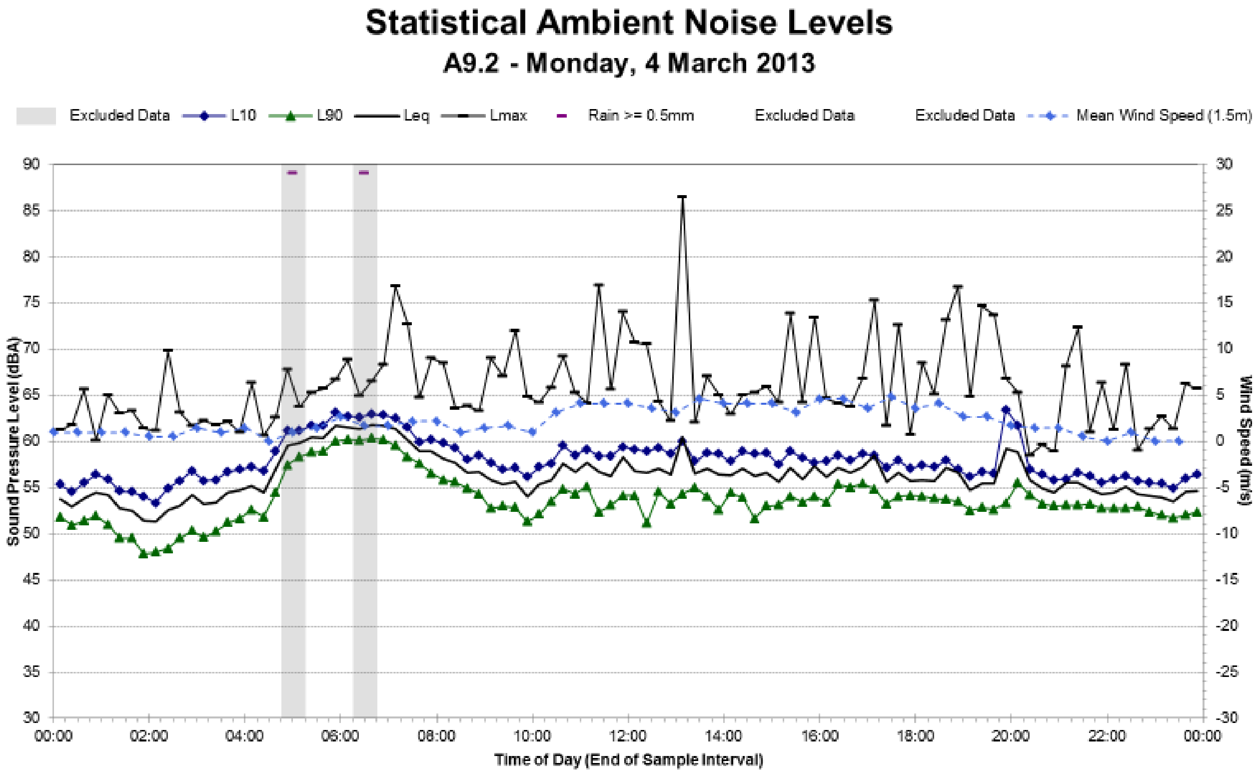
Photo of Noise Monitoring Location

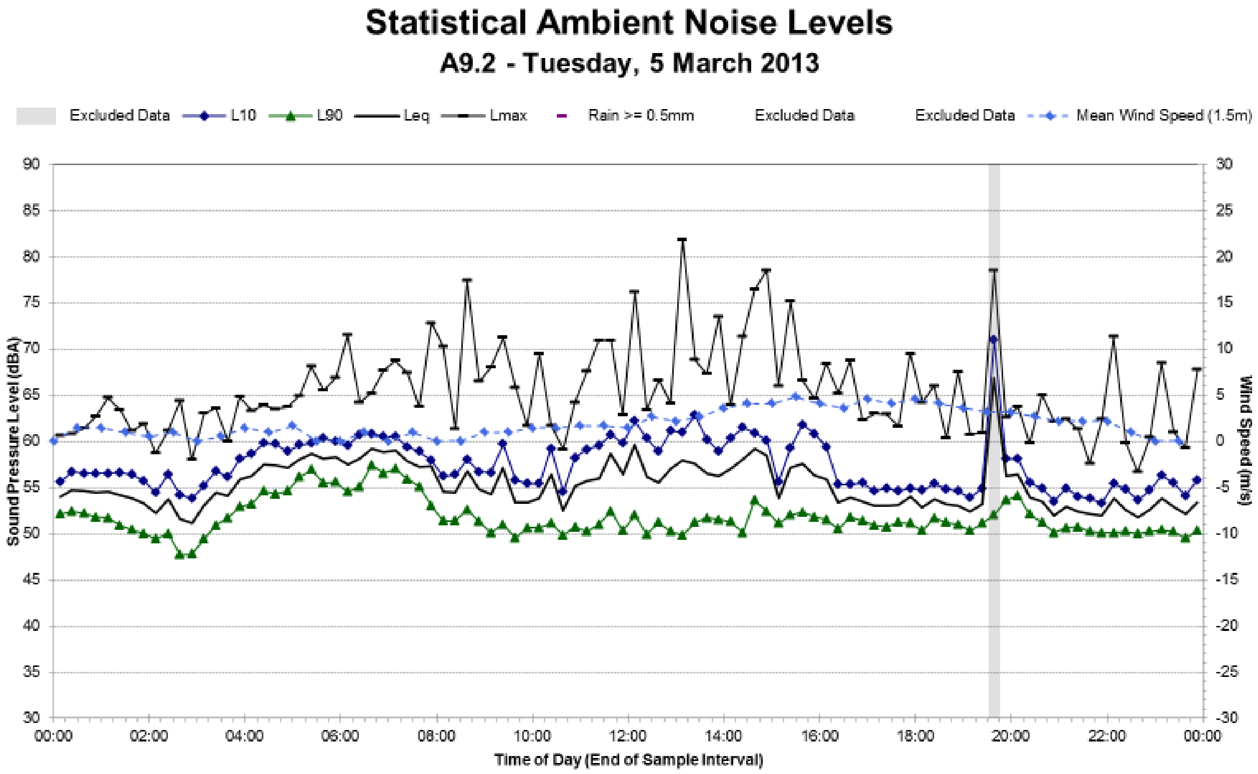

Statistical Ambient Noise Levels
A9.2 - Friday, 1 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A9.2 - Saturday, 2 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

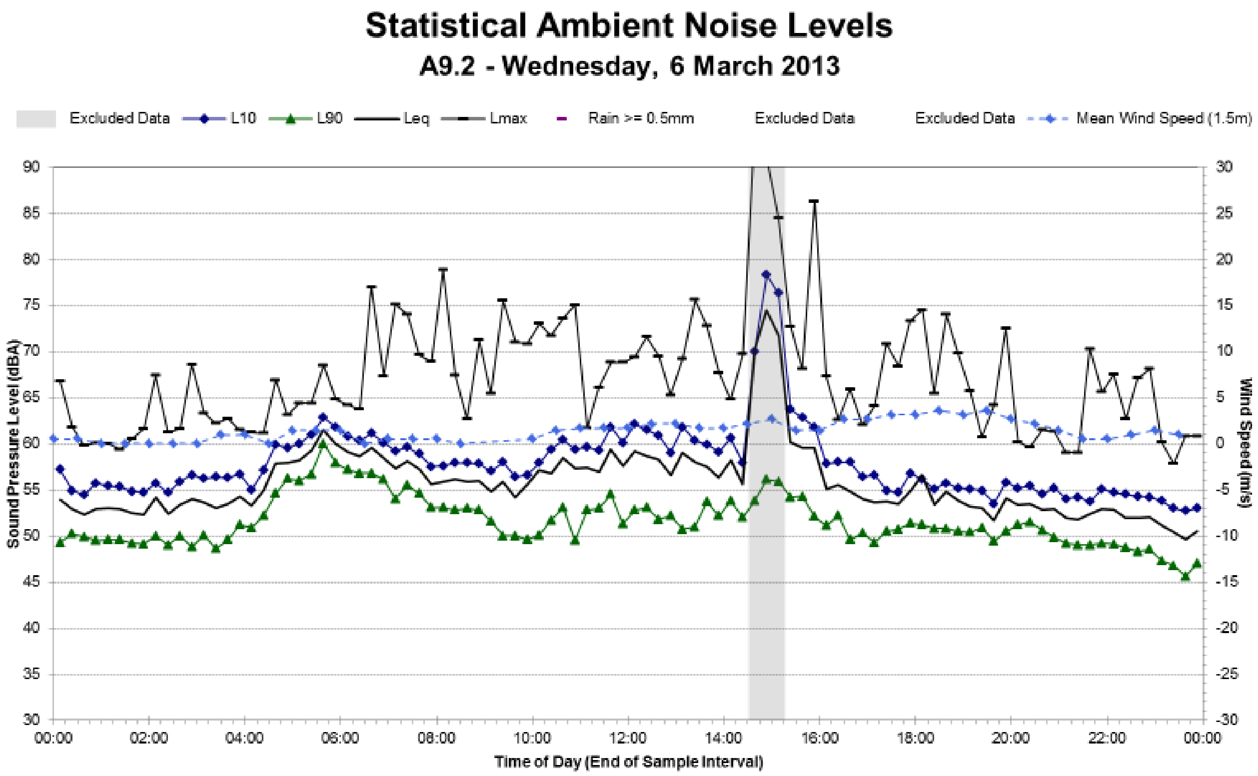
A9 Ambient Noise Monitoring Results



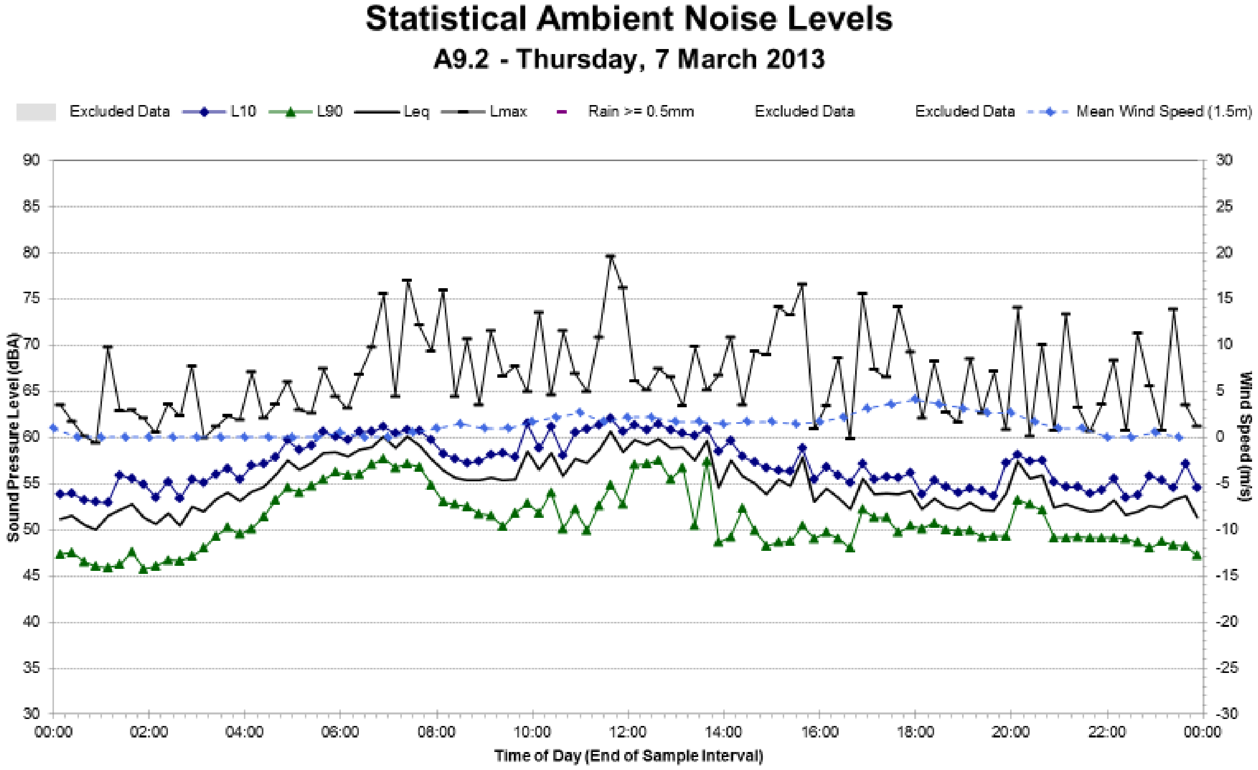


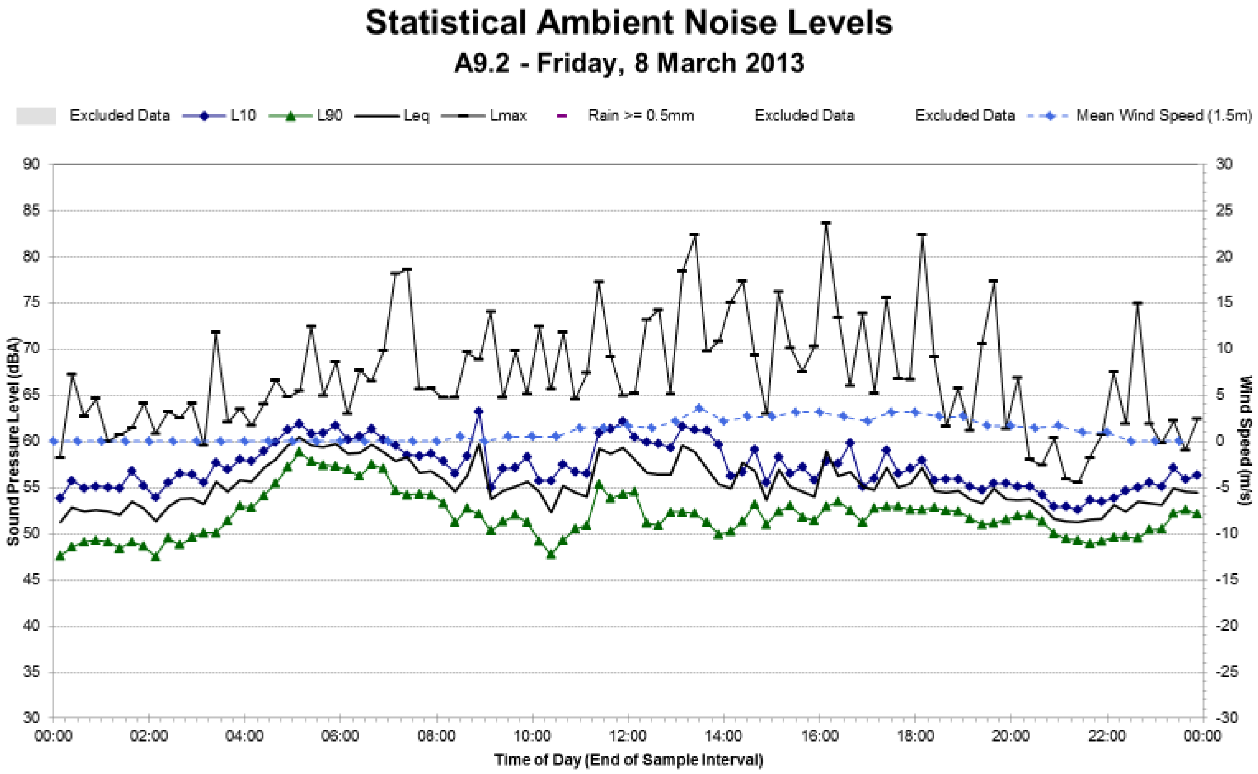


Statistical Ambient Noise Levels
A9.2 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

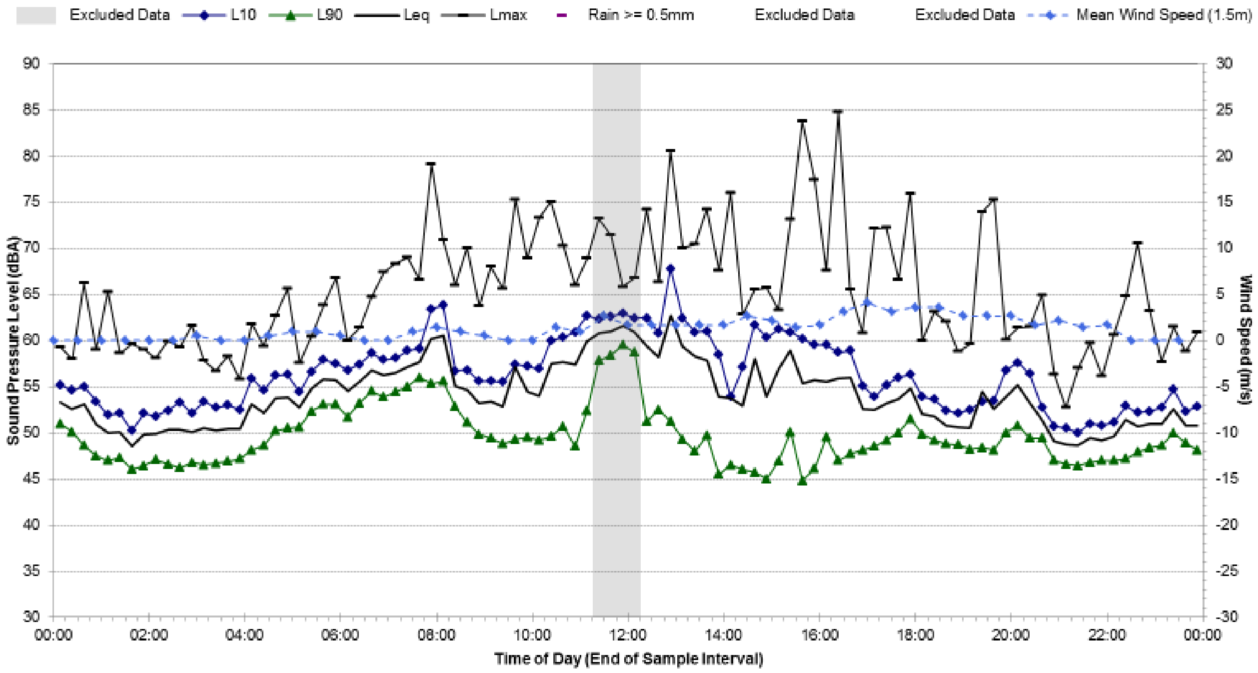


Statistical Ambient Noise Levels
A9.2 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

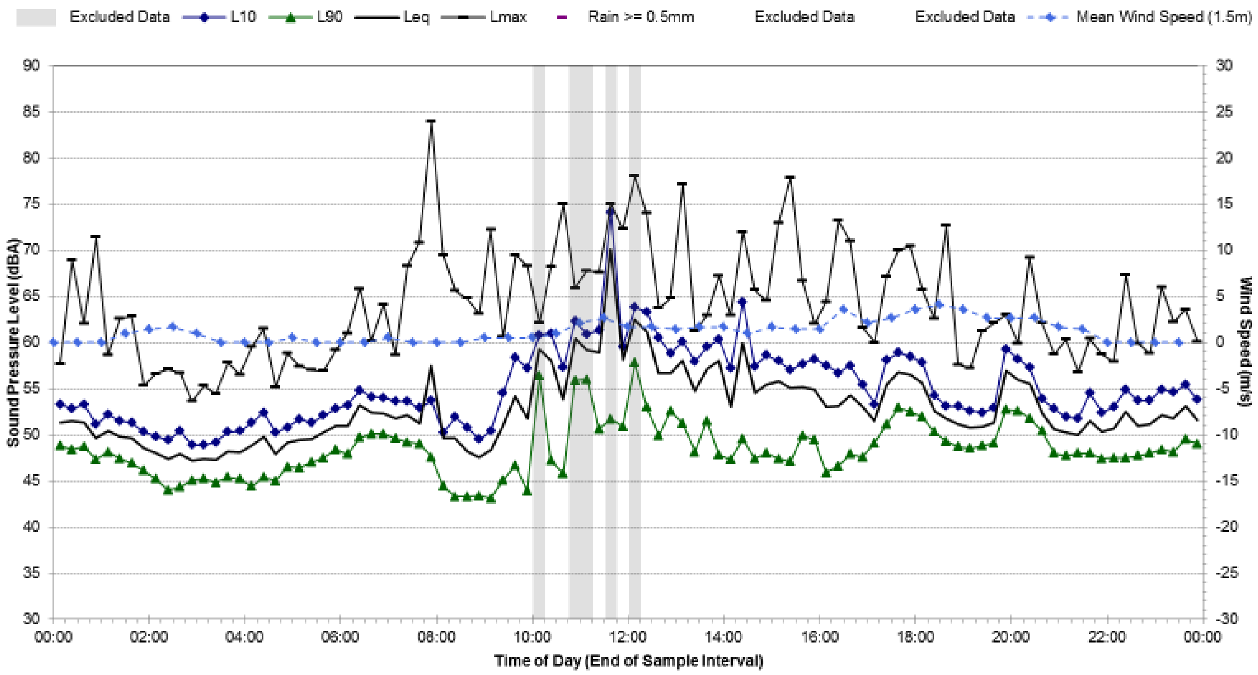

Statistical Ambient Noise Levels
A9.2 - Thursday, 7 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

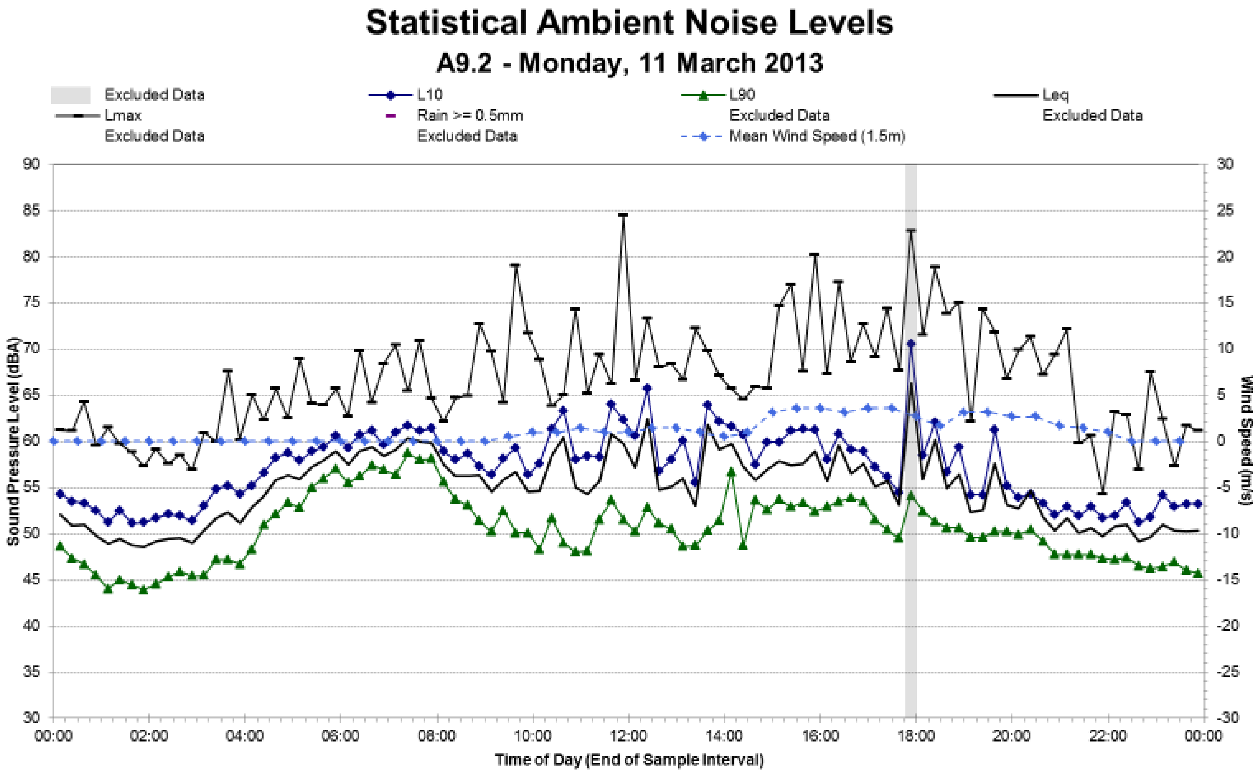

Statistical Ambient Noise Levels
A9.2 - Friday, 8 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

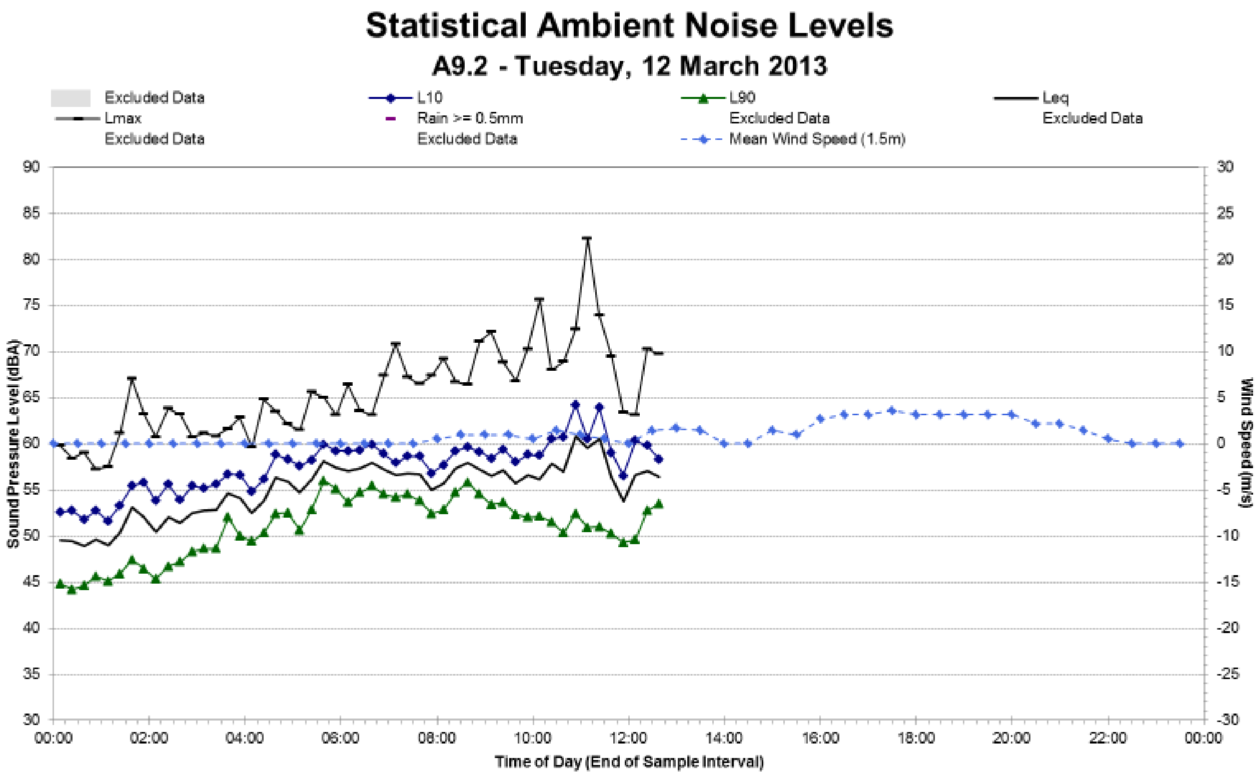
Statistical Ambient Noise Levels
A9.2 - Saturday, 9 March 2013



Statistical Ambient Noise Levels
A9.2 - Sunday, 10 March 2013




Statistical Ambient Noise Levels
A9.2 - Monday, 11 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A9.2 - Tuesday, 12 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A9 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A9.3**
Noise Monitoring Address:	**25 Farrington Street, Minchinbury**

Logger Device Type: Svantek 957
Logger Serial No: 20670

Ambient noise logger deployed at rear of residential address 25 Farrington Street, Minchinbury.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 50-55 dBA, Light-vehicle road traffic: ~49-52 dBA, Motorcycle: 55-57 dBA, Insects: 50-51 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	51	60	58	62
Evening	56	61	61	64
Night-time	49	57	58	60

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	3	N/A (7 Day Average)
Daytime (7am-10pm)	59	62	60
Night-time (10pm-7am)	57	58	57

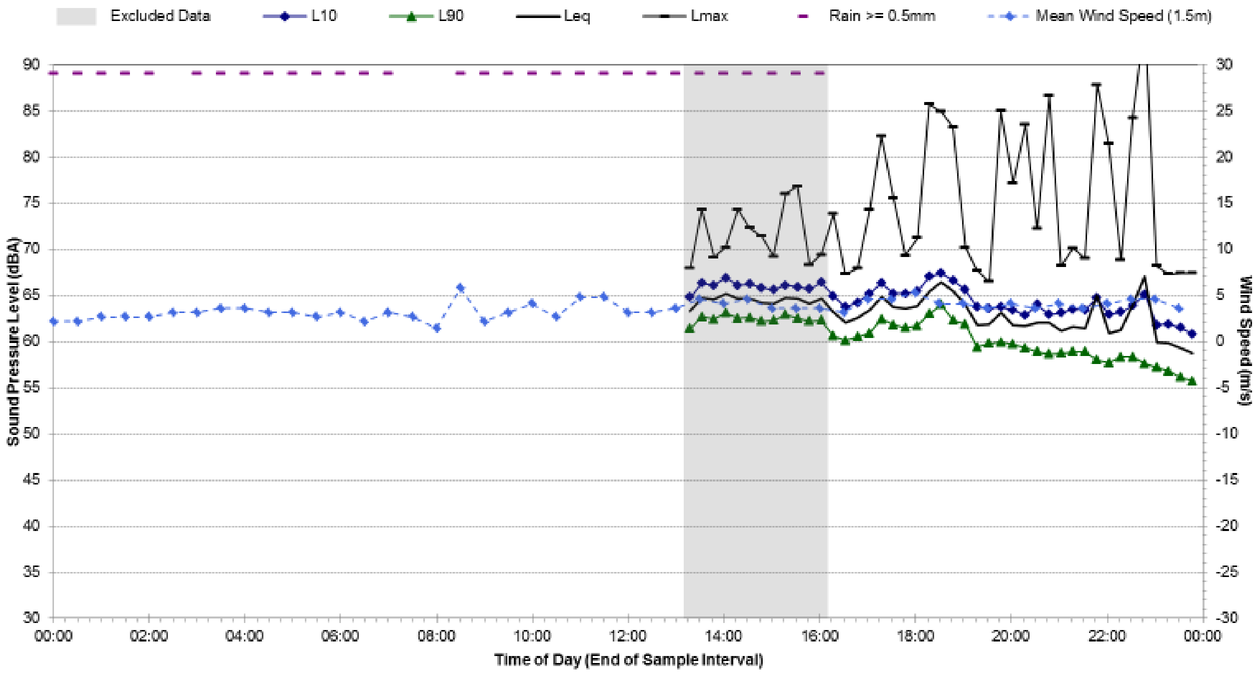
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
12/03/2013	12:06	49	51	63

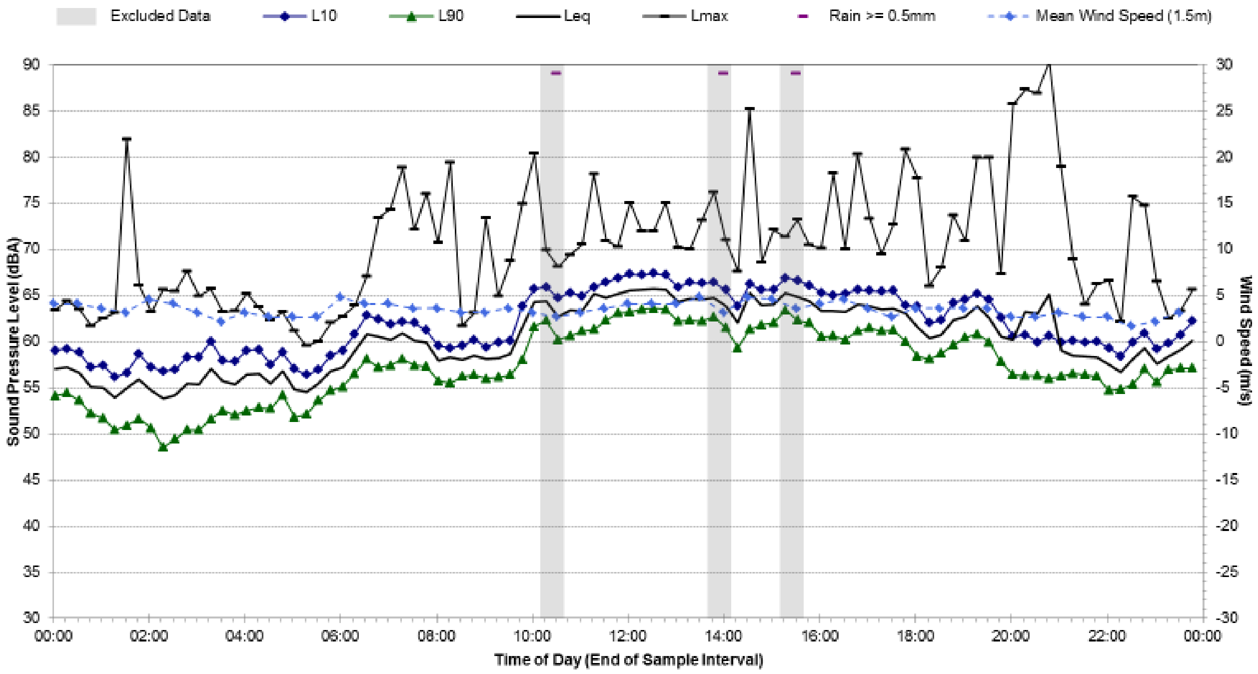
Photo of Noise Monitoring Location

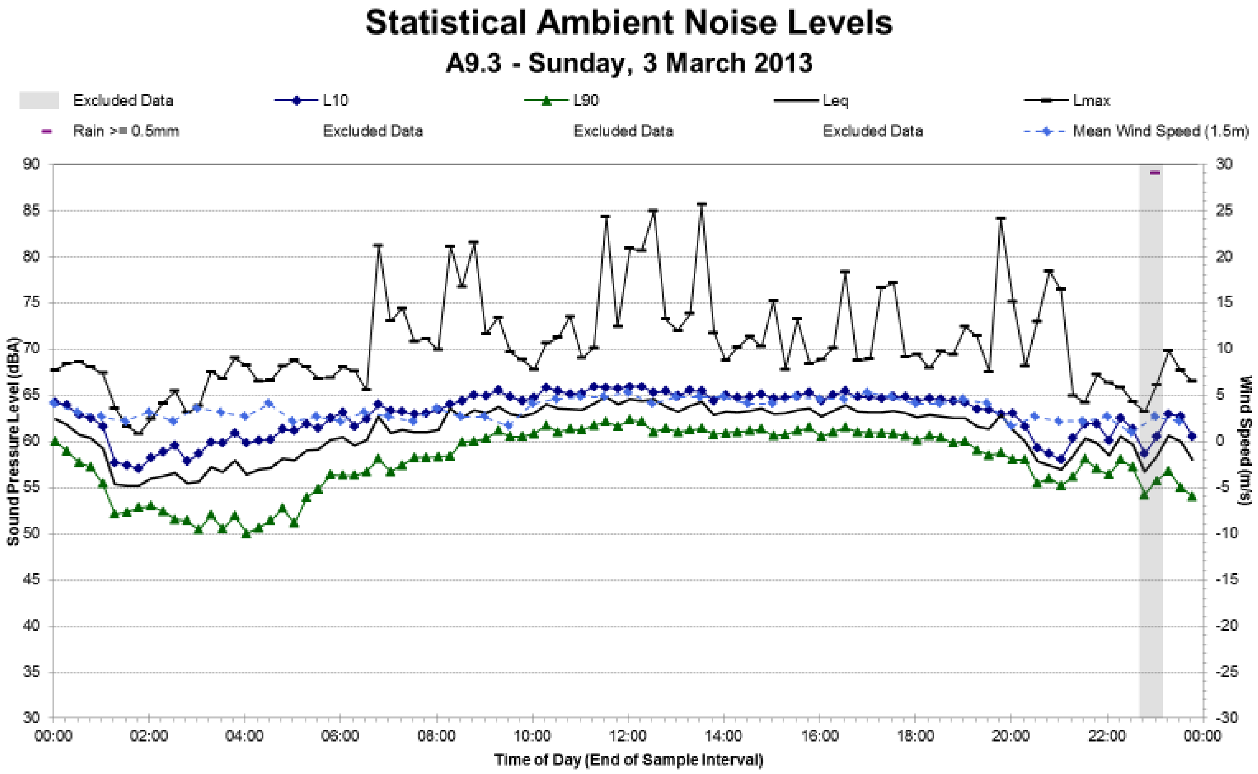
A9 Ambient Noise Monitoring Results

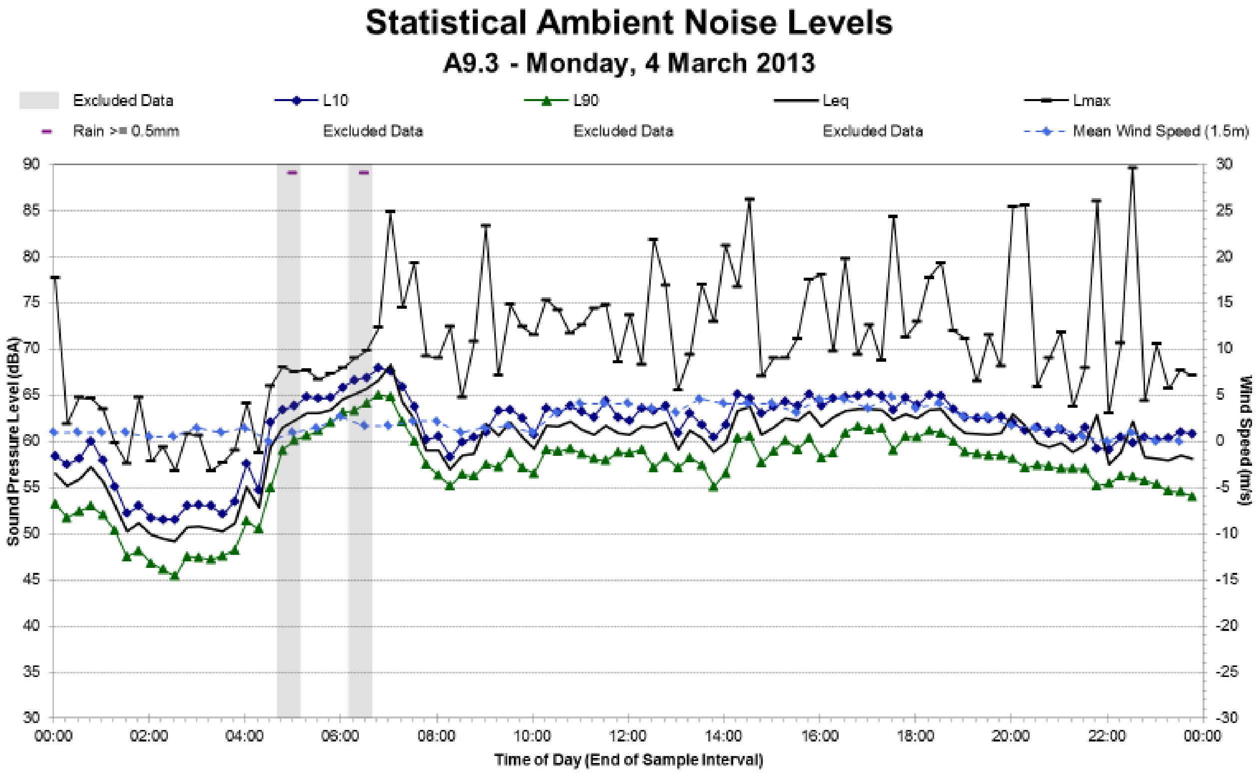
Statistical Ambient Noise Levels
A9.3 - Friday, 1 March 2013

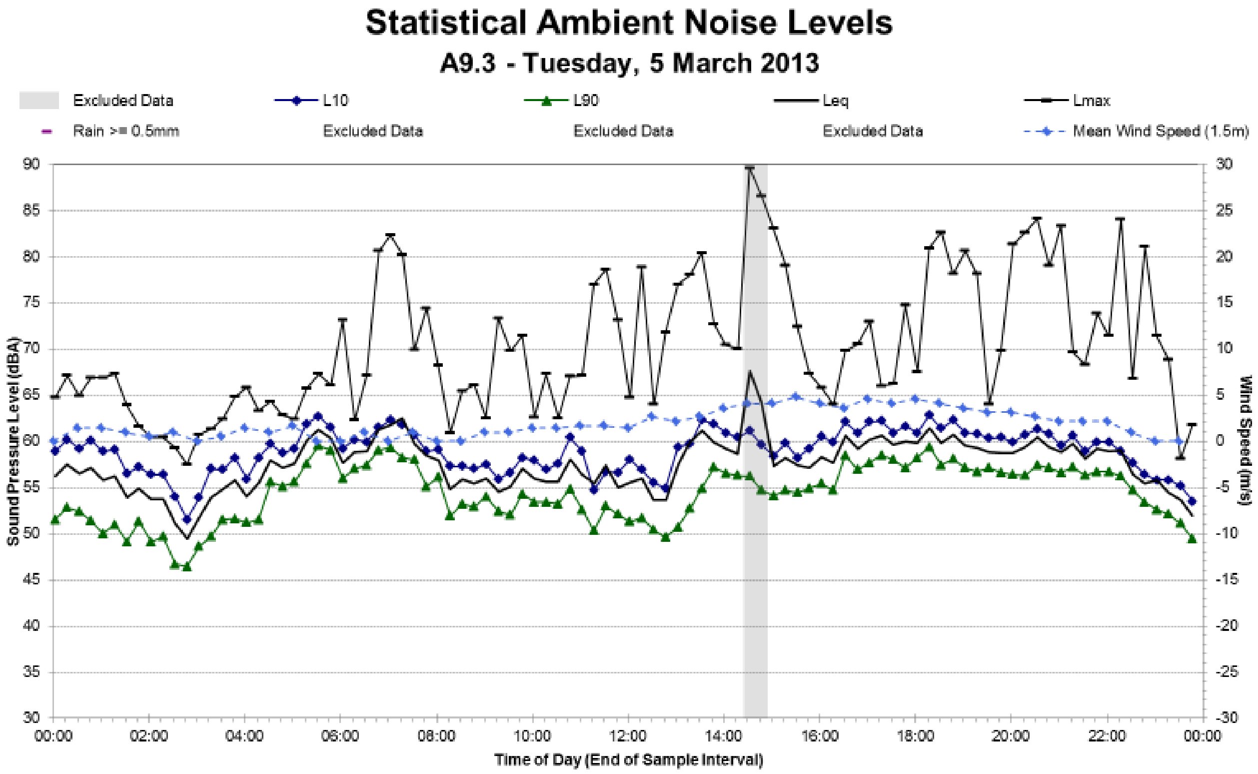


Statistical Ambient Noise Levels
A9.3 - Saturday, 2 March 2013

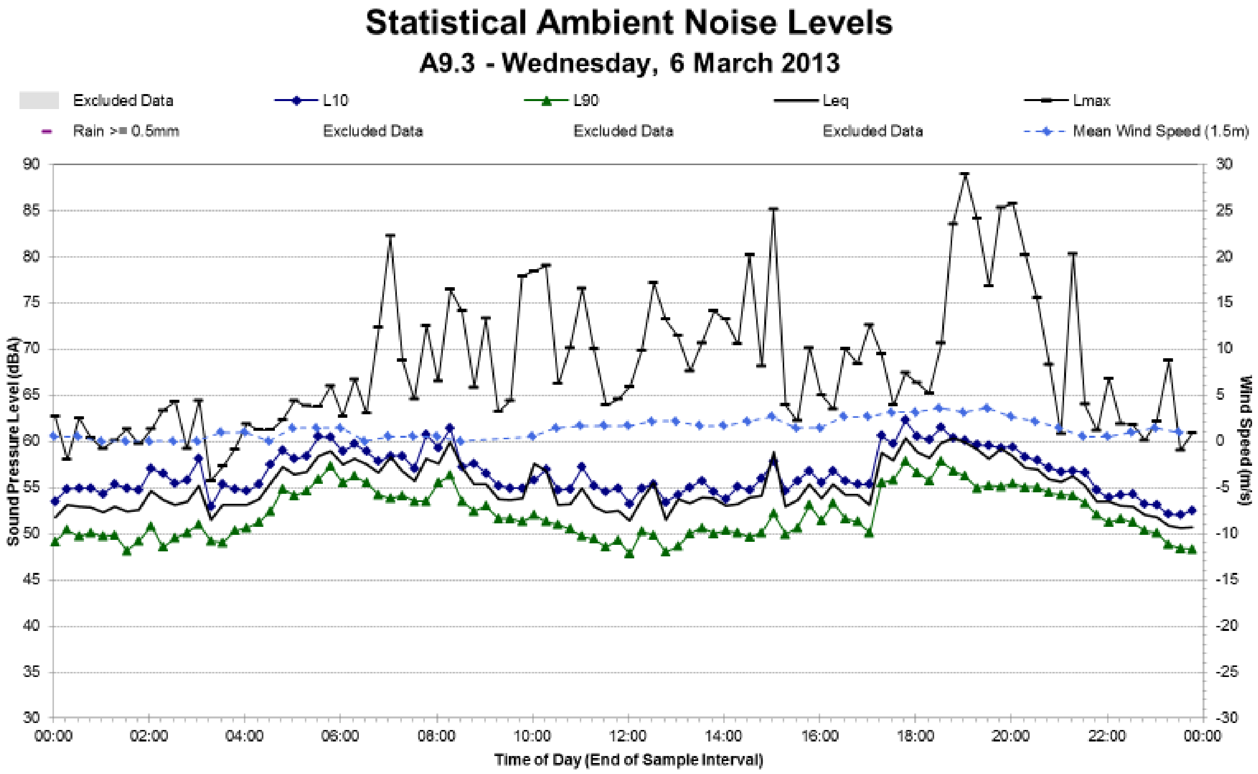



Statistical Ambient Noise Levels
A9.3 - Sunday, 3 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A9.3 - Monday, 4 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

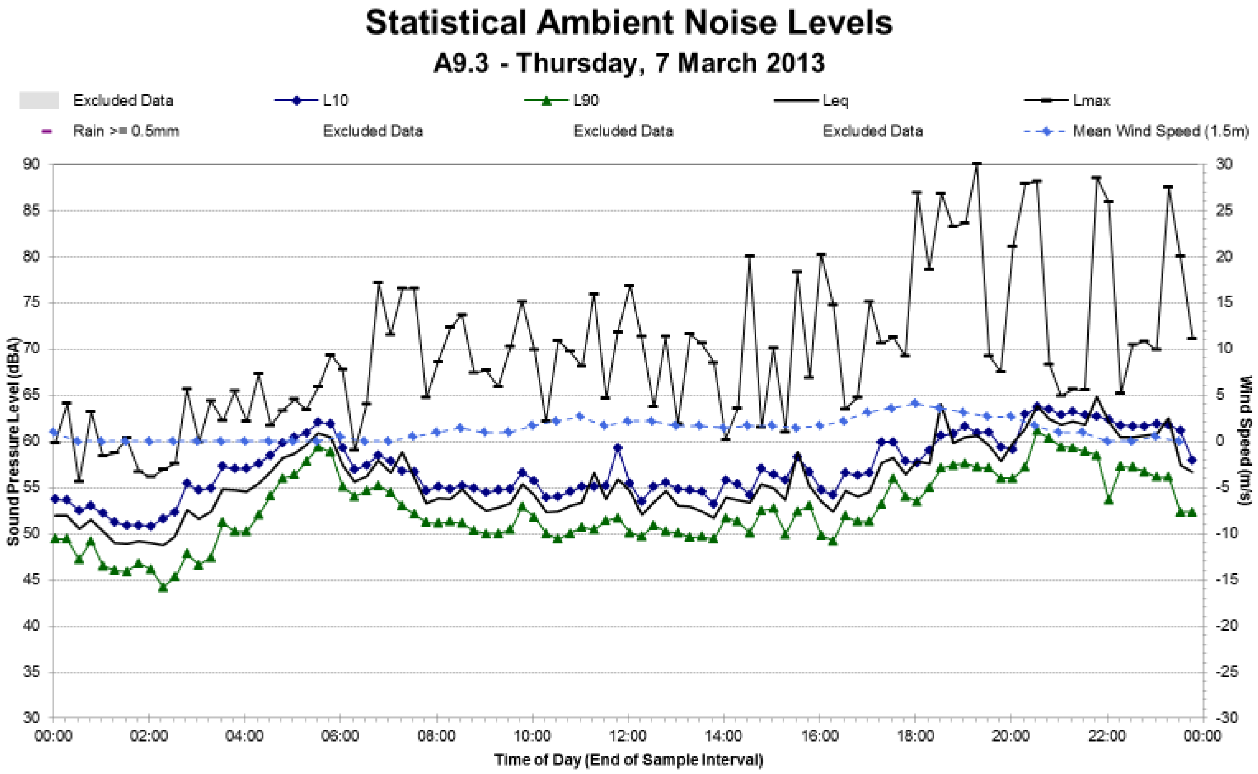


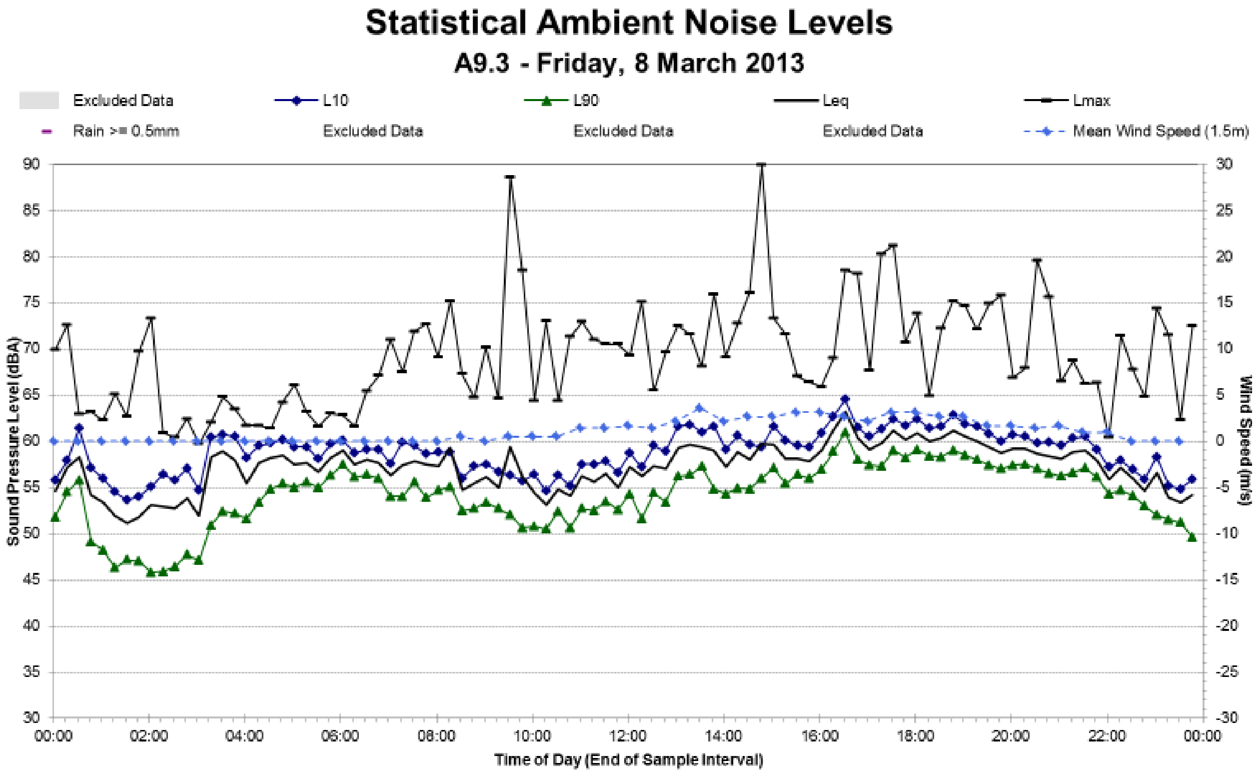
Statistical Ambient Noise Levels
A9.3 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

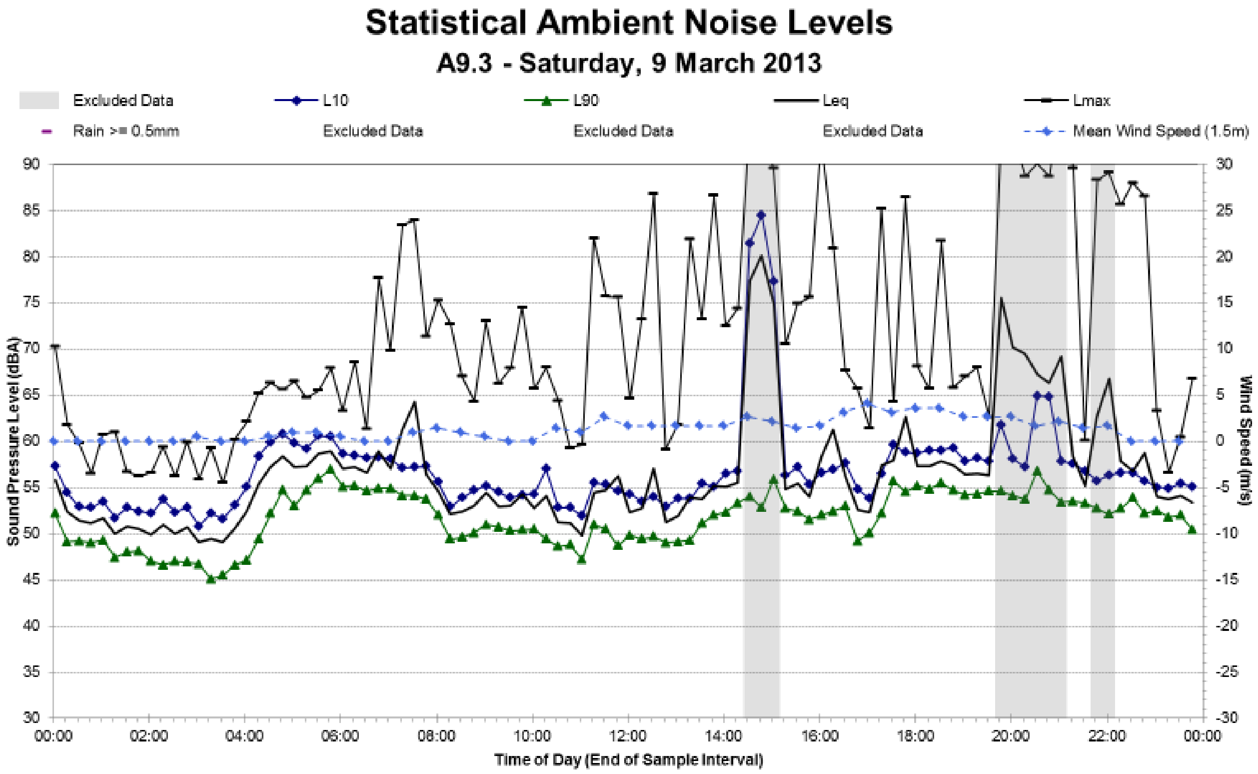


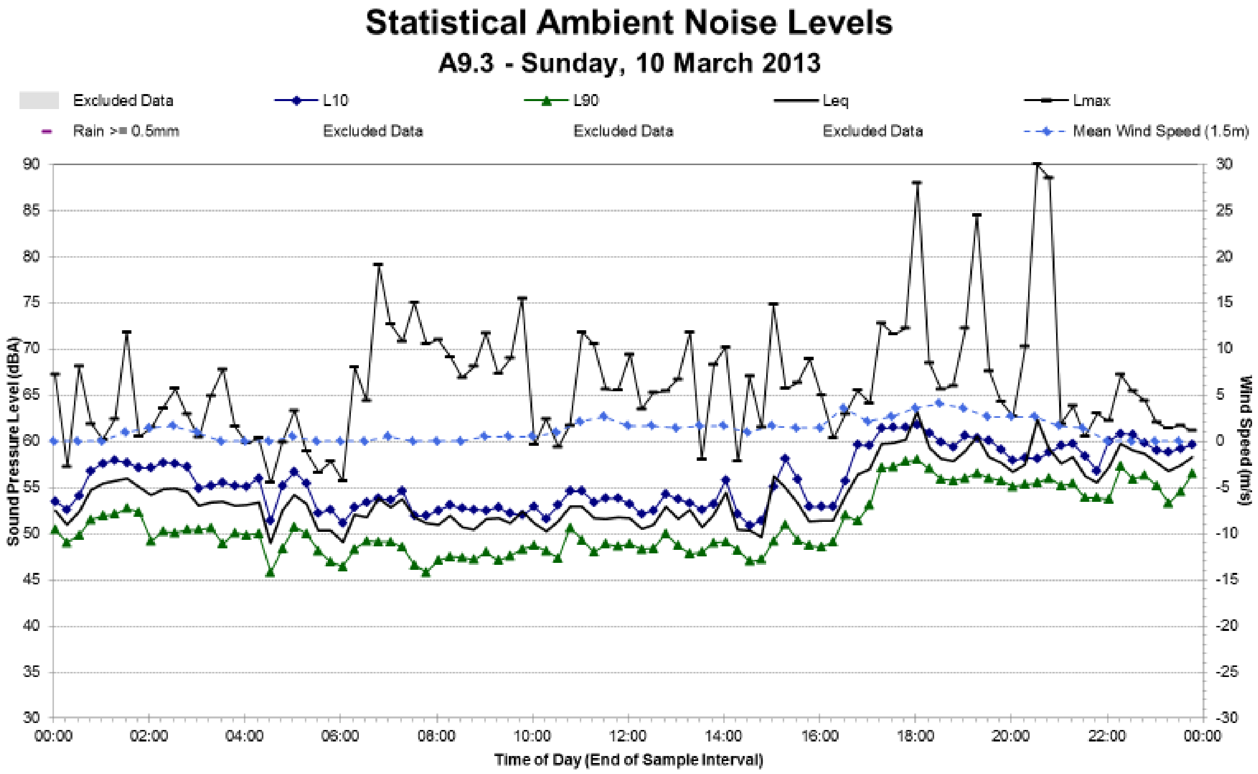
Statistical Ambient Noise Levels
A9.3 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A9 Ambient Noise Monitoring Results

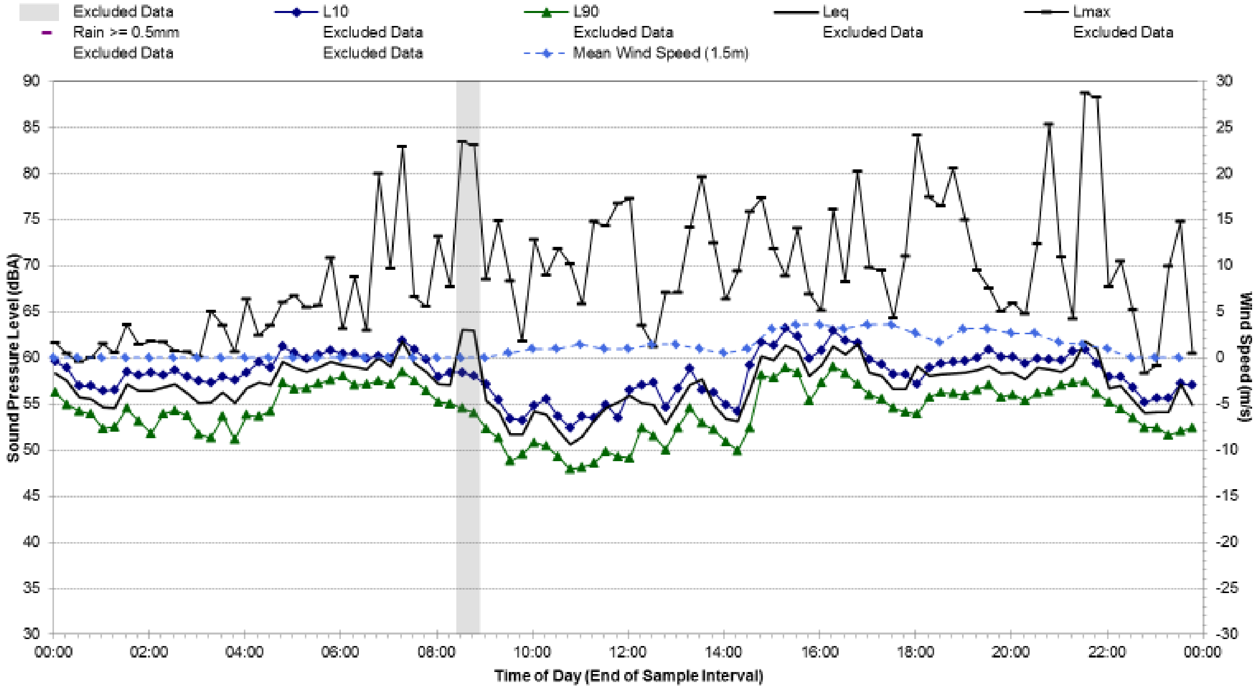




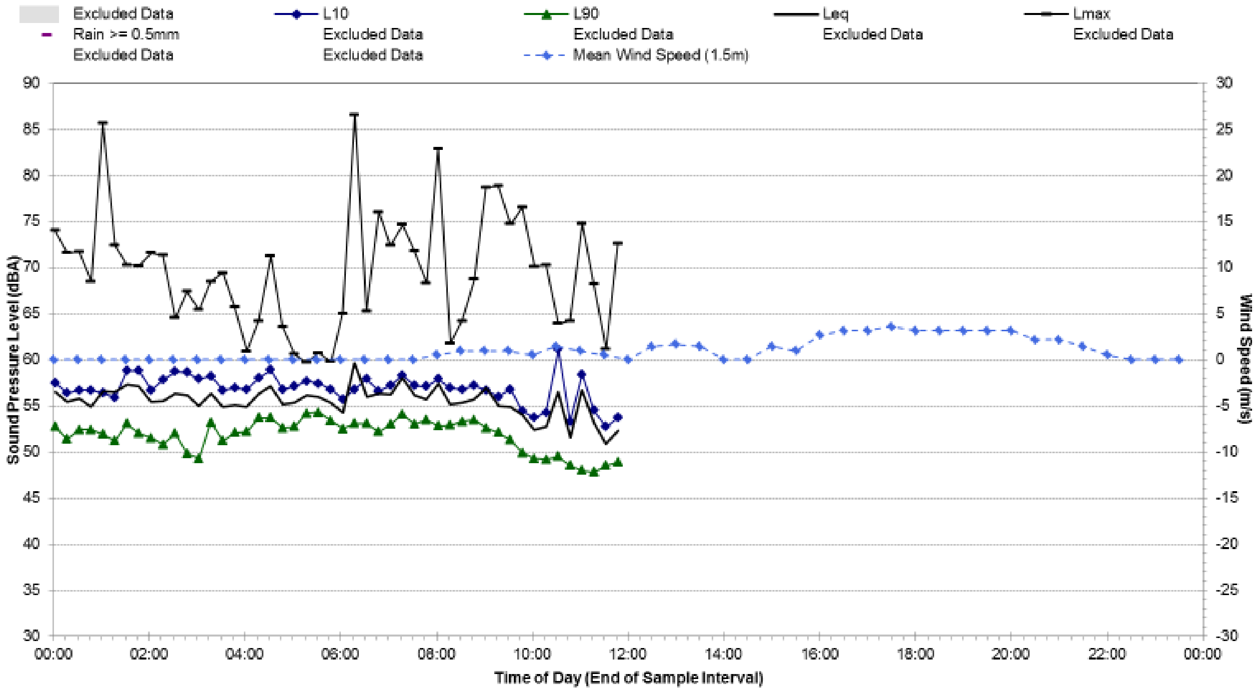

Statistical Ambient Noise Levels
A9.3 - Saturday, 9 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A9.3 - Sunday, 10 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Statistical Ambient Noise Levels
A9.3 - Monday, 11 March 2013



Statistical Ambient Noise Levels
A9.3 - Tuesday, 12 March 2013



A9 Ambient Noise Monitoring Results

Noise Monitoring Location:	A9.4
Noise Monitoring Address:	**5 Tod Place, Minchinbury**

Logger Device Type: Svantek 957
Logger Serial No: 23814

Ambient noise logger deployed at rear of residential address 5 Tod Place, Minchinbury.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 56-63 dBA, Light-vehicle road traffic: ~53-54 dBA, Insects: ~56 dBA, Birds: 53-59

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	**LAeq**	**L10**	**L1**
Daytime	52	58	59	62
Evening	55	60	60	63
Night-time	53	61	62	64

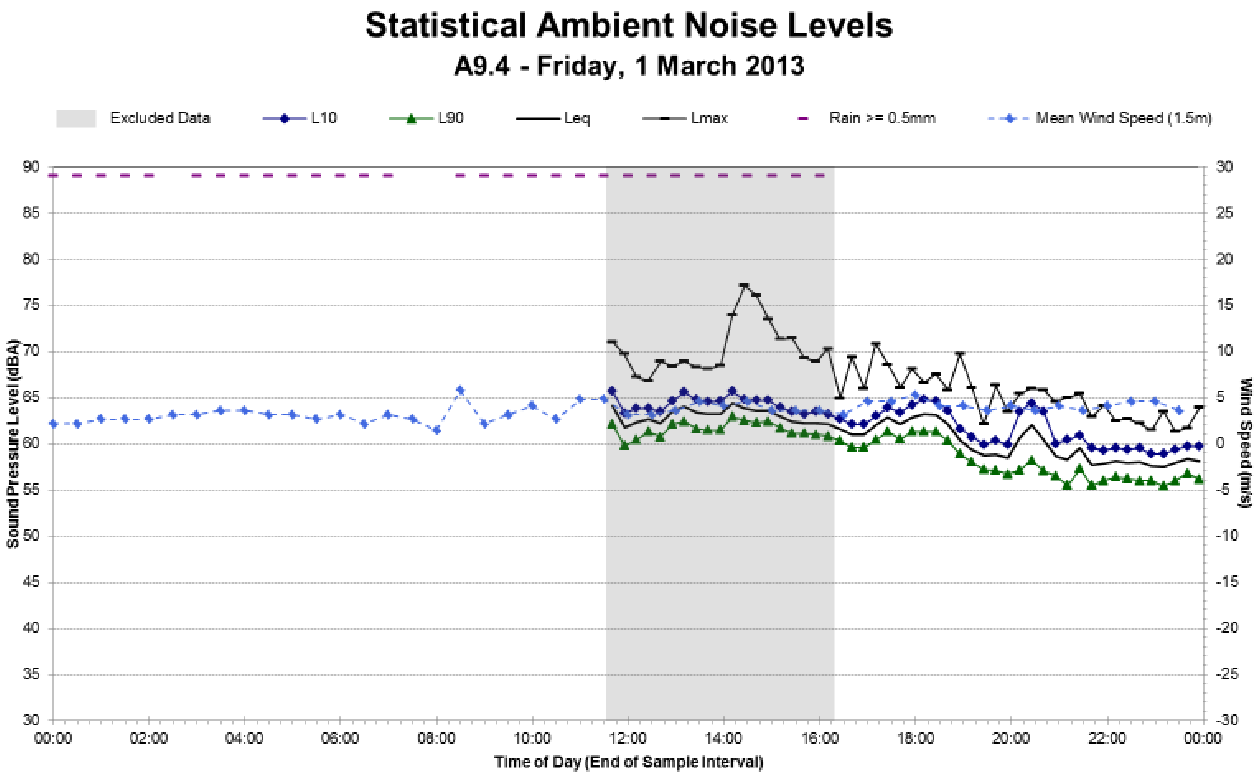
Ambient Noise Logging Results – RNP Defined Time Periods

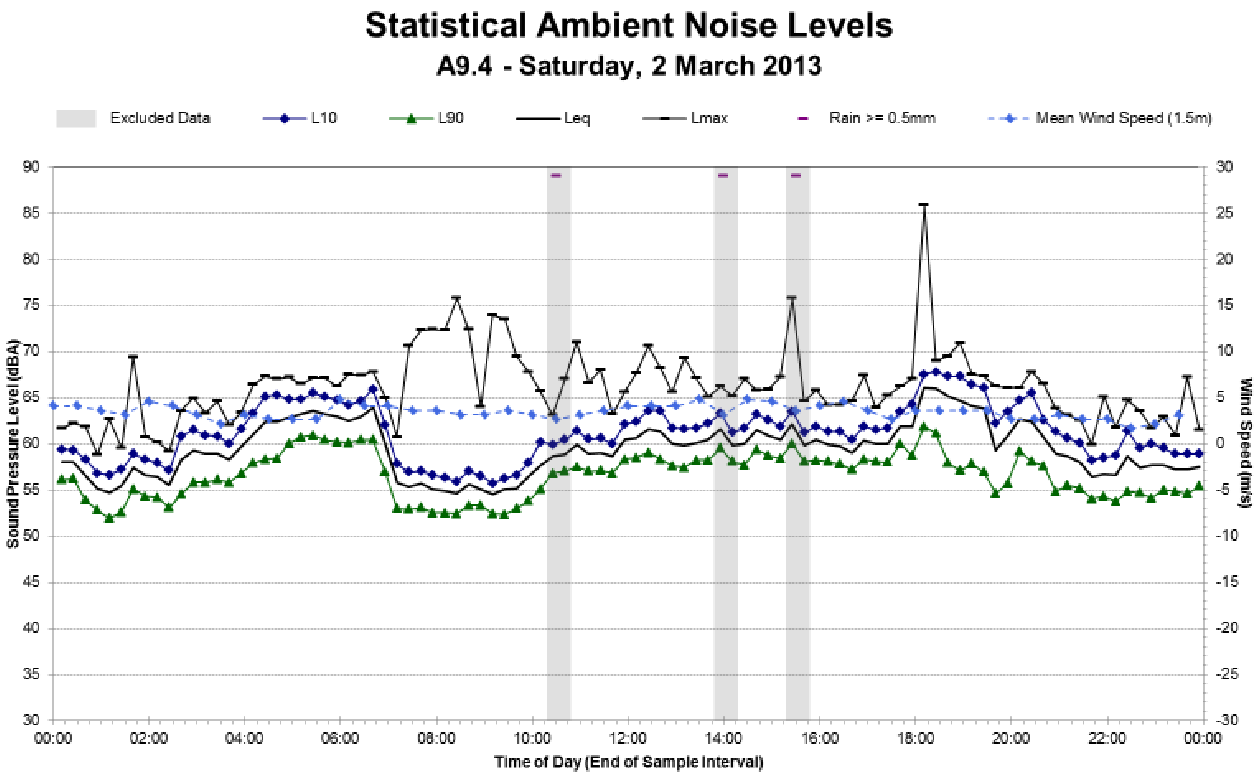
Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	5	4	N/A (7 Day Average)
Daytime (7am-10pm)	58	59	58
Night-time (10pm-7am)	62	60	62

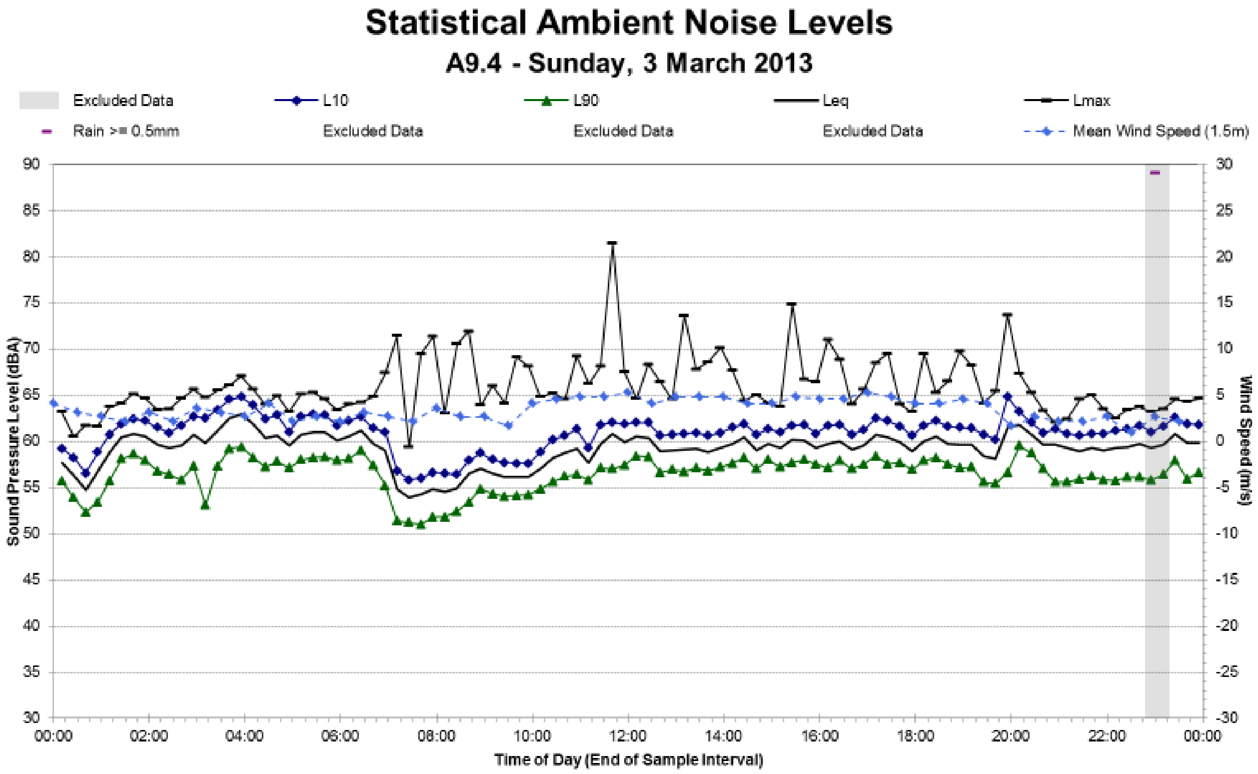
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	**LAeq**	**LAmax**
12/03/2013	11:22	53	56	63

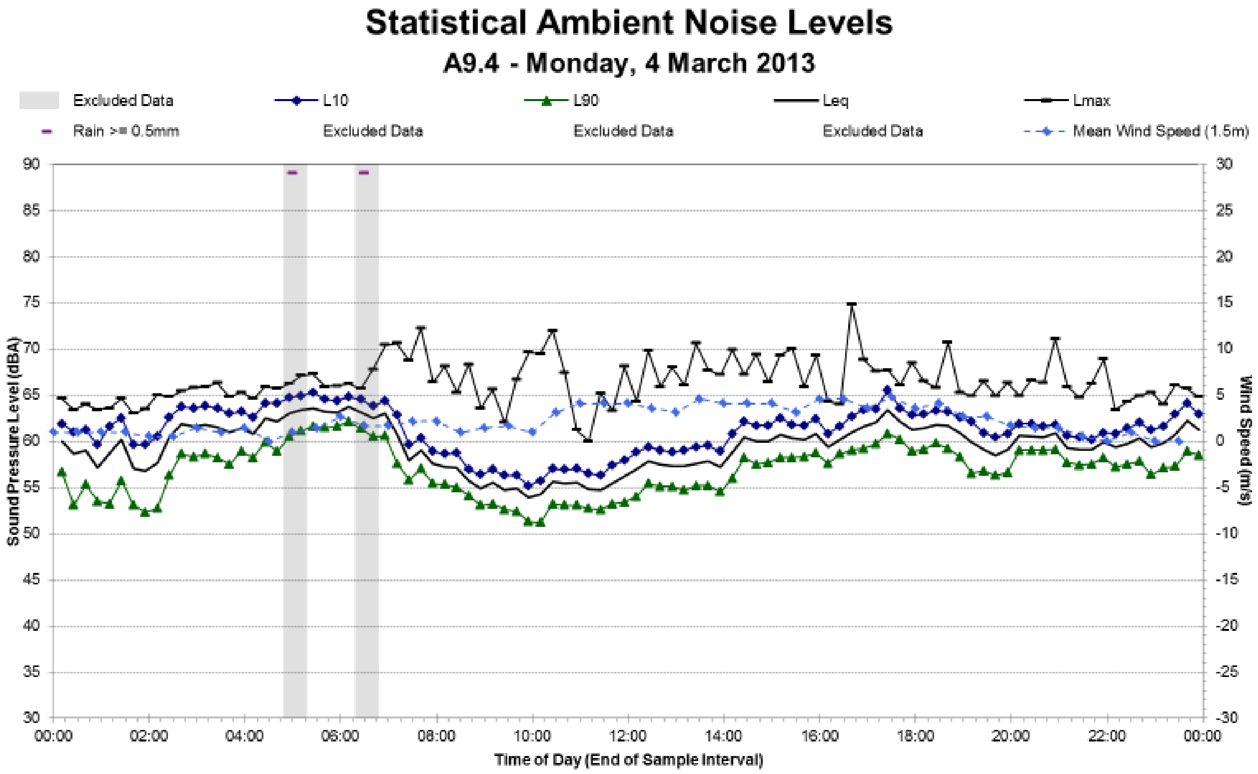
Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
A9.4 - Friday, 1 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

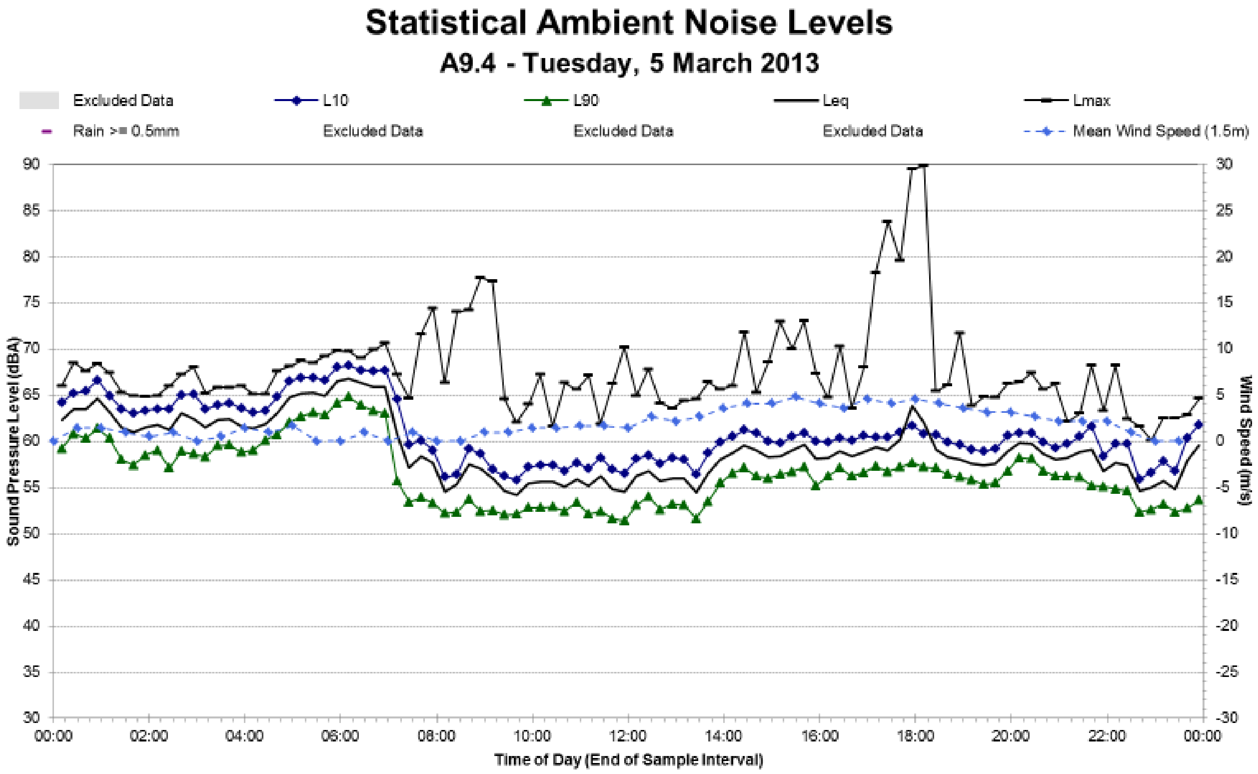

Statistical Ambient Noise Levels
A9.4 - Saturday, 2 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

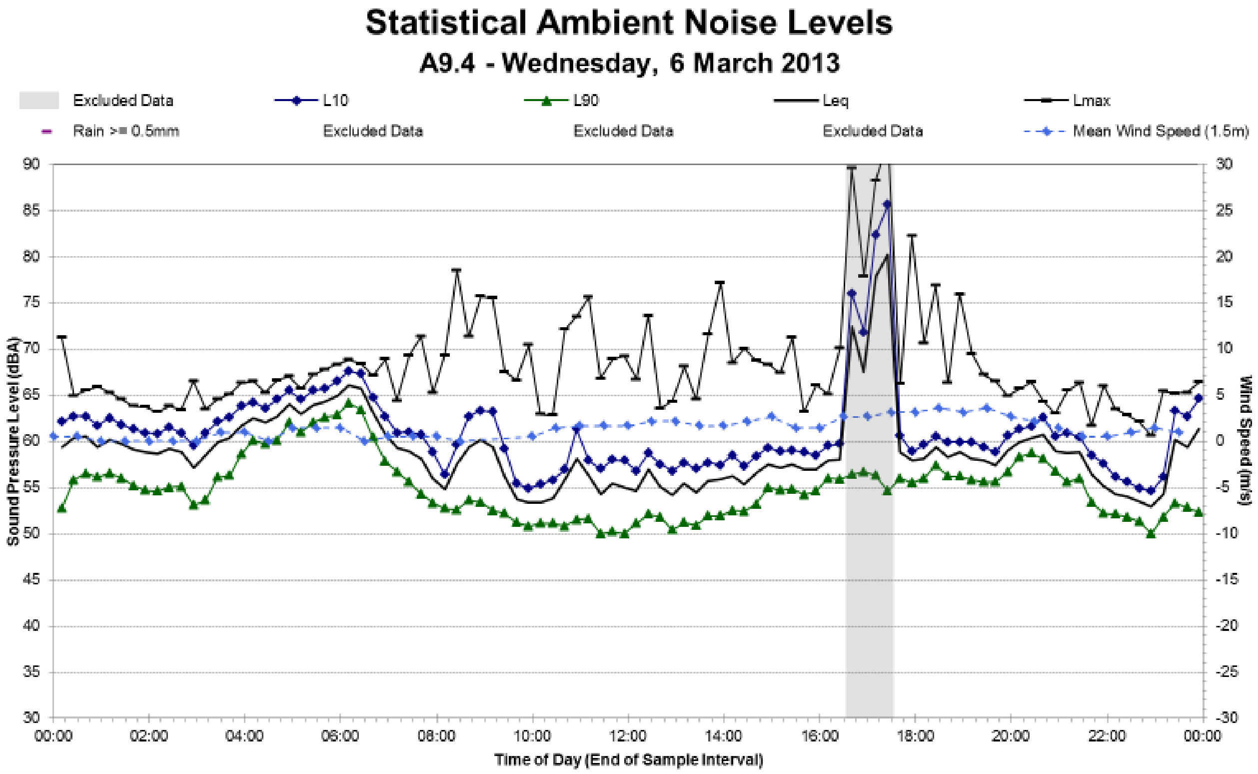


Statistical Ambient Noise Levels
A9.4 - Sunday, 3 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

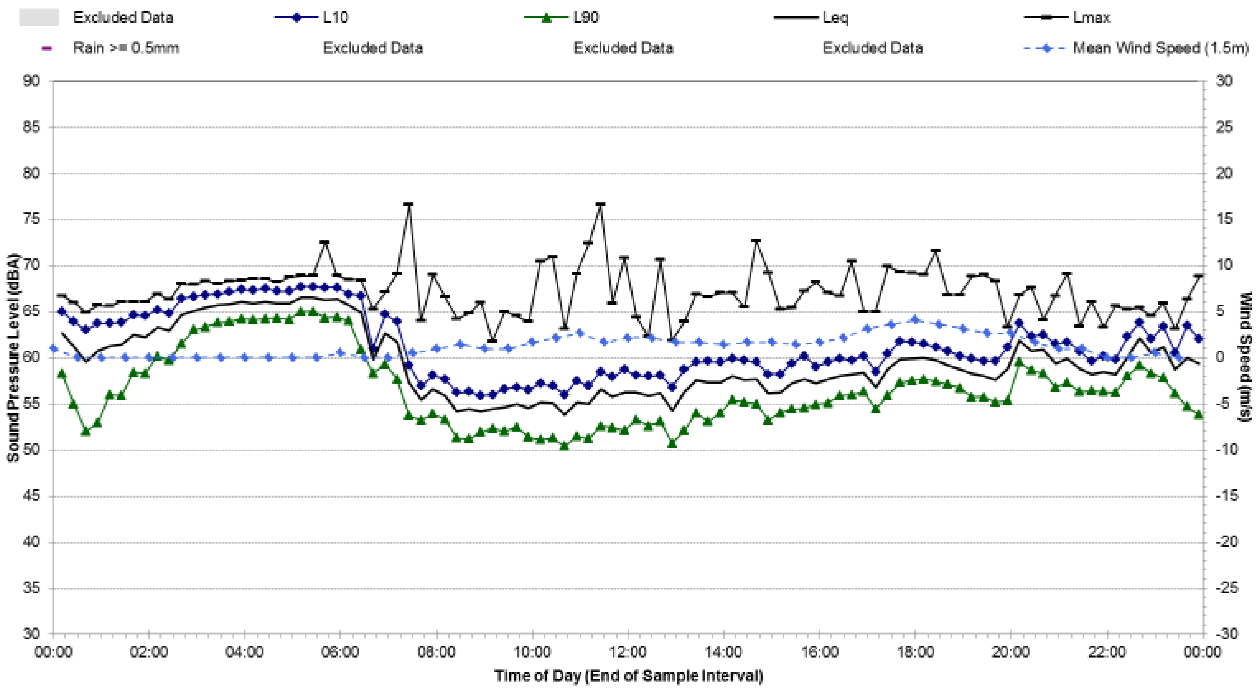


Statistical Ambient Noise Levels
A9.4 - Monday, 4 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

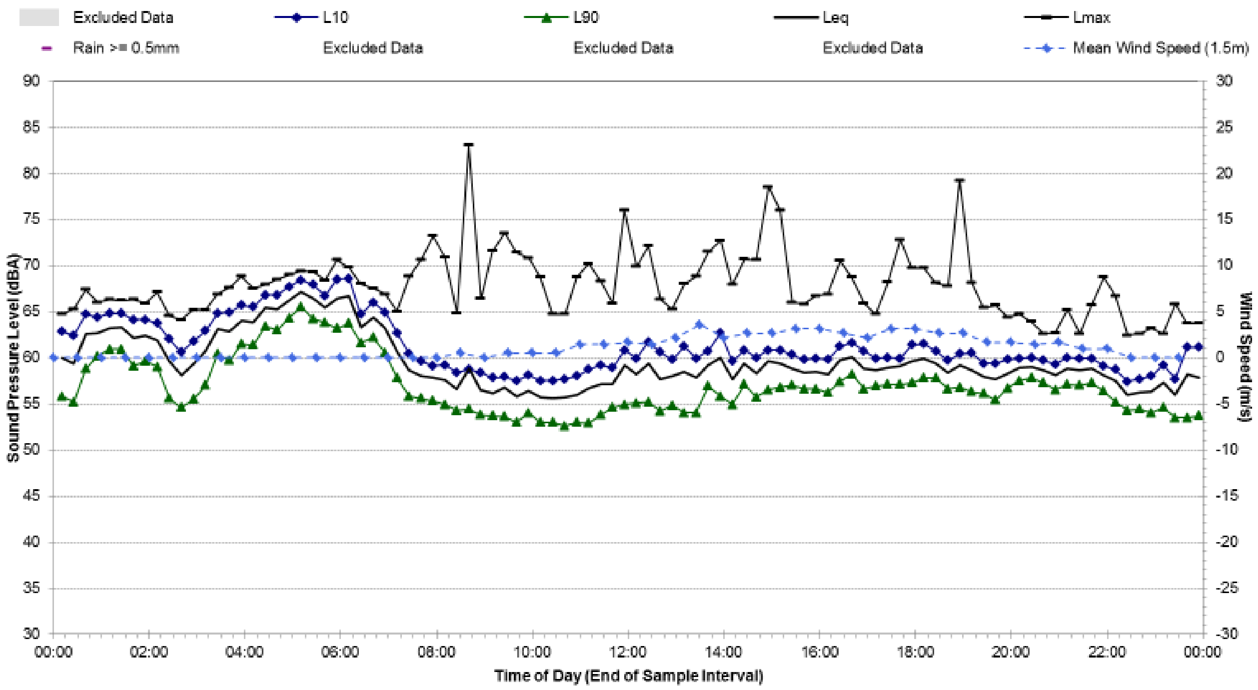

Statistical Ambient Noise Levels
A9.4 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A9.4 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

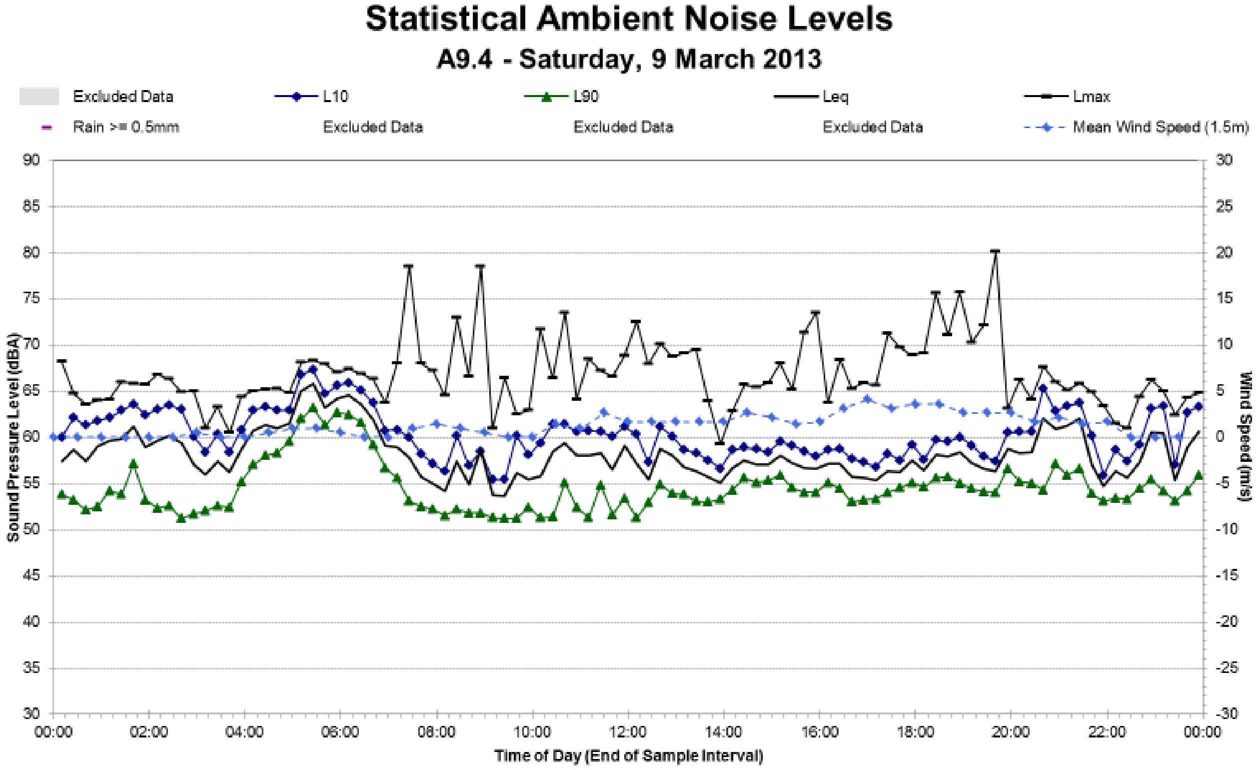
Statistical Ambient Noise Levels
A9.4 - Thursday, 7 March 2013

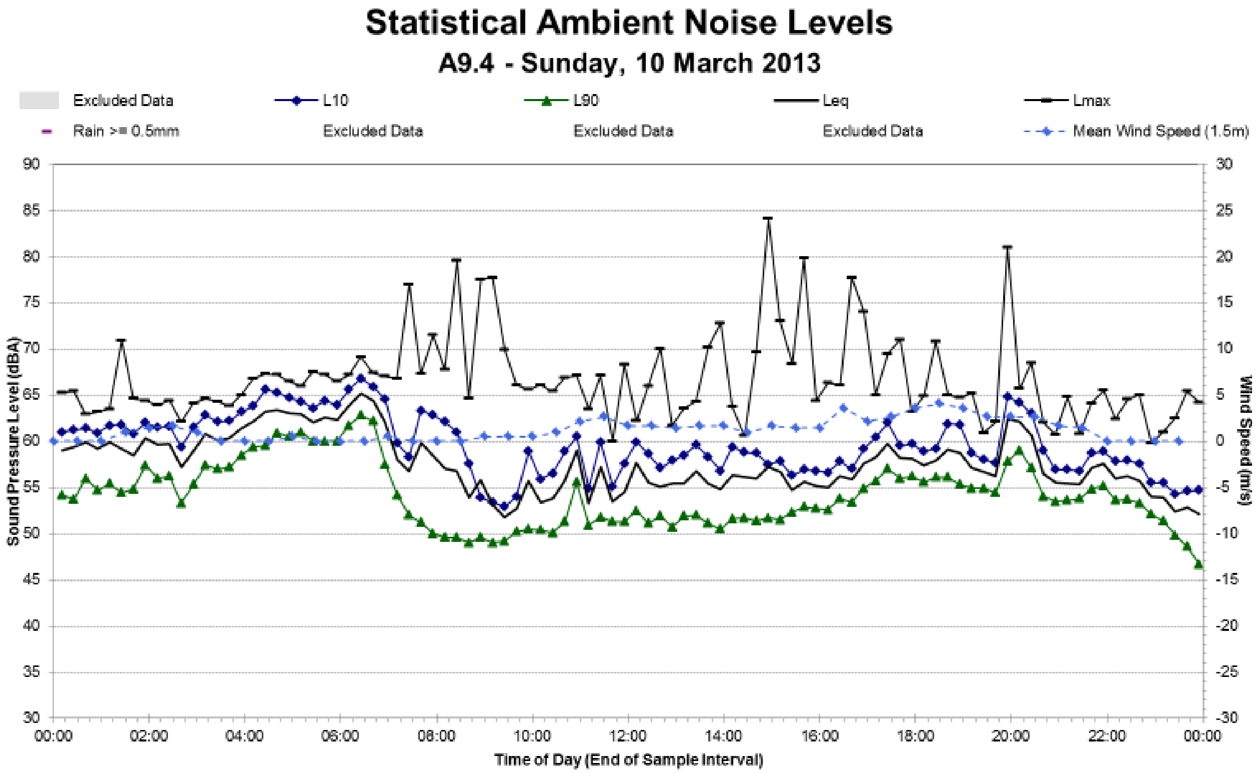


Statistical Ambient Noise Levels
A9.4 - Friday, 8 March 2013

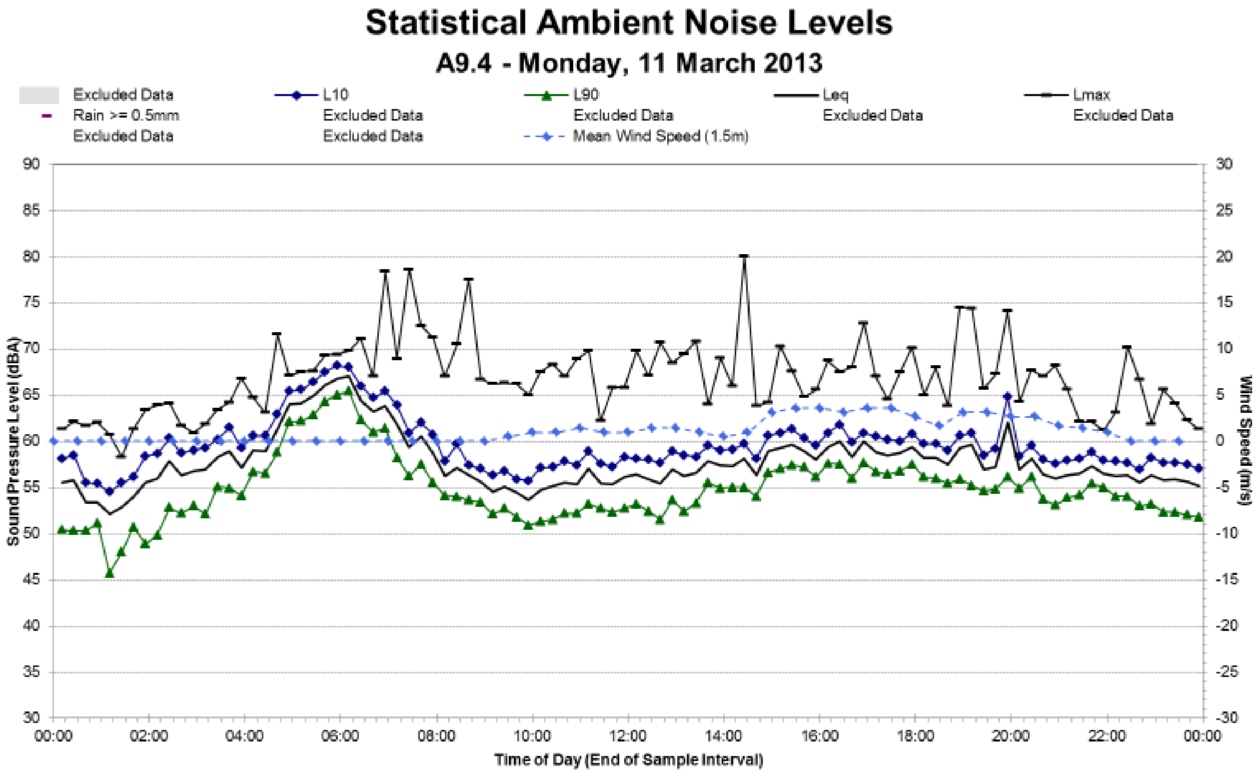


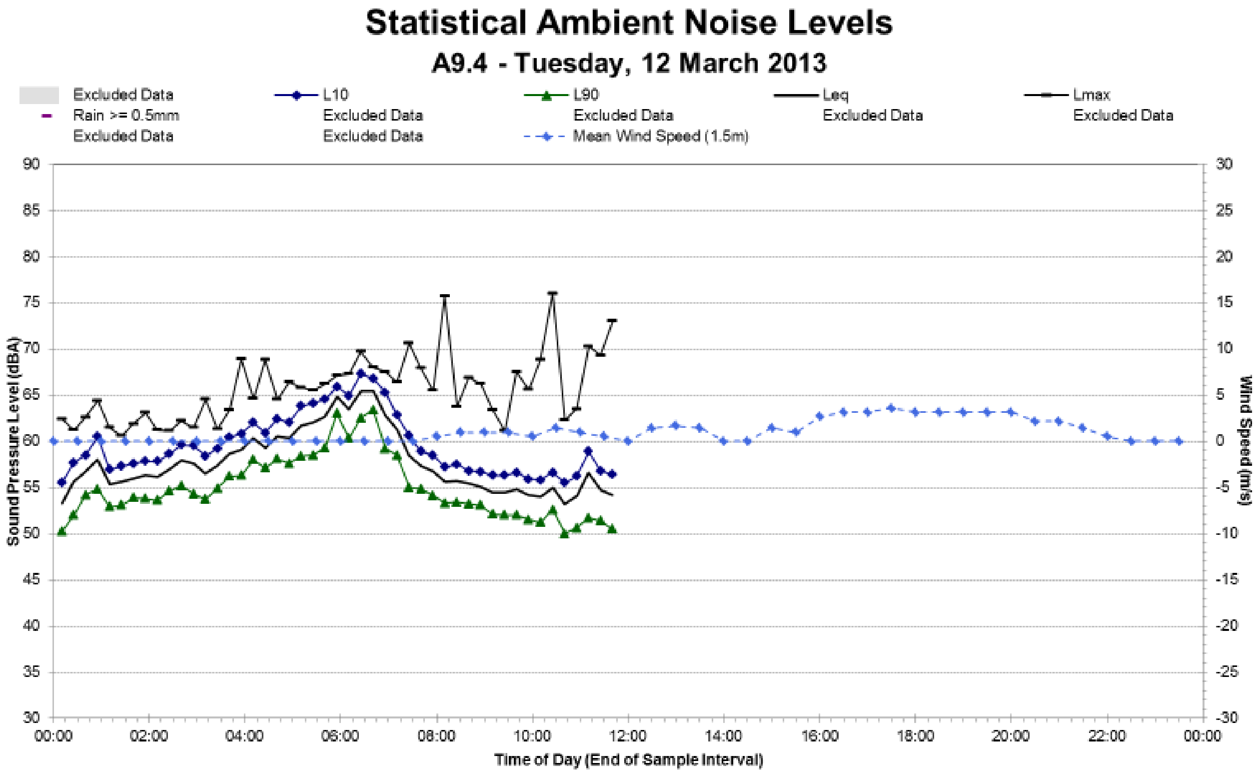
A9 Ambient Noise Monitoring Results





A9 Ambient Noise Monitoring Results





A9 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A9.5**
Noise Monitoring Address:	**6 Shepard Street, Colyton**

Logger Device Type: Svantek 957
Logger Serial No: 23244

Ambient noise logger deployed at rear of residential address 6 Shepard Street, Colyton.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4 and subject to insect noise. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements on east-bound on-ramp are apparent and are generally engine/exhaust generated.

Detailed analysis of background noise levels shows a regular rise in L90 noise levels around 20:00 most nights. These events have been removed from the dataset.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 55-65 dBA, Air Traffic: 56-58 dBA, Insects: ~56 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	52	59	60	64
Evening	54	58	59	63
Night-time	47	56	58	61

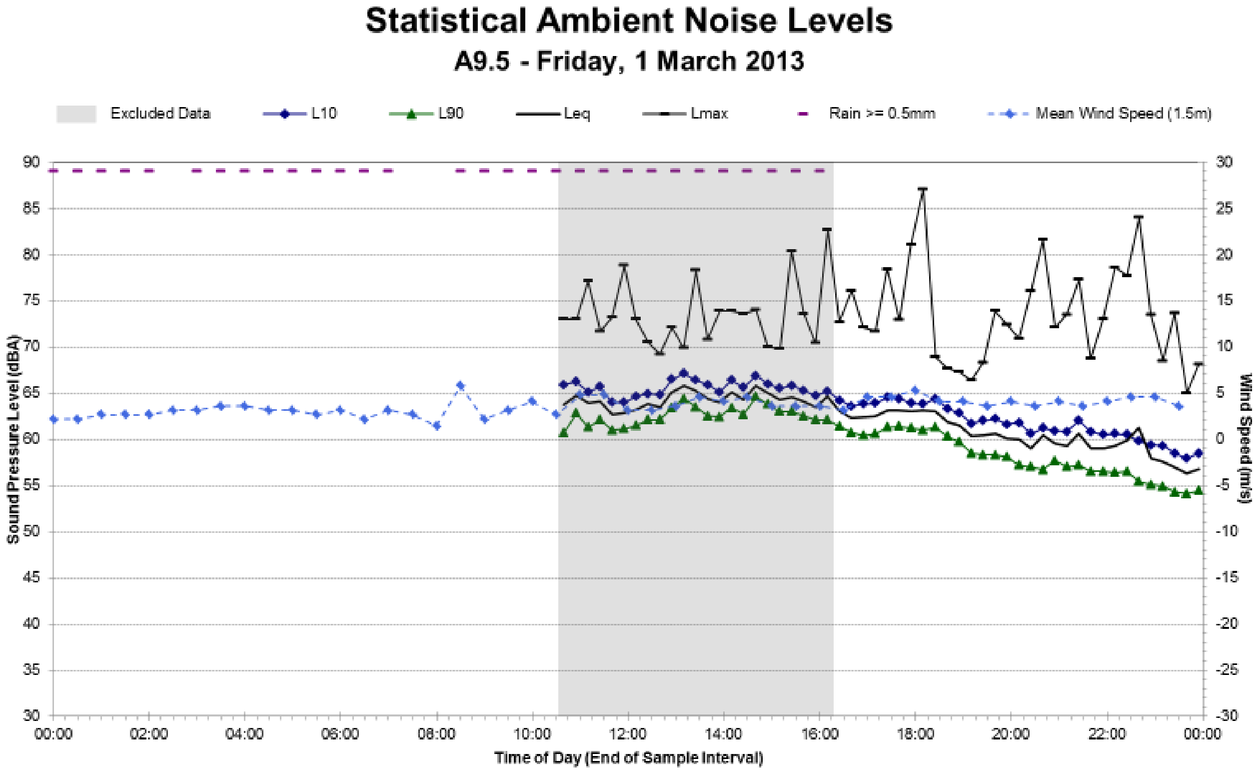
Ambient Noise Logging Results – RNP Defined Time Periods

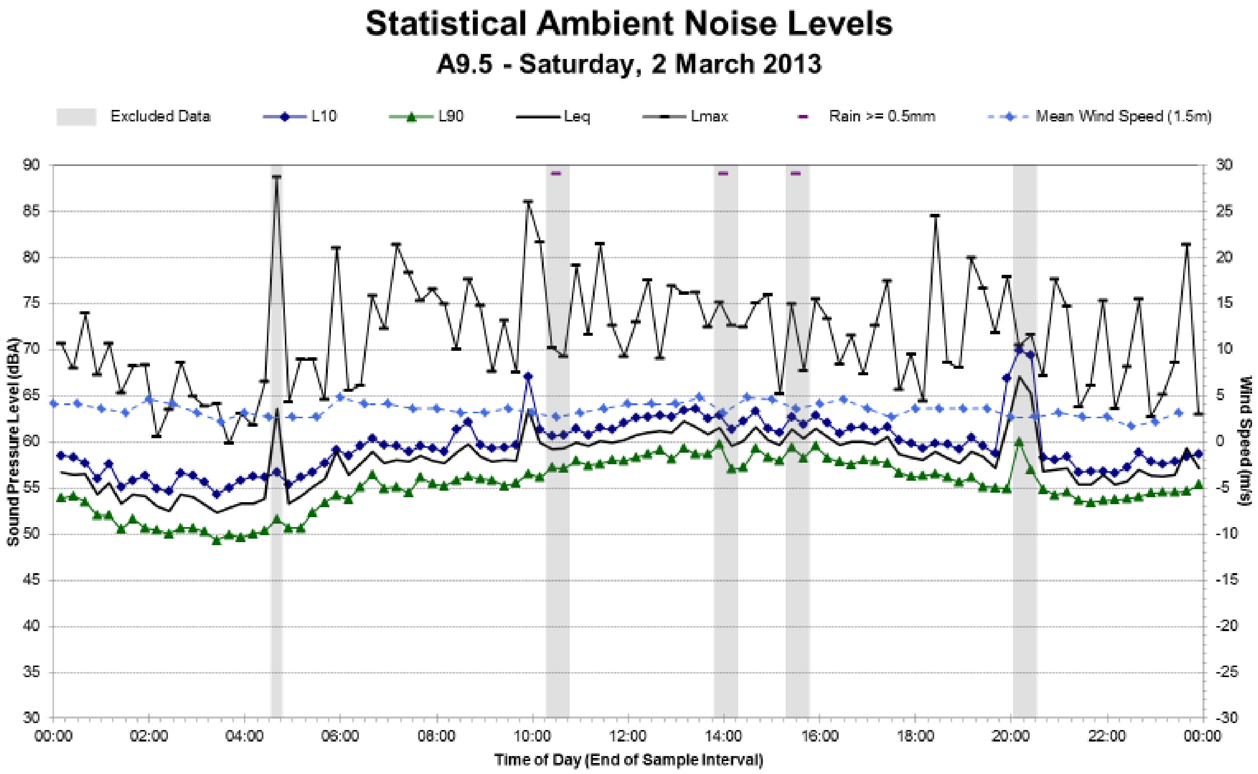
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	5	2	N/A (7 Day Average)
Daytime (7am-10pm)	60	59	60
Night-time (10pm-7am)	56	55	56

Attended Noise Measurement Results

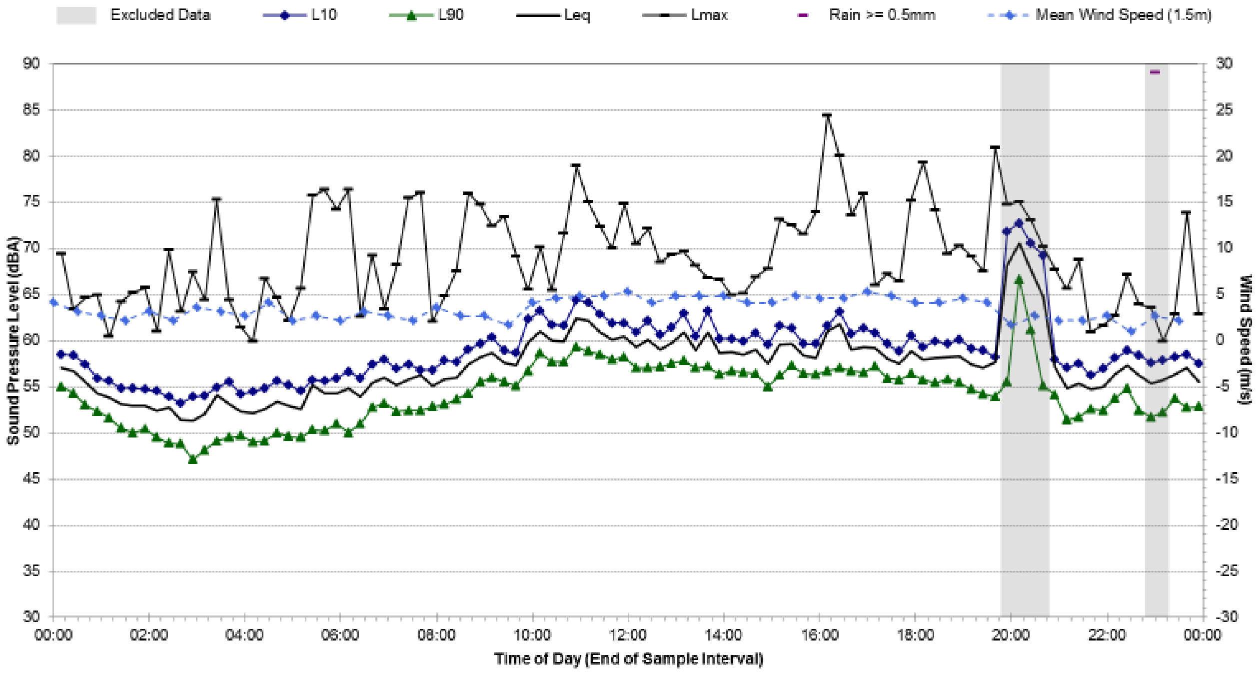
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
12/03/2013	10:08	54	57	66

Photo of Noise Monitoring Location

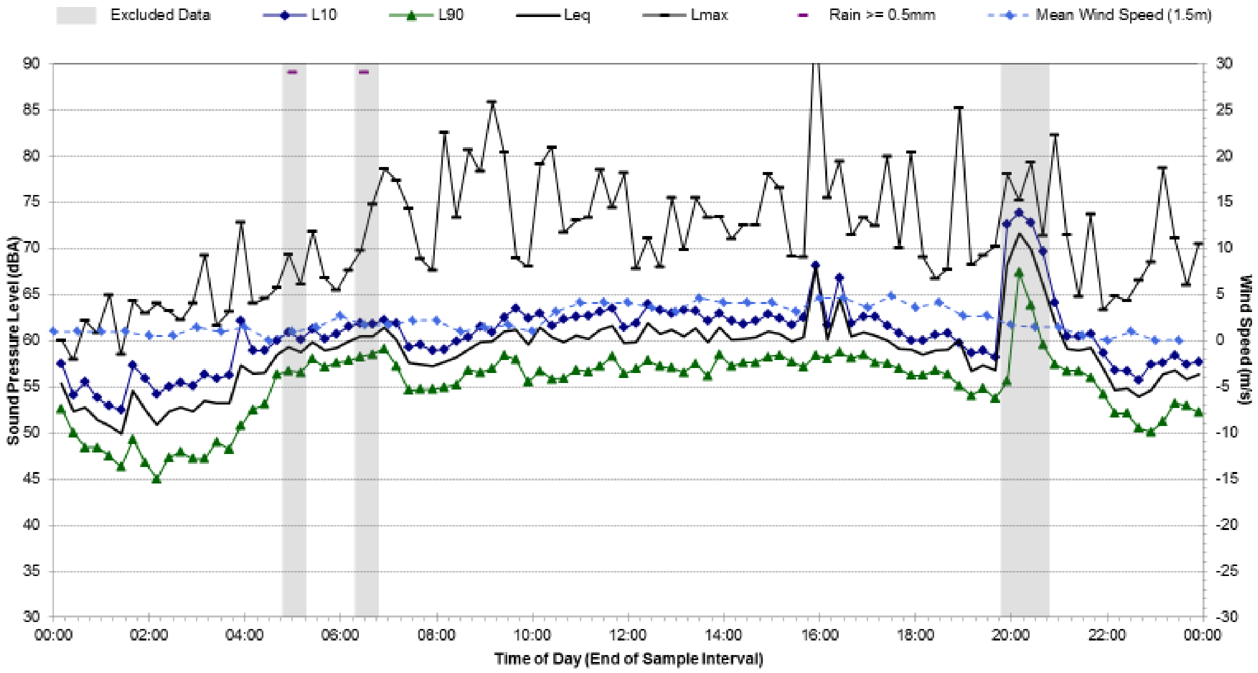

Statistical Ambient Noise Levels
A9.5 - Friday, 1 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

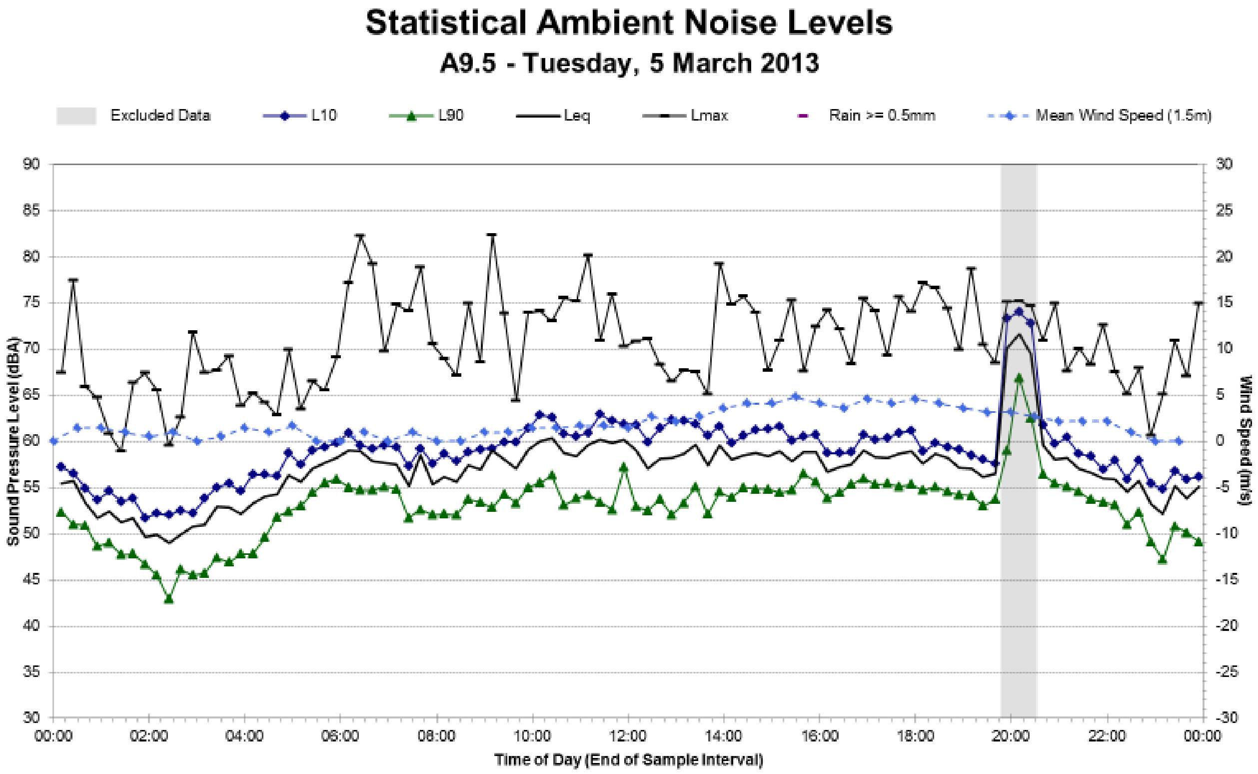

Statistical Ambient Noise Levels
A9.5 - Saturday, 2 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

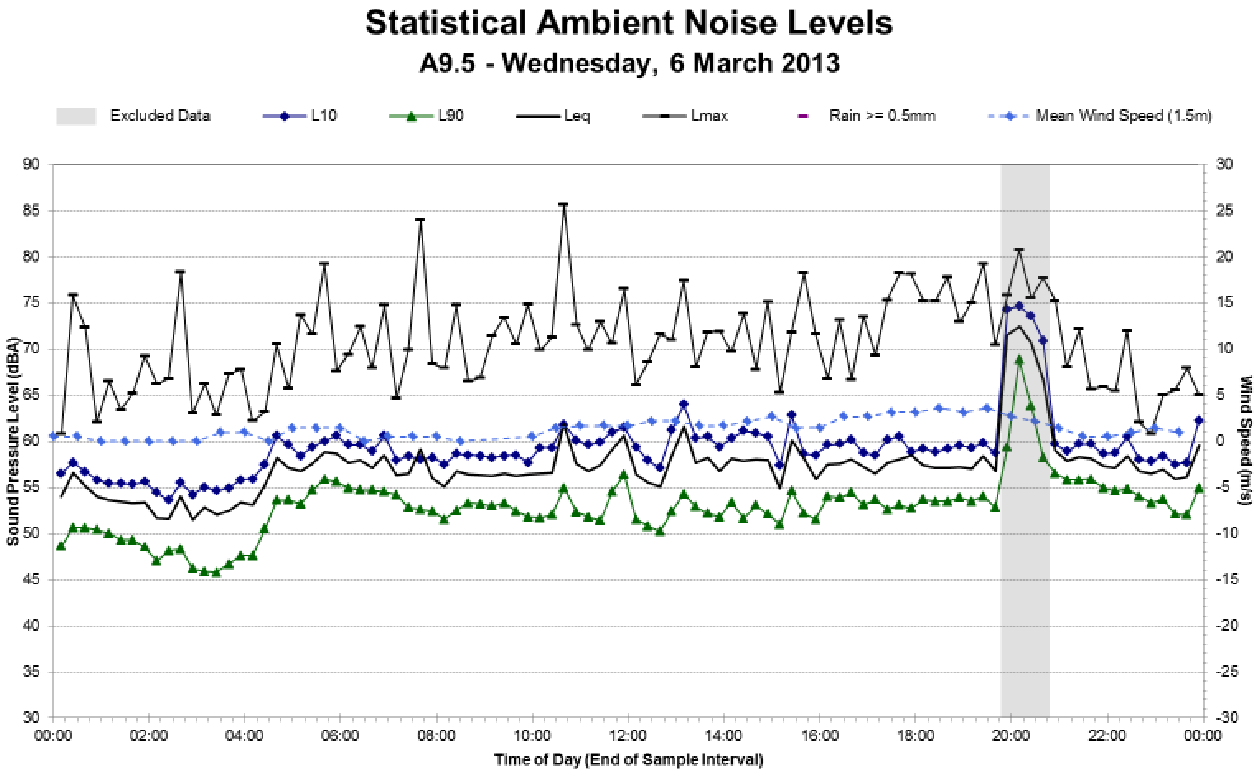
Statistical Ambient Noise Levels
A9.5 - Sunday, 3 March 2013

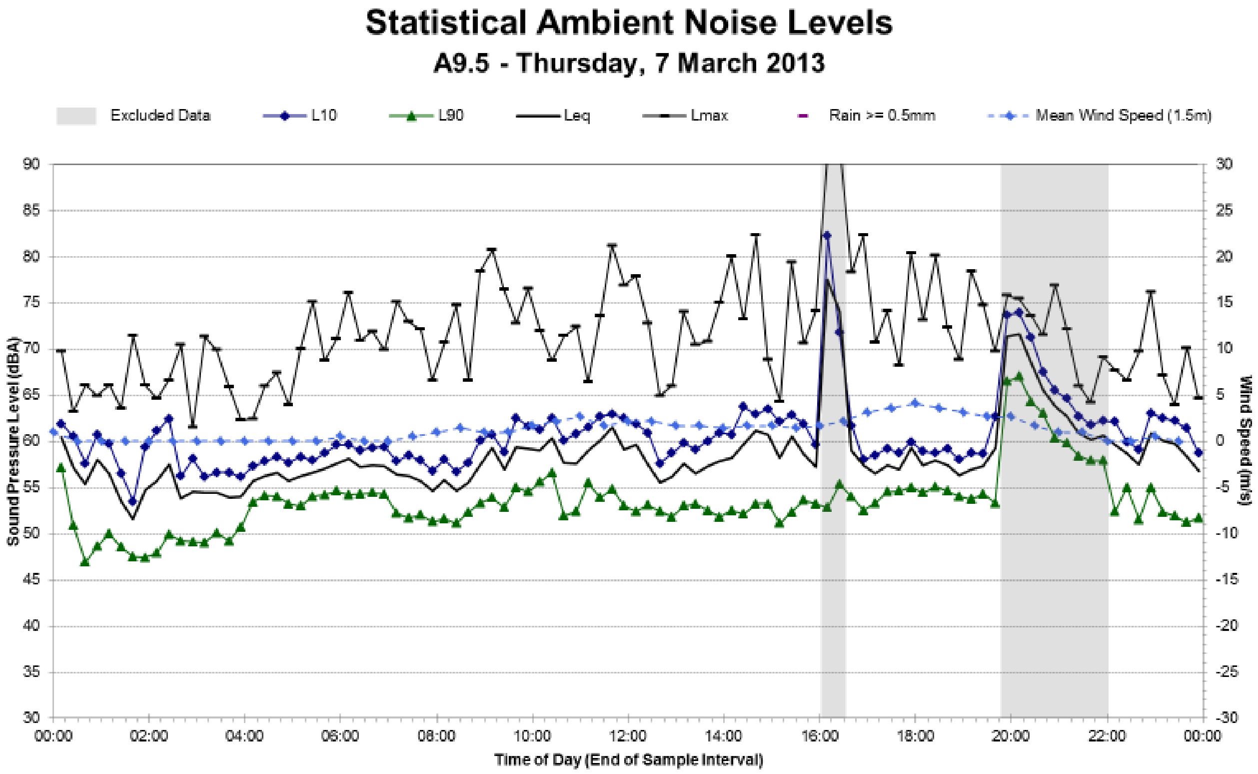


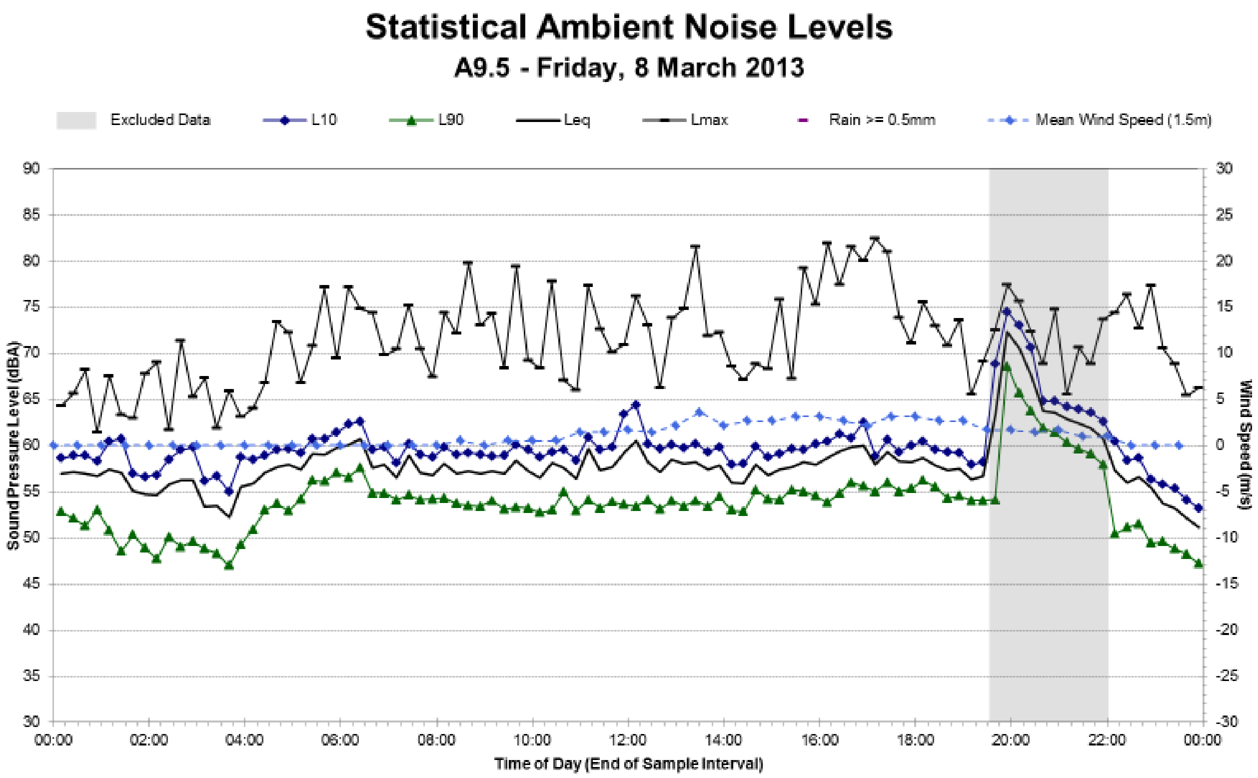
Statistical Ambient Noise Levels
A9.5 - Monday, 4 March 2013



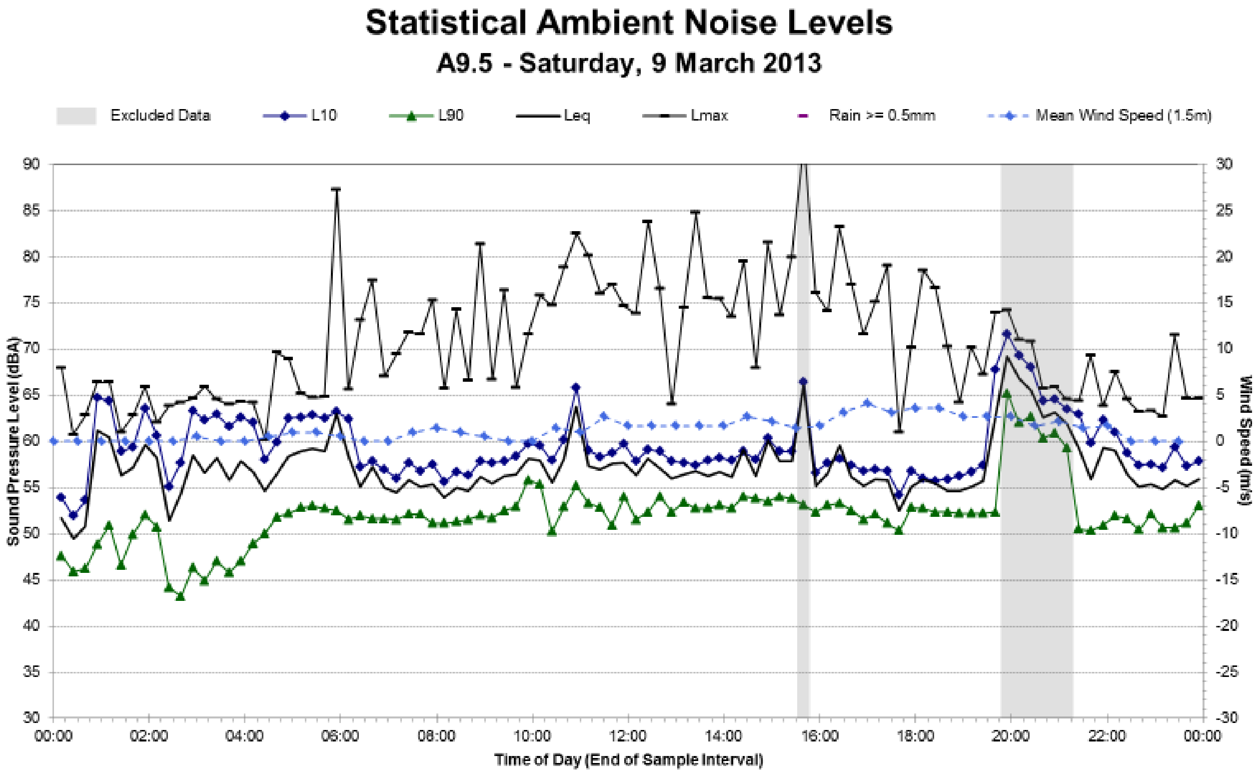

Statistical Ambient Noise Levels
A9.5 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

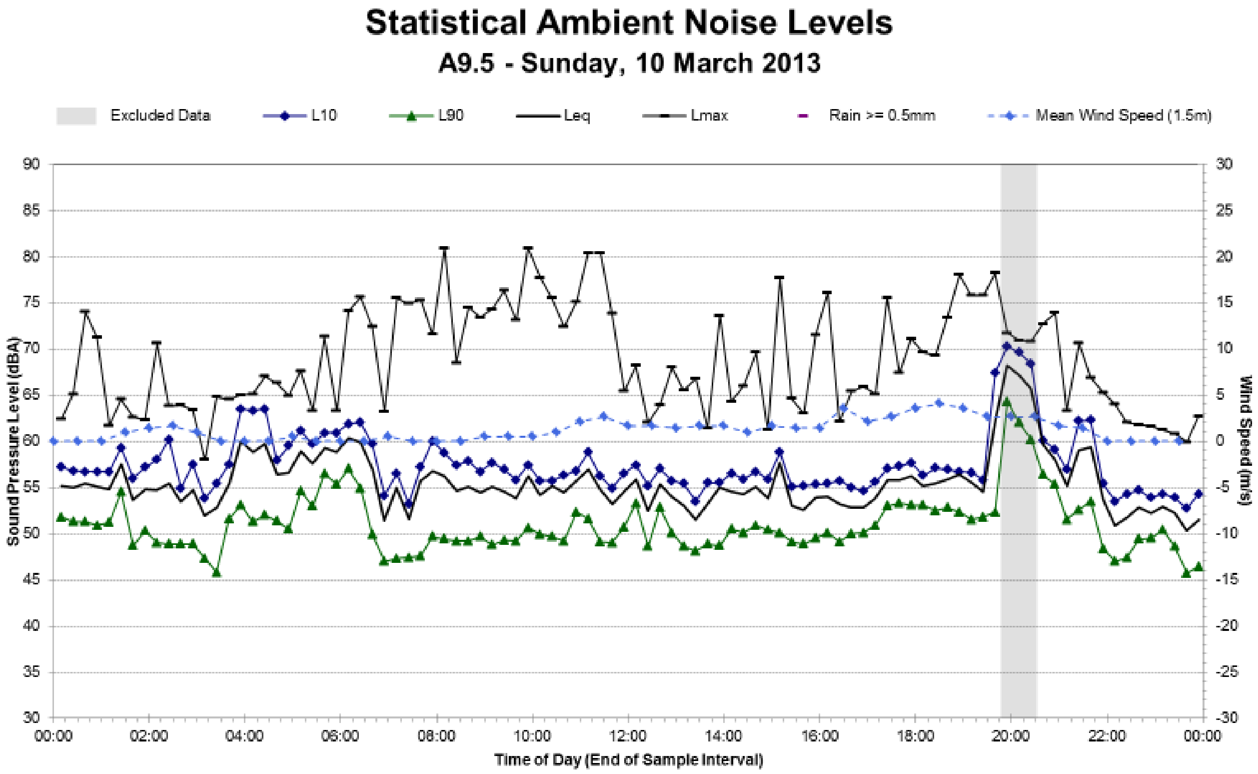

Statistical Ambient Noise Levels
A9.5 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

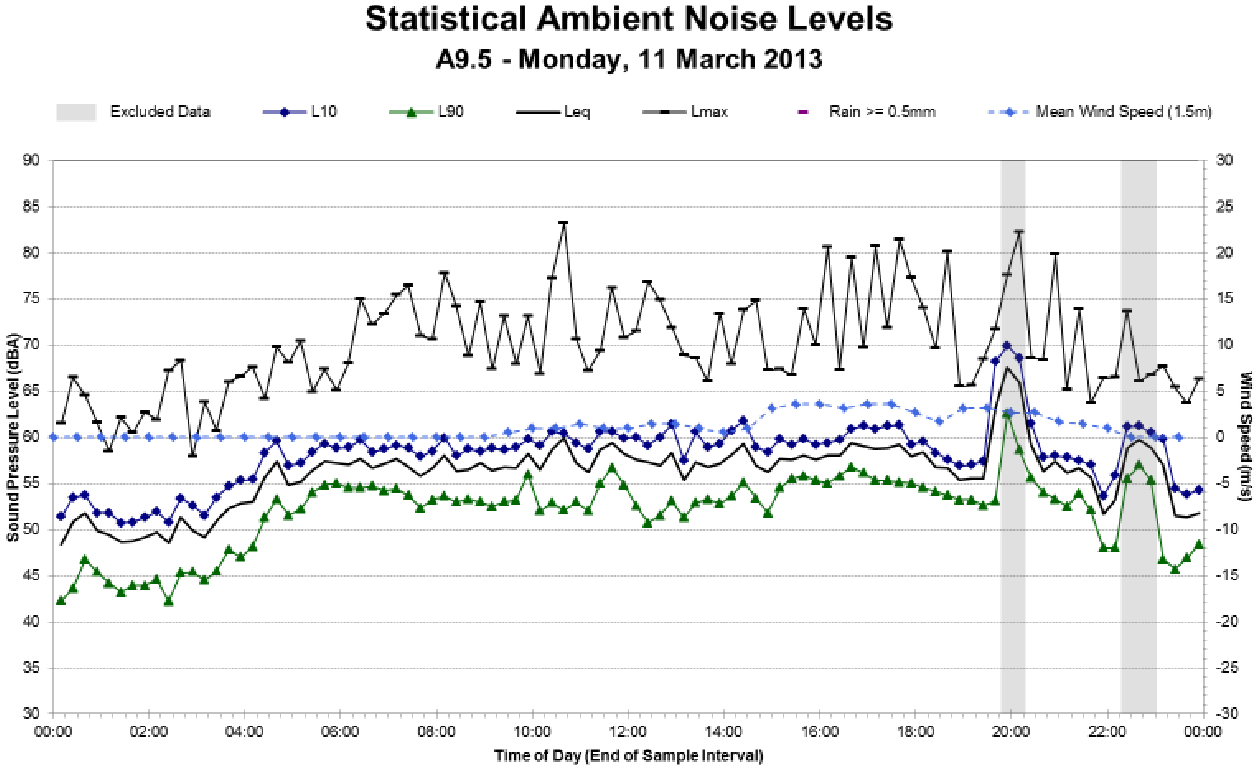

Statistical Ambient Noise Levels
A9.5 - Thursday, 7 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

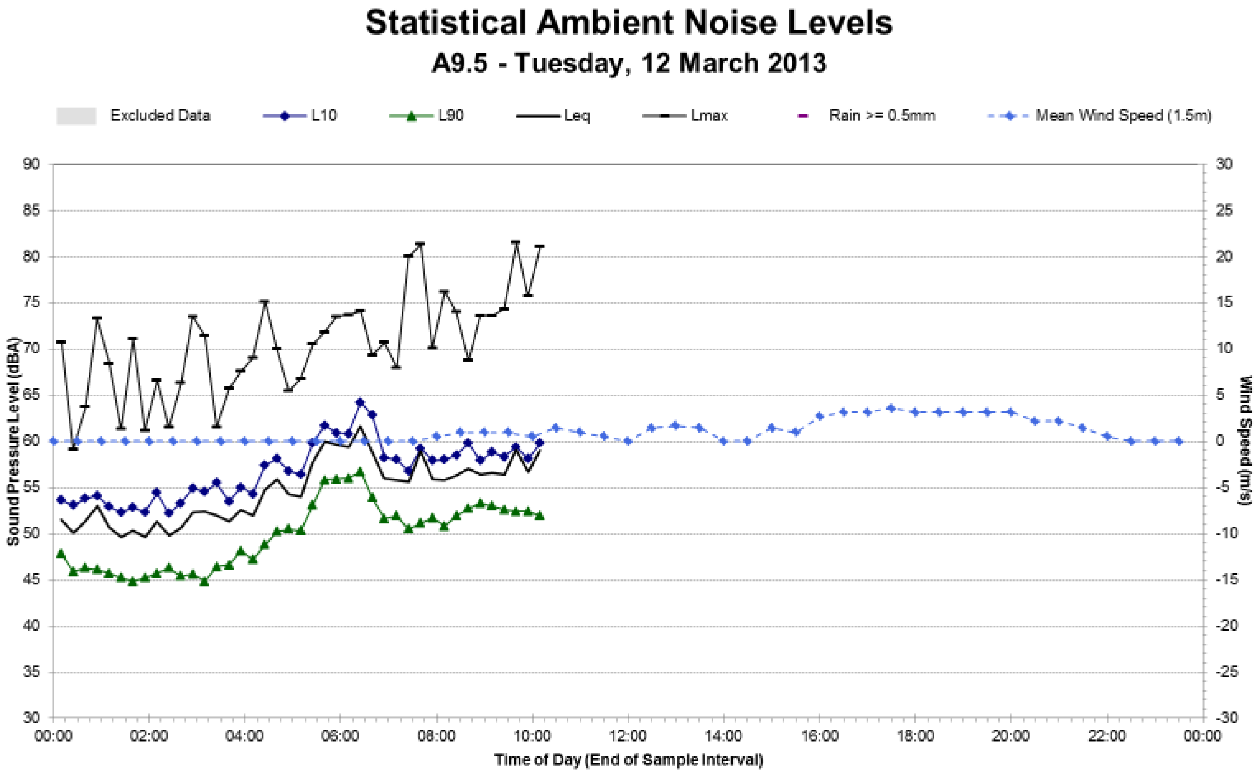

Statistical Ambient Noise Levels
A9.5 - Friday, 8 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A9 Ambient Noise Monitoring Results






Statistical Ambient Noise Levels
A9.5 - Monday, 11 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A9.5 - Tuesday, 12 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A9 Ambient Noise Monitoring Results

Noise Monitoring Location:	A9.6
Noise Monitoring Address:	**2 Hartwell Court, St. Clair**

Logger Device Type: Svantek 957
Logger Serial No: 20675

Ambient noise logger deployed at front of residential address 6 Shepard Street, Colyton.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements on M4 are generally engine/exhaust generated.

Detailed analysis of background noise levels shows a regular rise in L90 noise levels around 20:00 most nights. These events have been removed from the dataset.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 59-66 dBA, Light-vehicle road traffic: 56-58 dBA, Motorcycles: 58-60 dBA, Air Traffic: 61 dBA, Birds: 56-63 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	**LAeq**	**L10**	**L1**
Daytime	54	60	61	63
Evening	54	59	60	63
Night-time	44	56	57	61

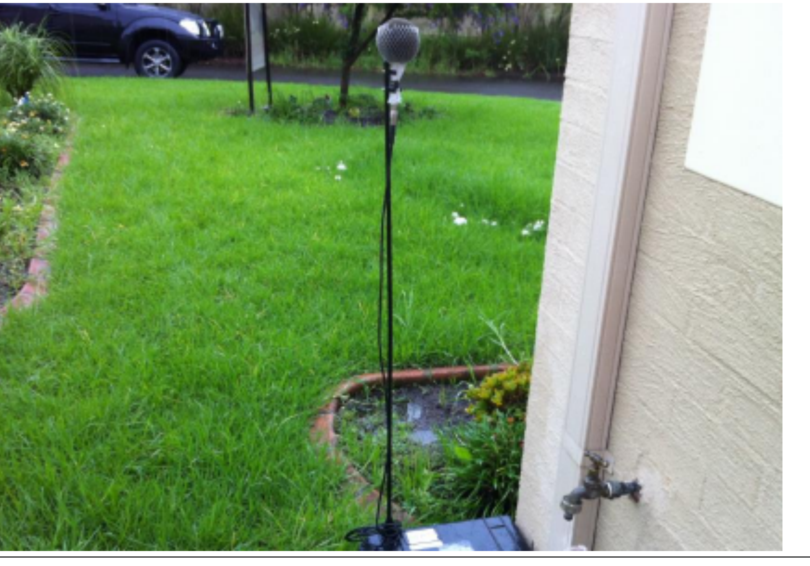
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	4	N/A (7 Day Average)
Daytime (7am-10pm)	60	58	60
Night-time (10pm-7am)	56	56	56

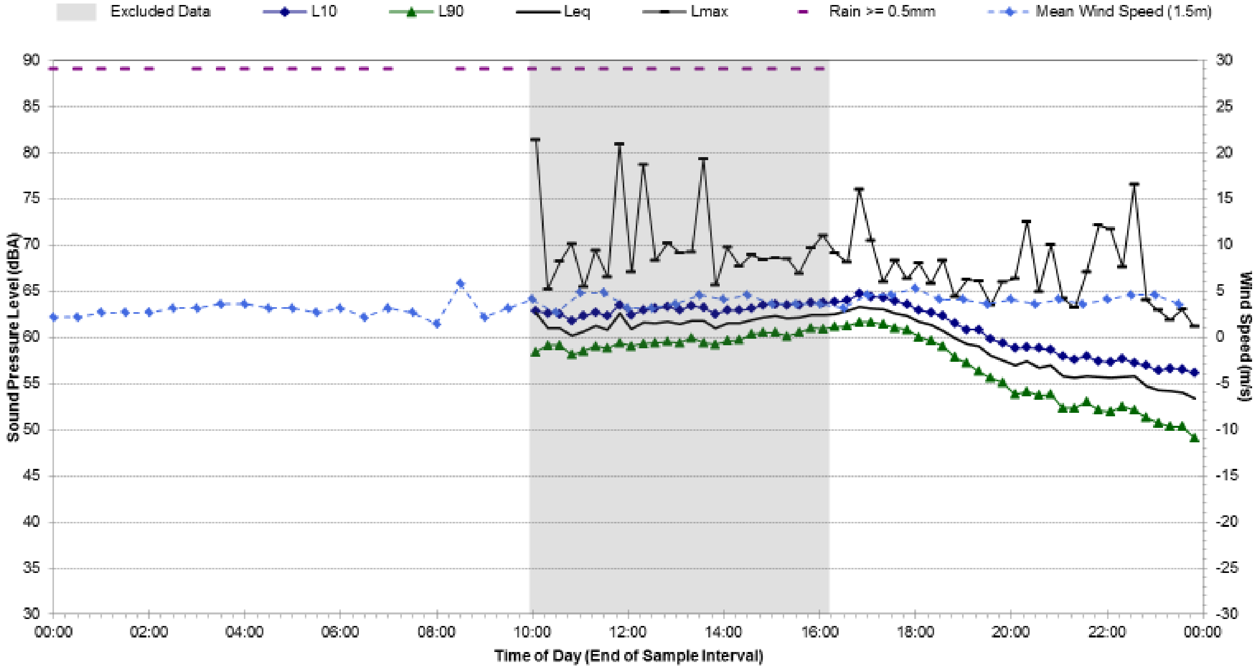
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	**LAeq**	**LAmax**
12/03/2013	09:03	54	57	66

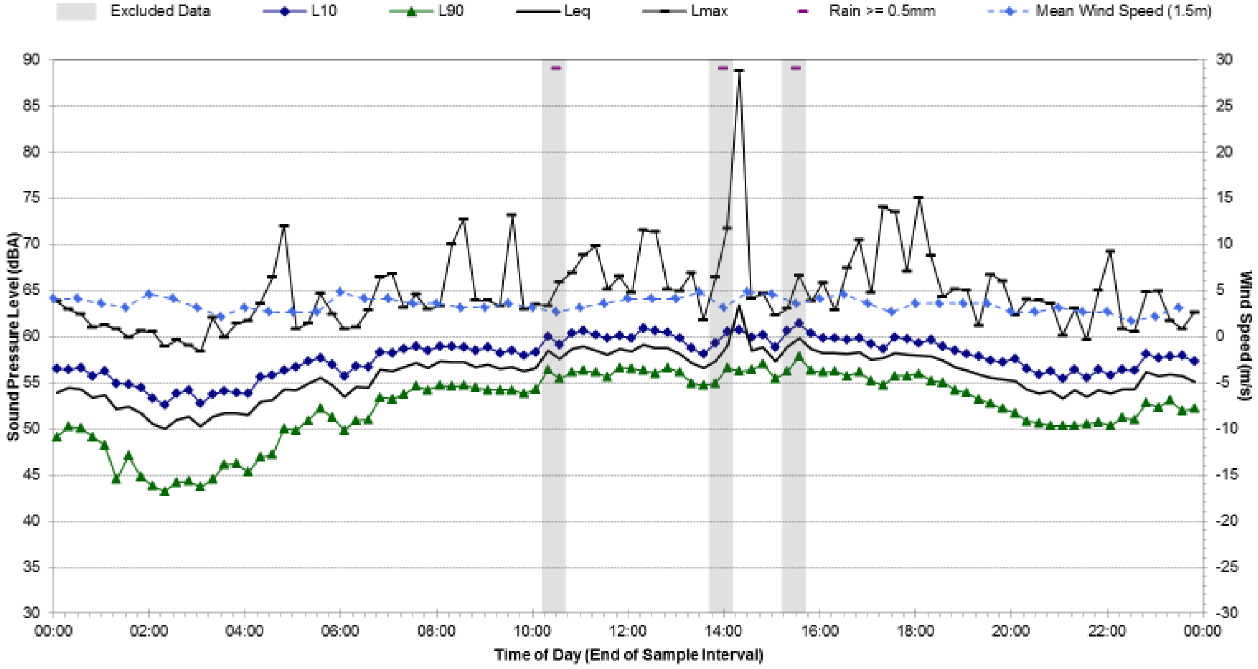
Photo of Noise Monitoring Location

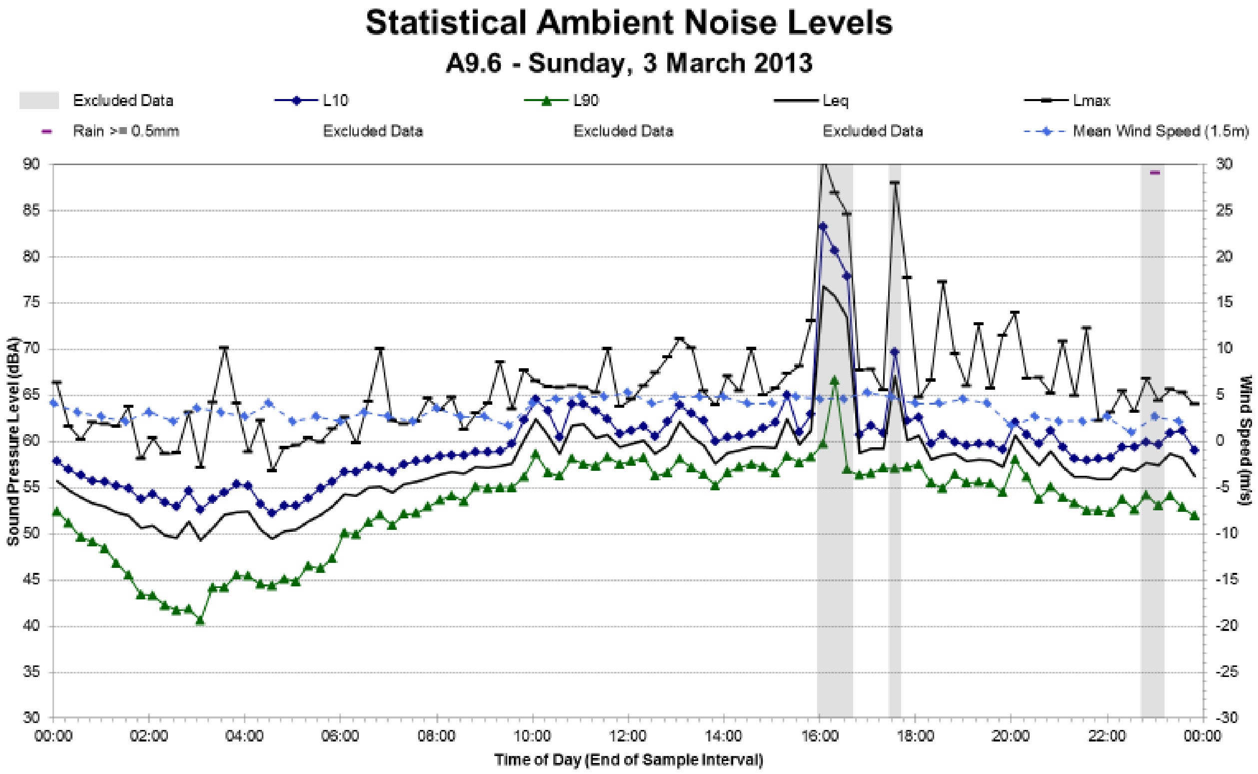


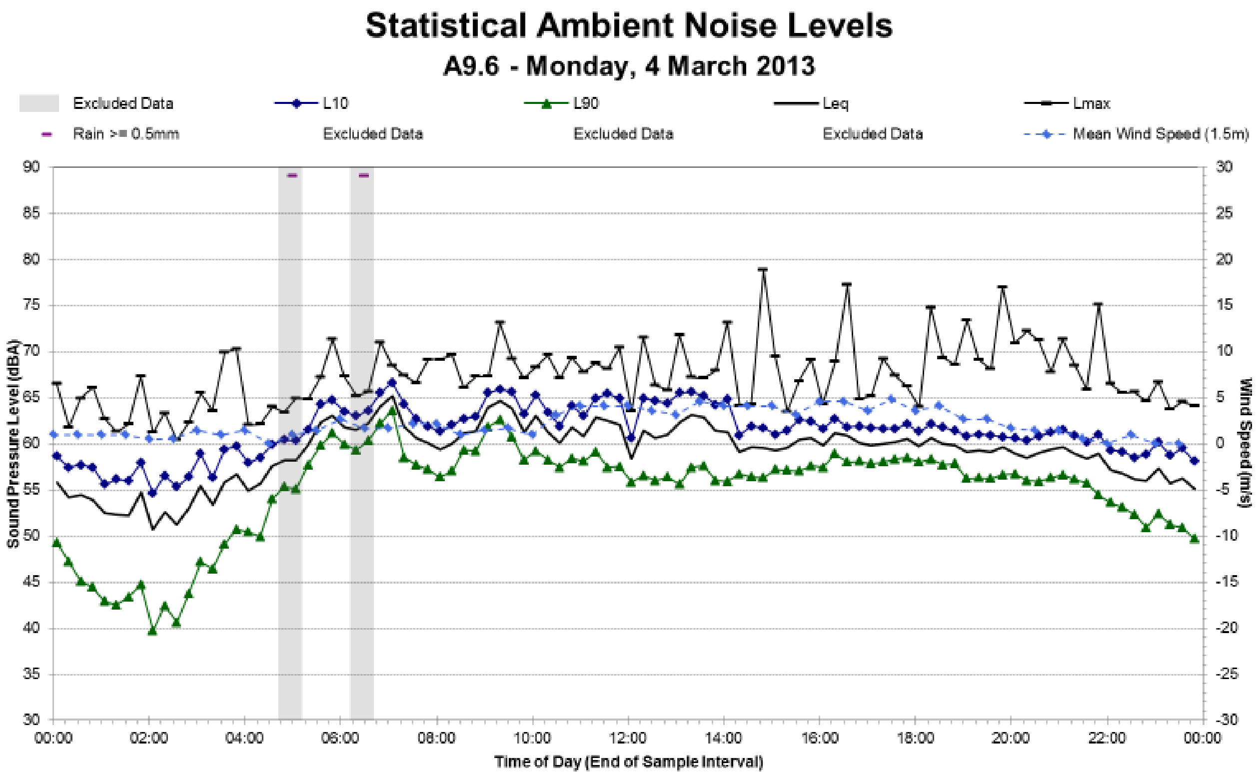
Statistical Ambient Noise Levels
A9.6 - Friday, 1 March 2013

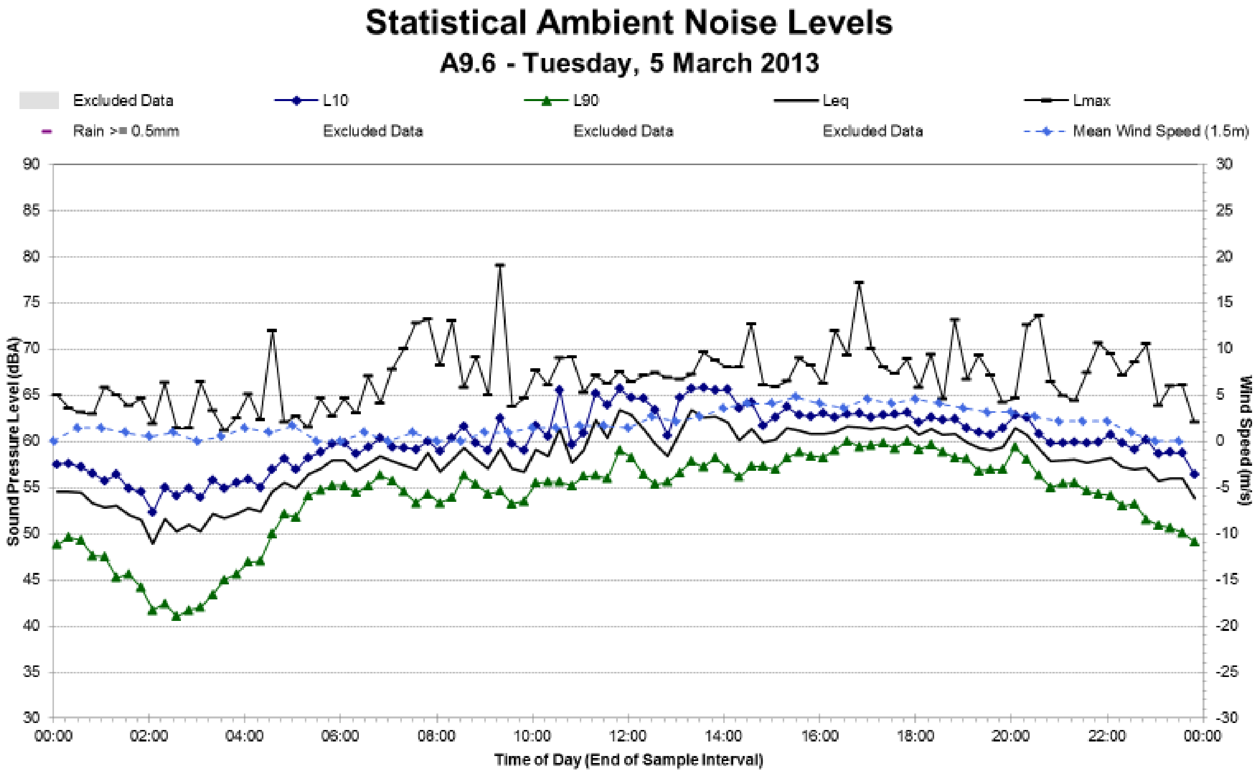


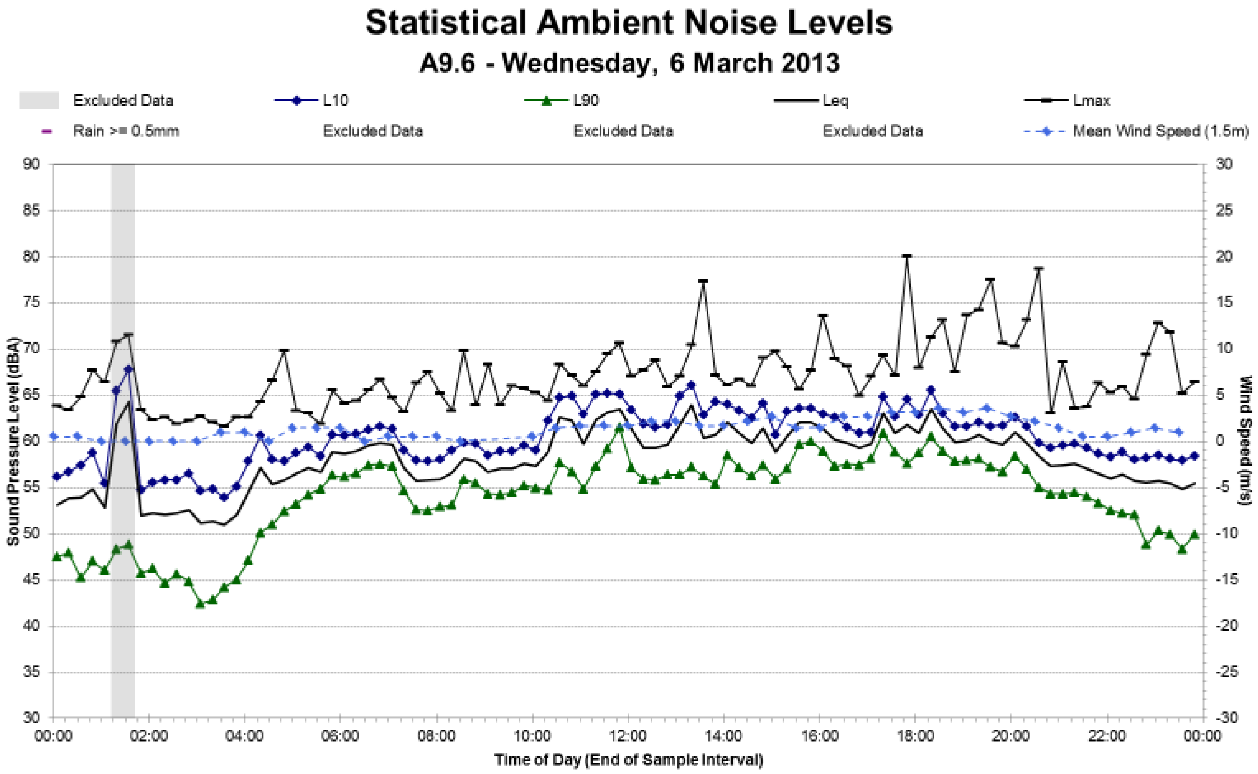
Statistical Ambient Noise Levels
A9.6 - Saturday, 2 March 2013



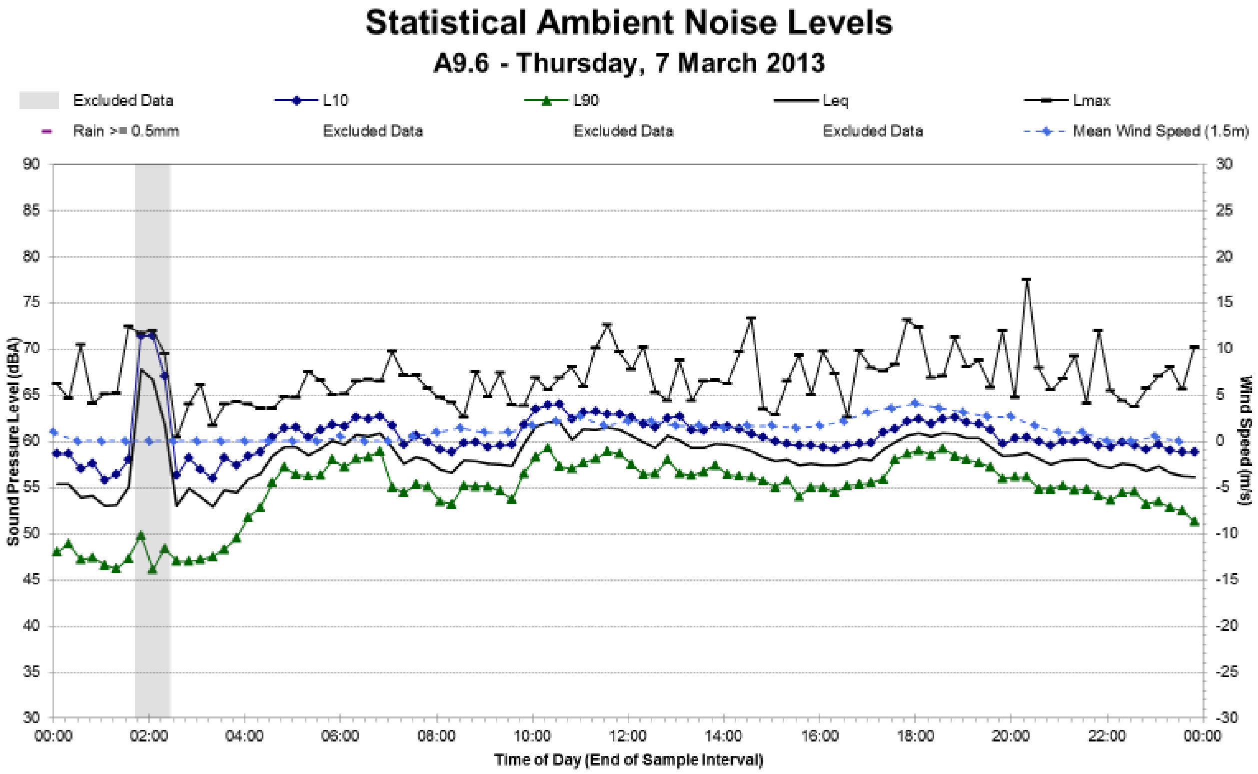

Statistical Ambient Noise Levels
A9.6 - Sunday, 3 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

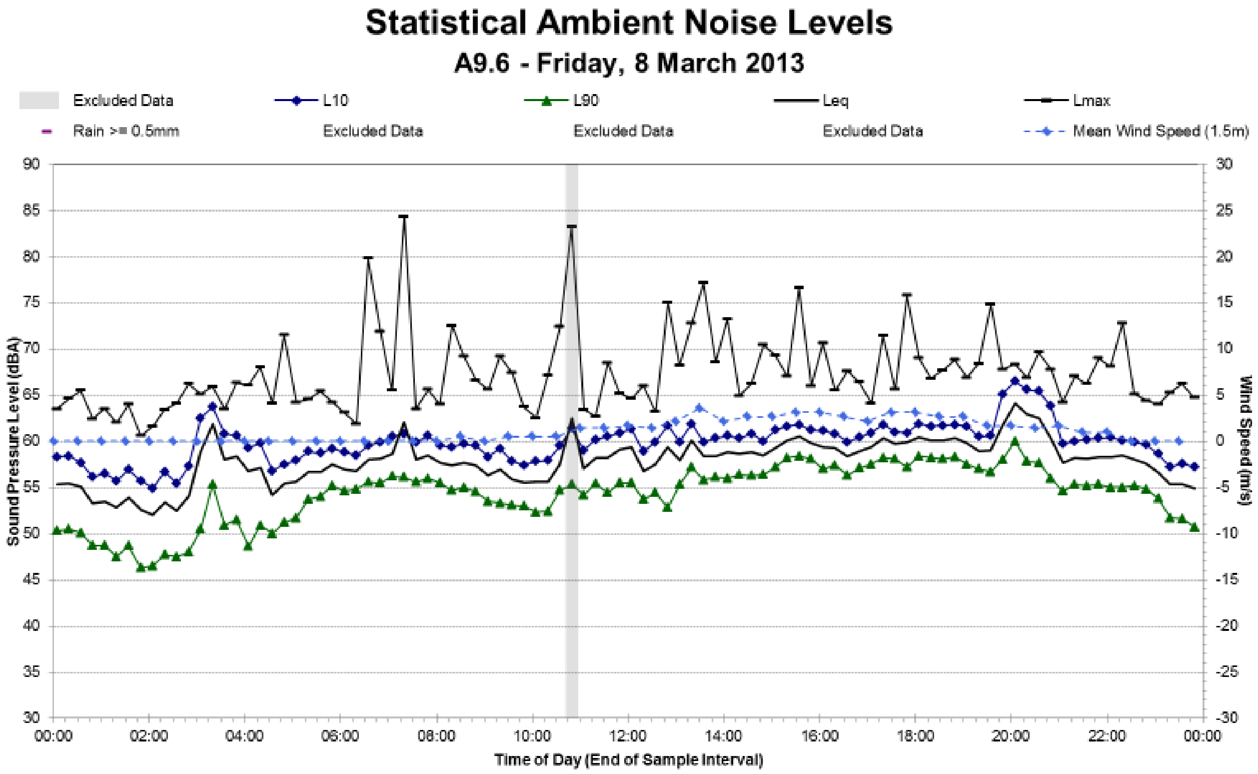

Statistical Ambient Noise Levels
A9.6 - Monday, 4 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

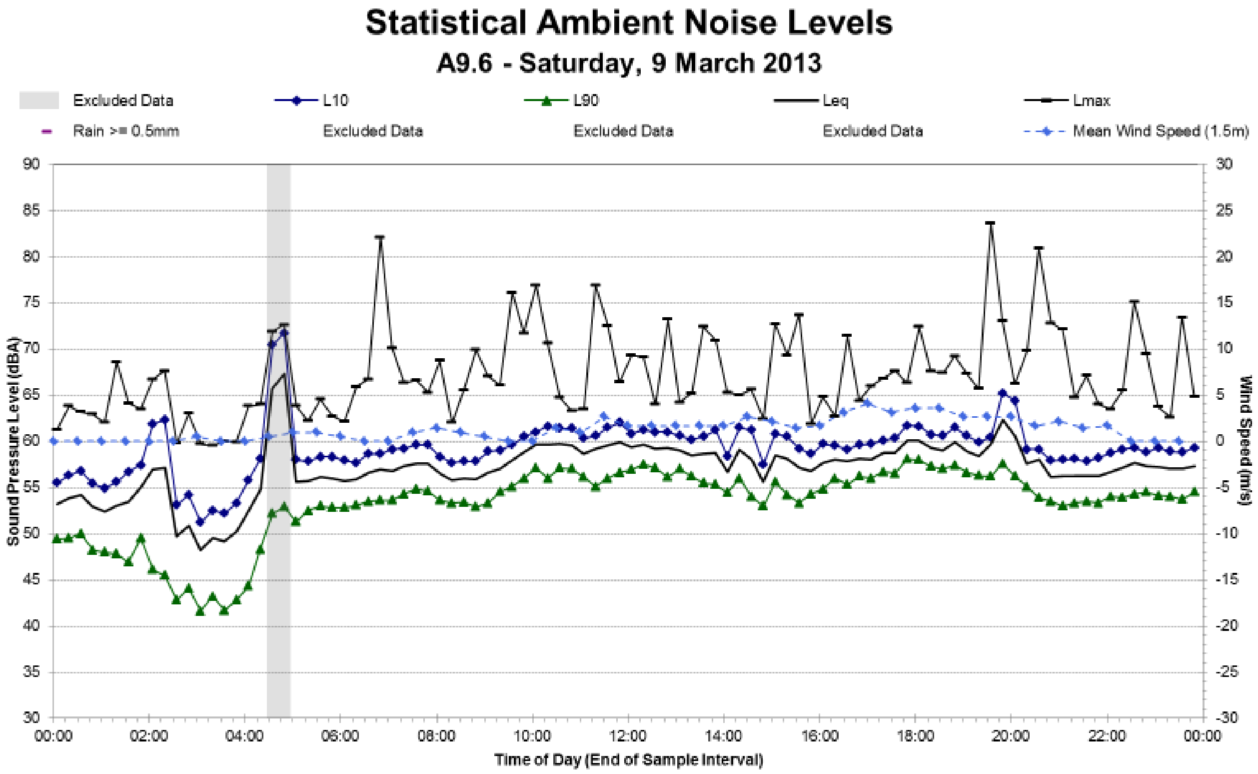

Statistical Ambient Noise Levels
A9.6 - Tuesday, 5 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

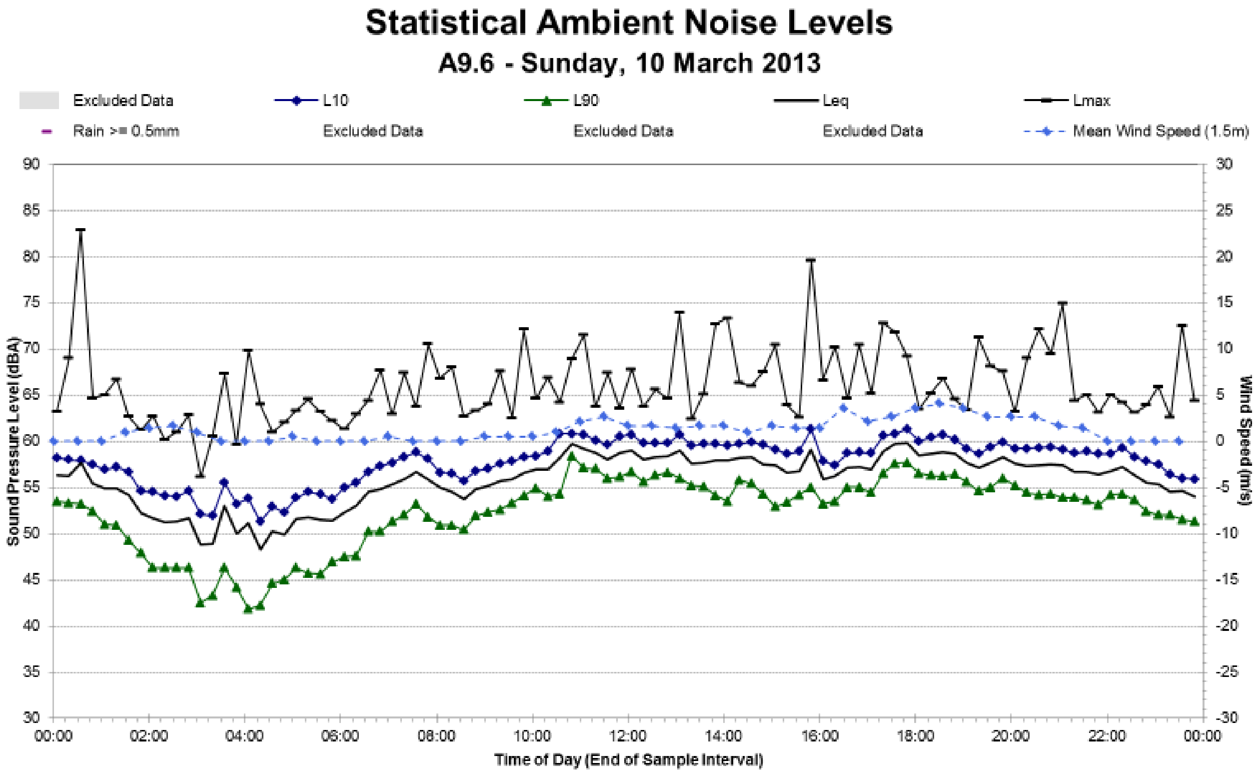

Statistical Ambient Noise Levels
A9.6 - Wednesday, 6 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A9 Ambient Noise Monitoring Results



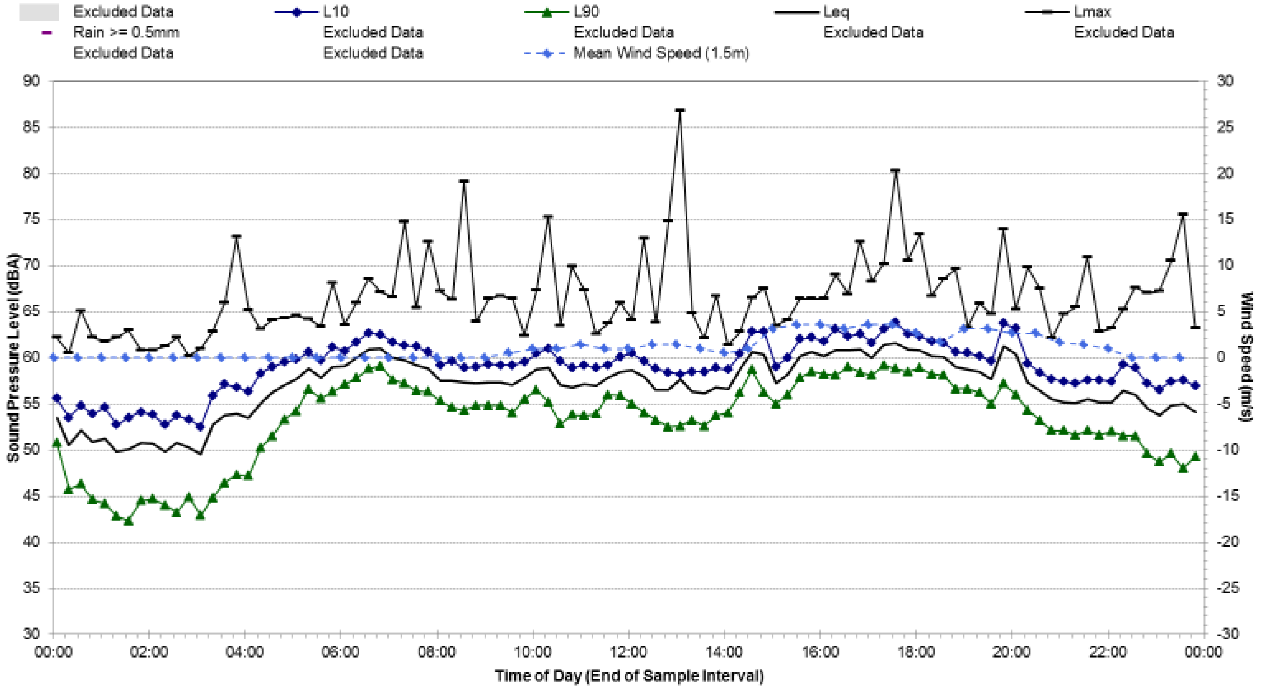



Statistical Ambient Noise Levels
A9.6 - Saturday, 9 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A9.6 - Sunday, 10 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

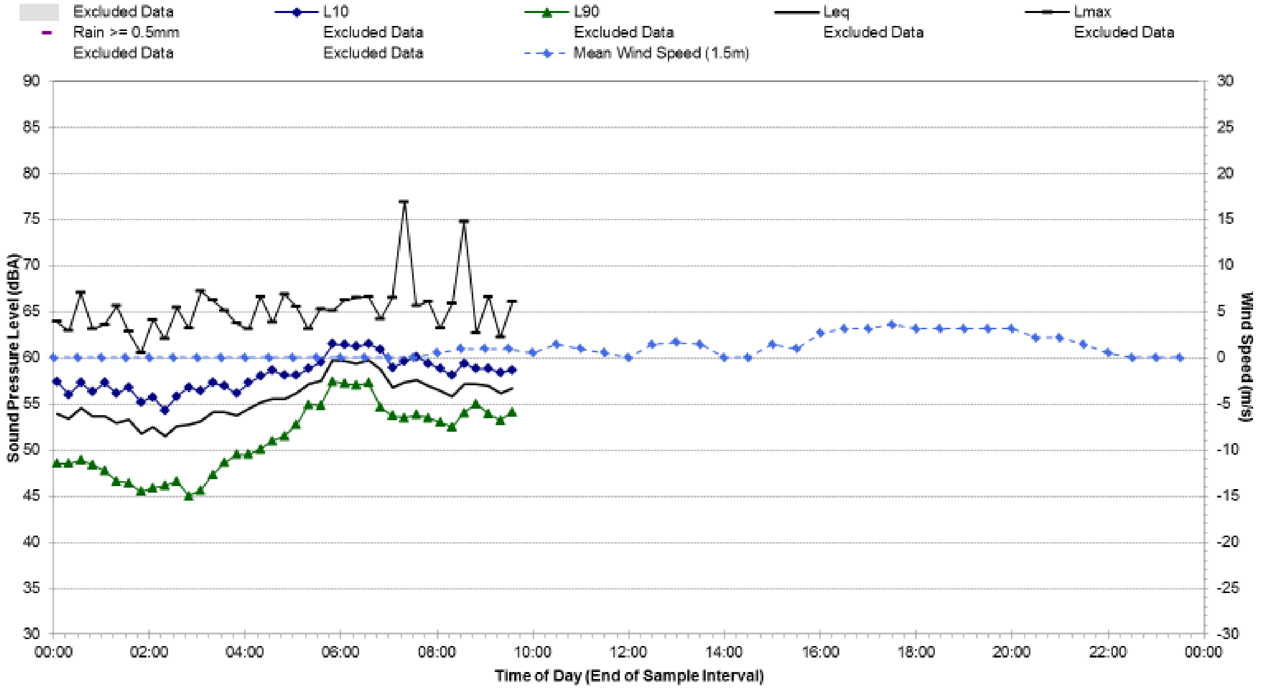
Statistical Ambient Noise Levels

A9.6 - Monday, 11 March 2013



Statistical Ambient Noise Levels

A9.6 - Tuesday, 12 March 2013



A10 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A10.1**
Noise Monitoring Address:	**27 Caines Cr, St Marys**

Logger Device Type: Svantek 957
Logger Serial No: 20673

Ambient noise logger deployed on property boundary of residential address 27 Caines Cr, St Marys.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 58-65 dBA, Light-vehicle road traffic: ~56-58 dBA, Birds: 56-67 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	**LAeq**	**L10**	**L1**
Daytime	55	59	61	64
Evening	51	57	58	61
Night-time	43	54	55	59

Ambient Noise Logging Results – RNP Defined Time Periods

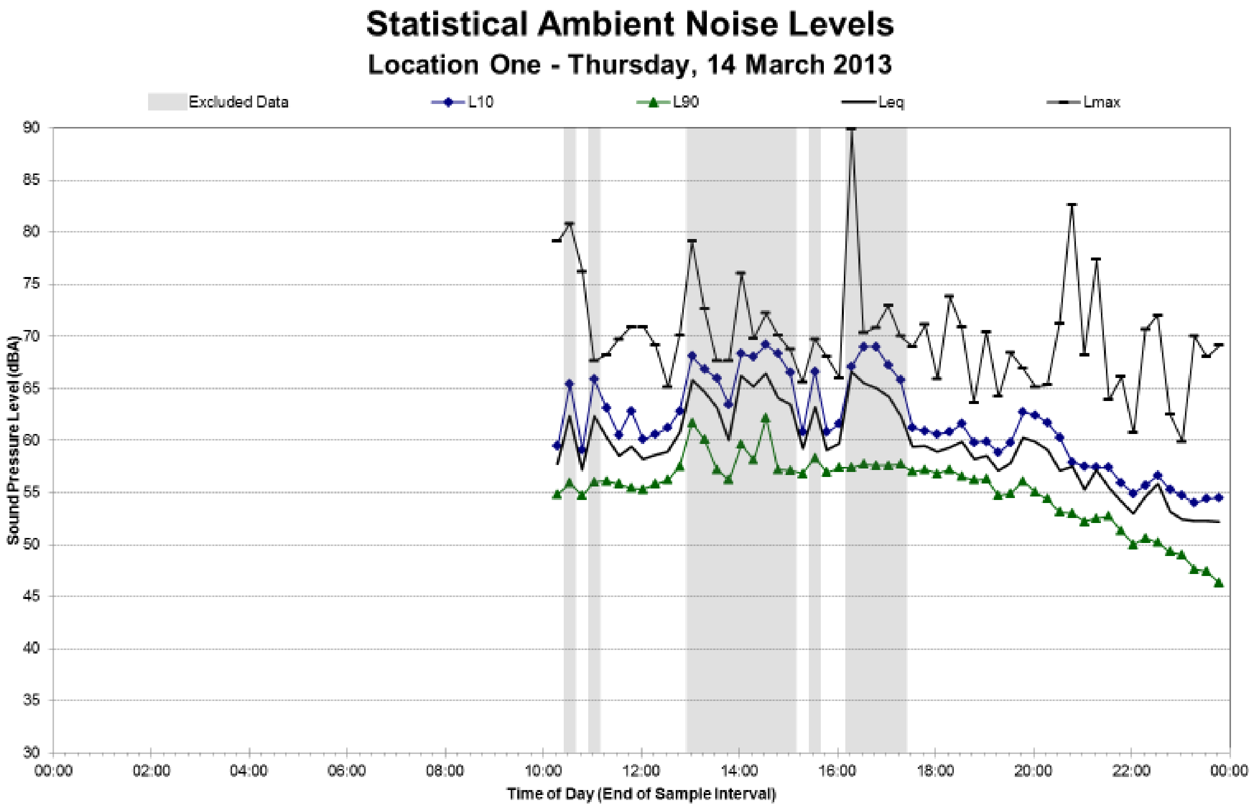
Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	6	2	N/A (7 Day Average)
Daytime (7am-10pm)	59	60	59
Night-time (10pm-7am)	54	54	54

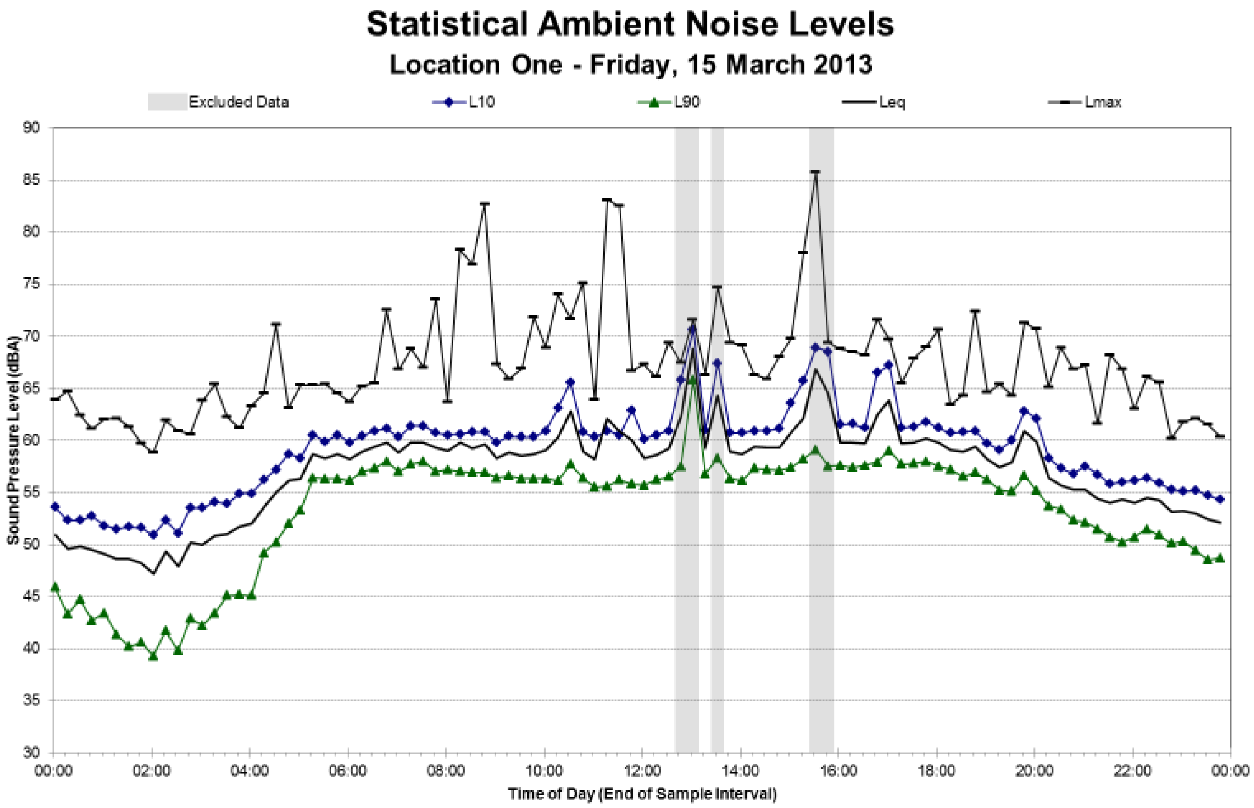
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	**LAeq**	**LAmax**
14/03/2013	09:55	55	57	67

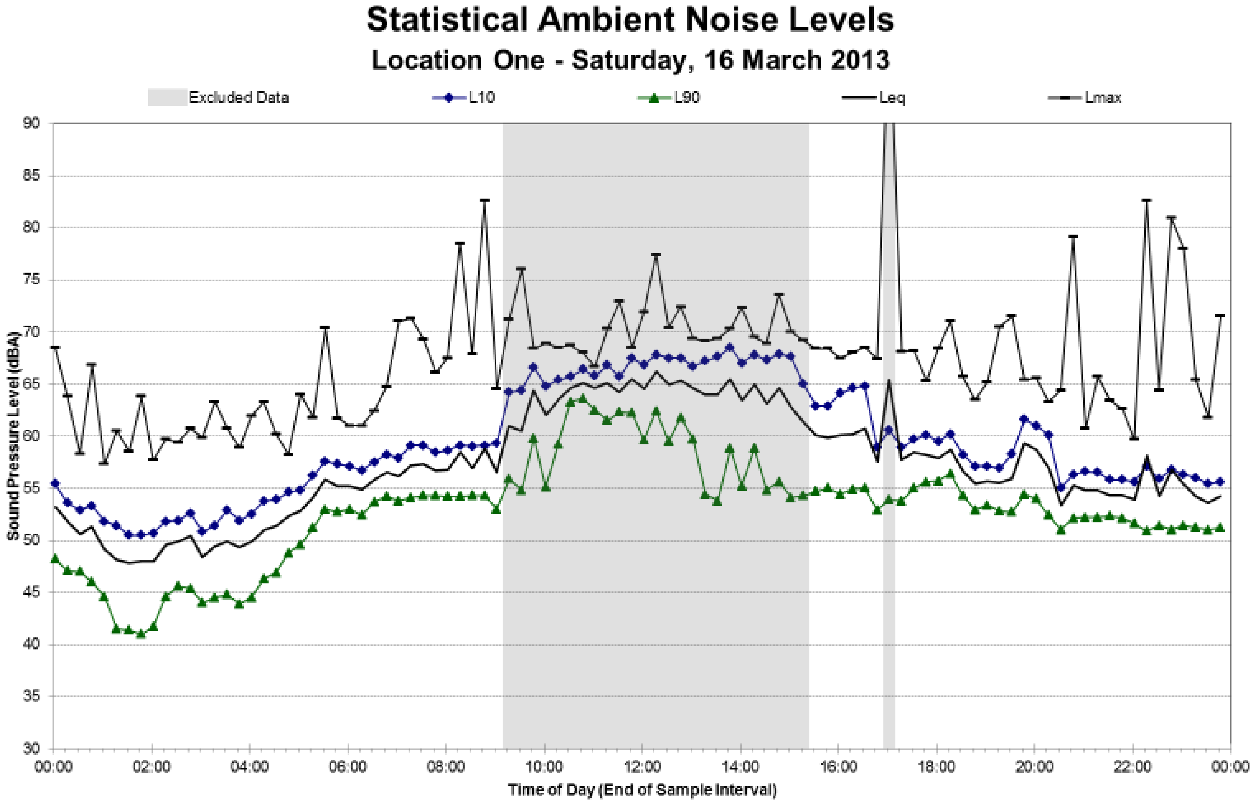
Photo of Noise Monitoring Location

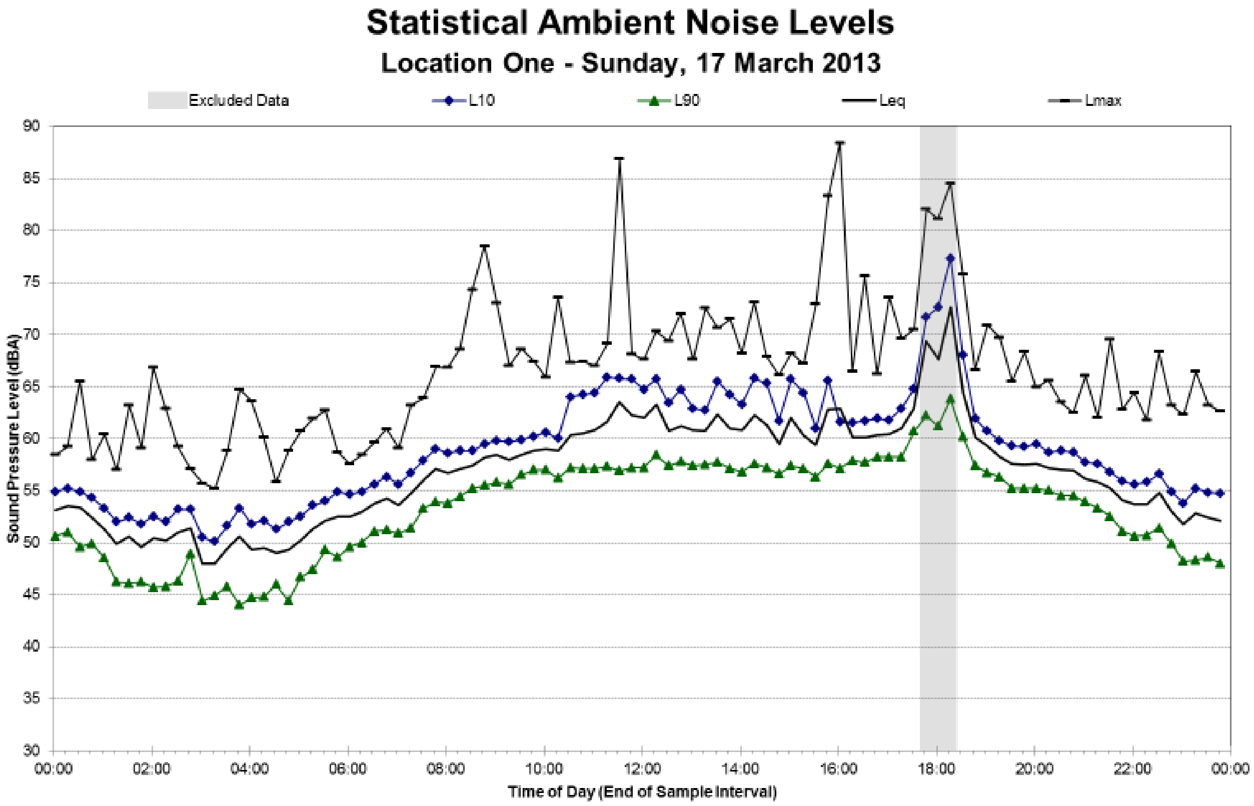
A10 Ambient Noise Monitoring Results



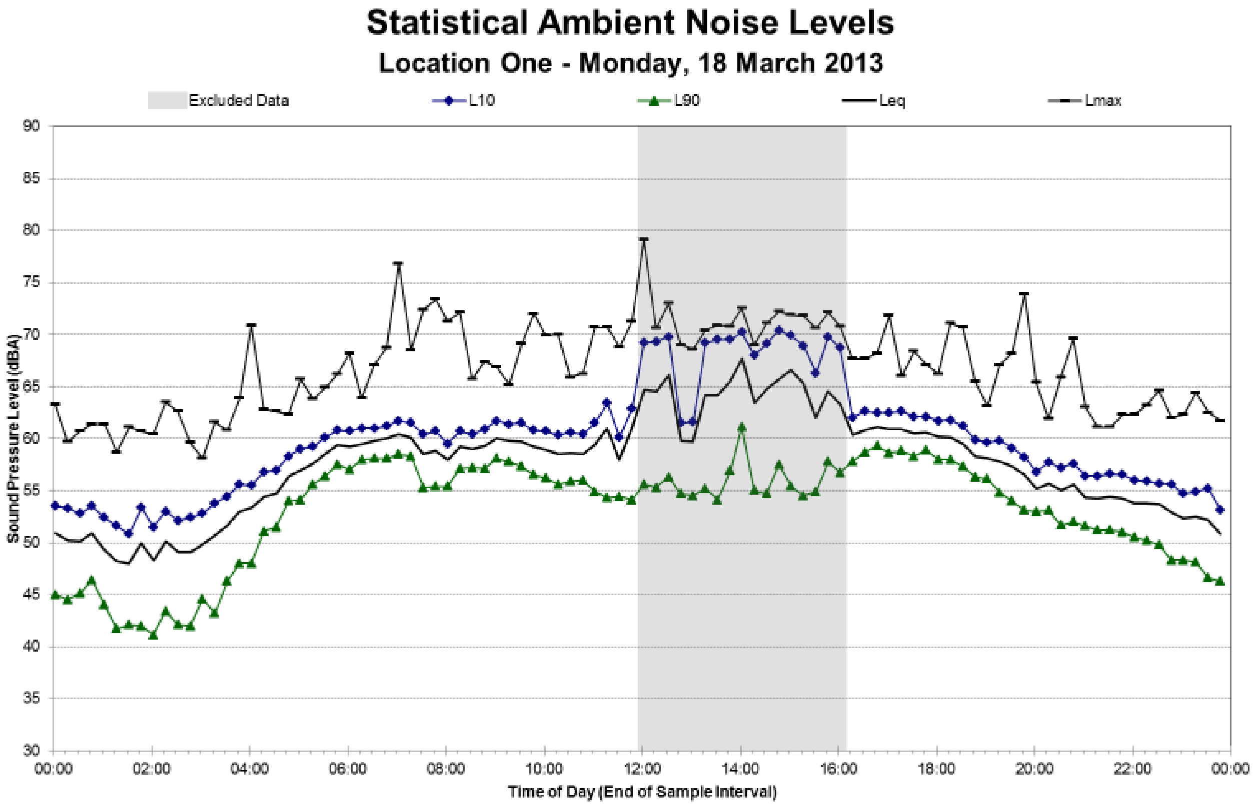


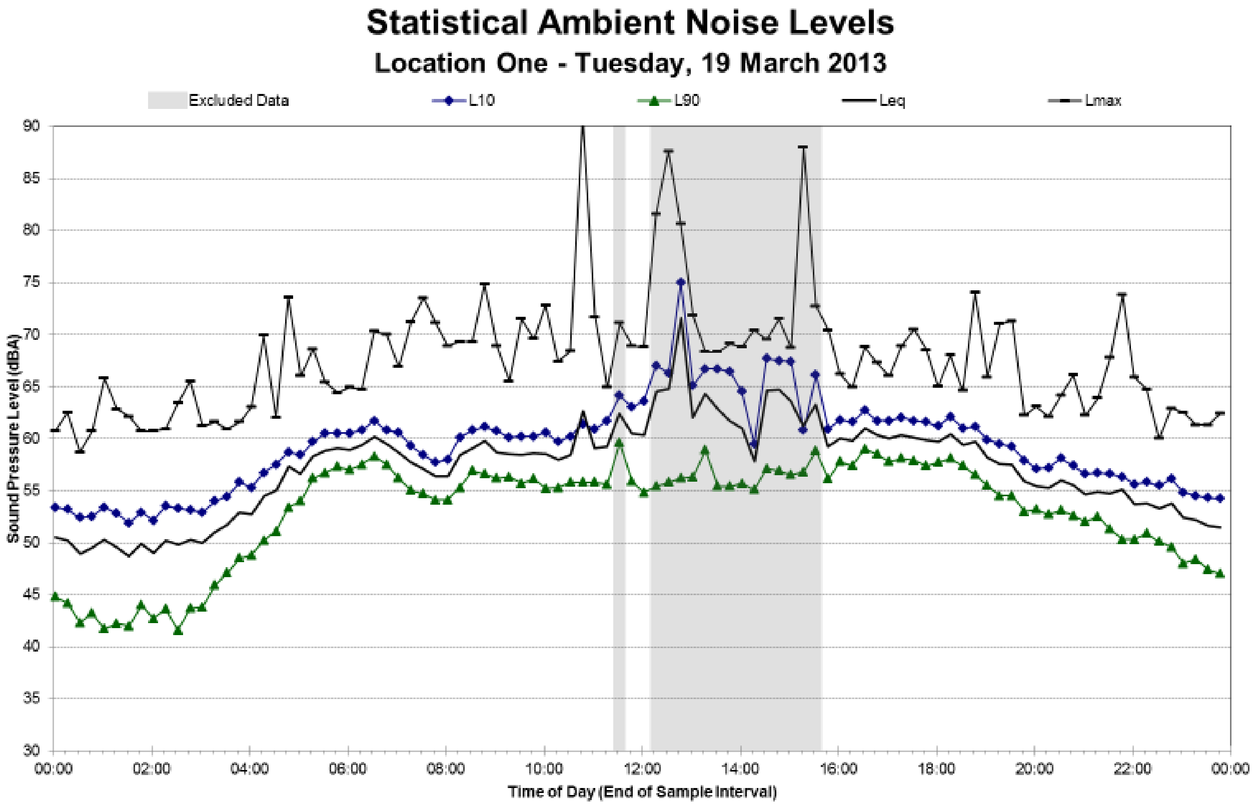
A10 Ambient Noise Monitoring Results



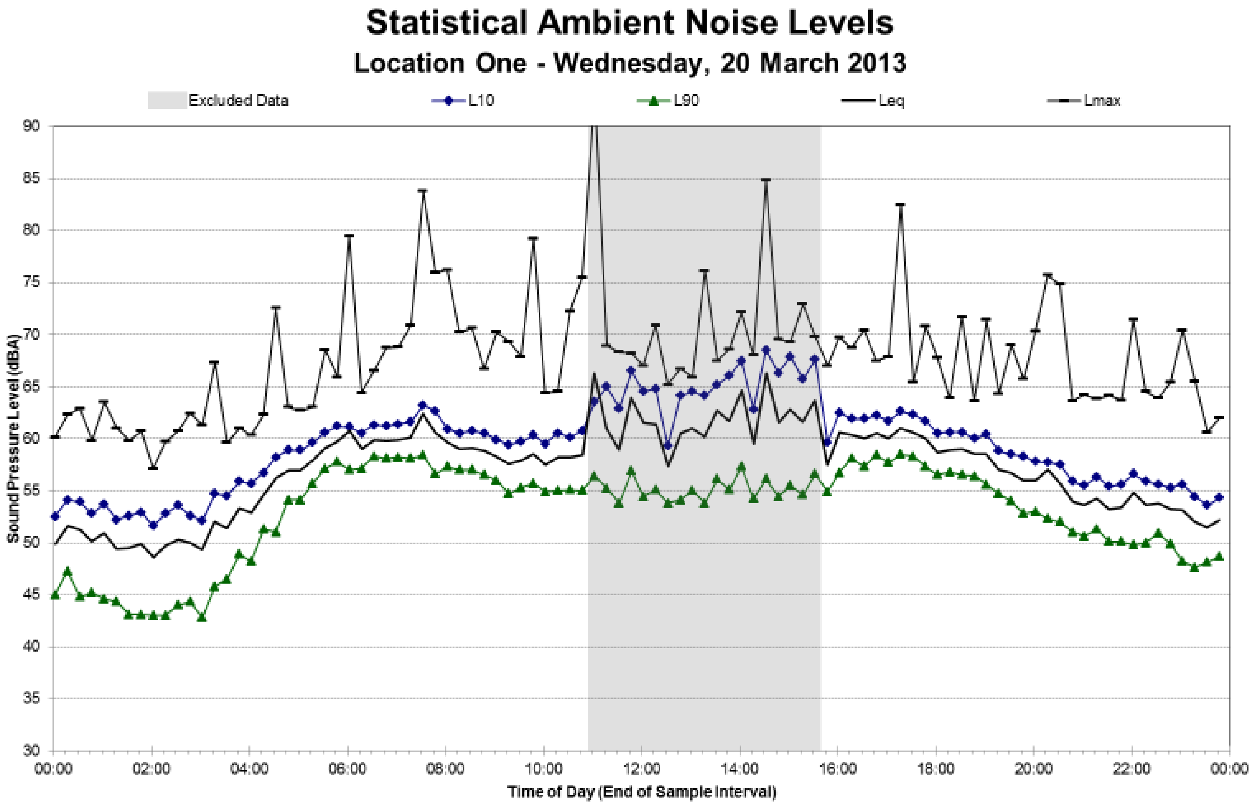


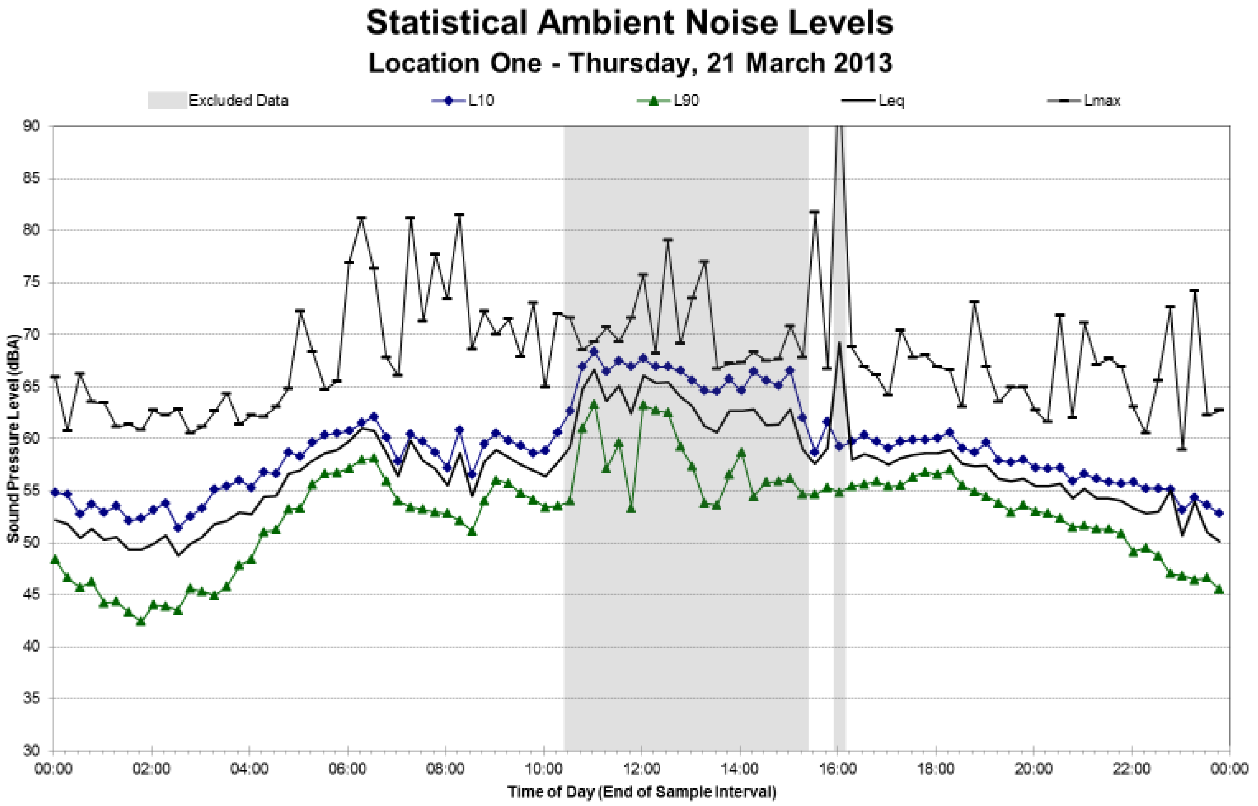
A10 Ambient Noise Monitoring Results



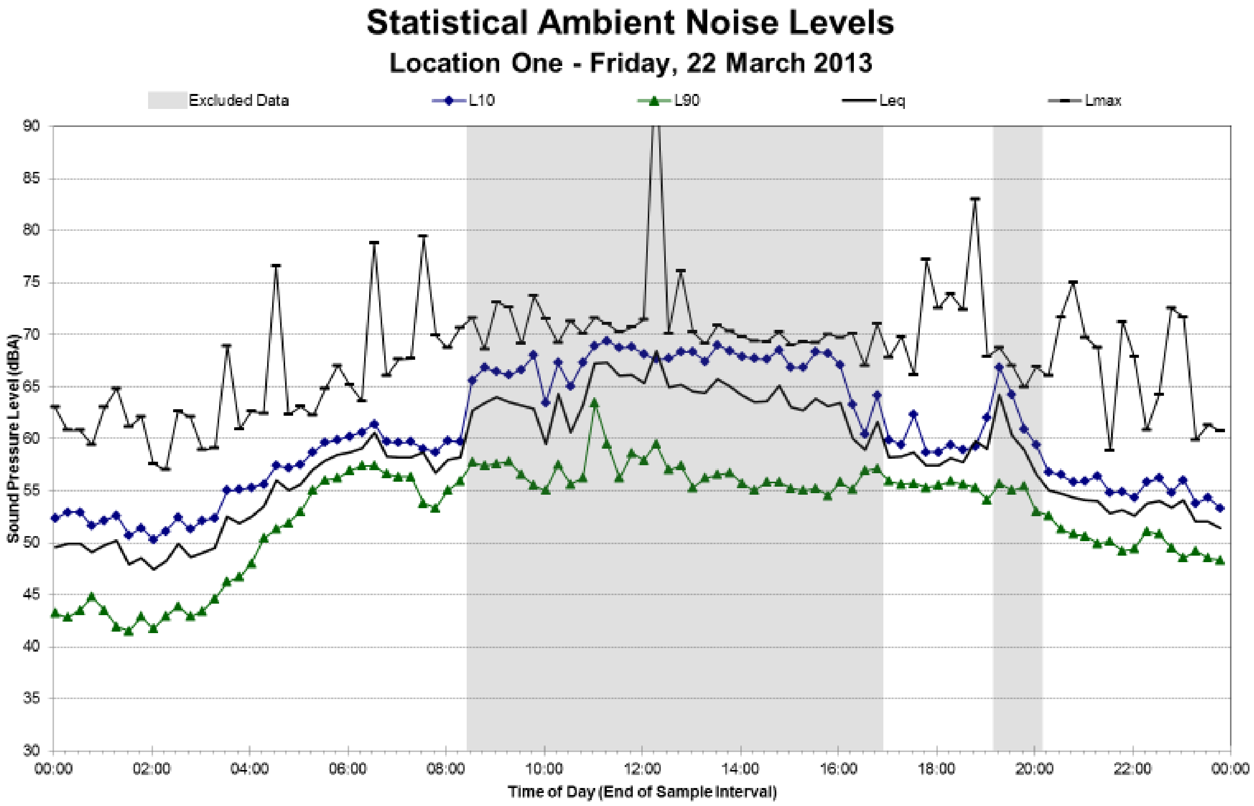


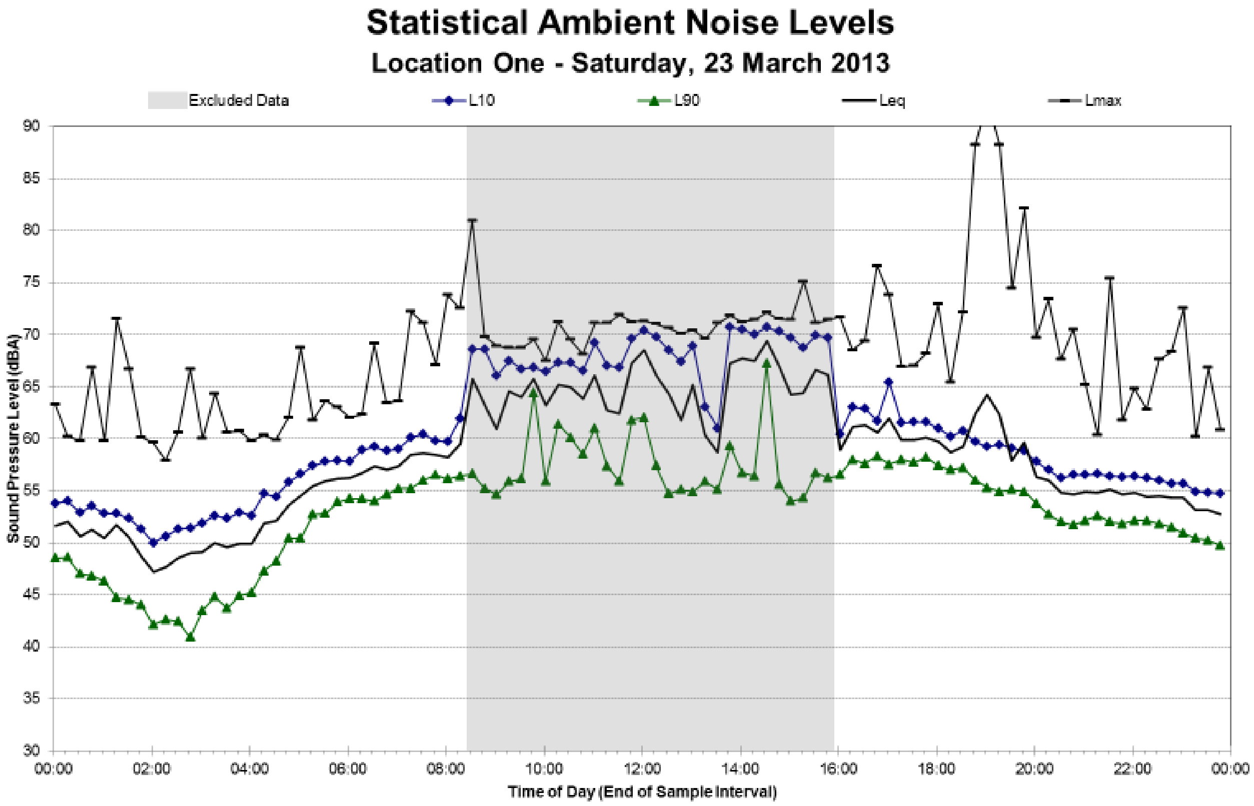
A10 Ambient Noise Monitoring Results



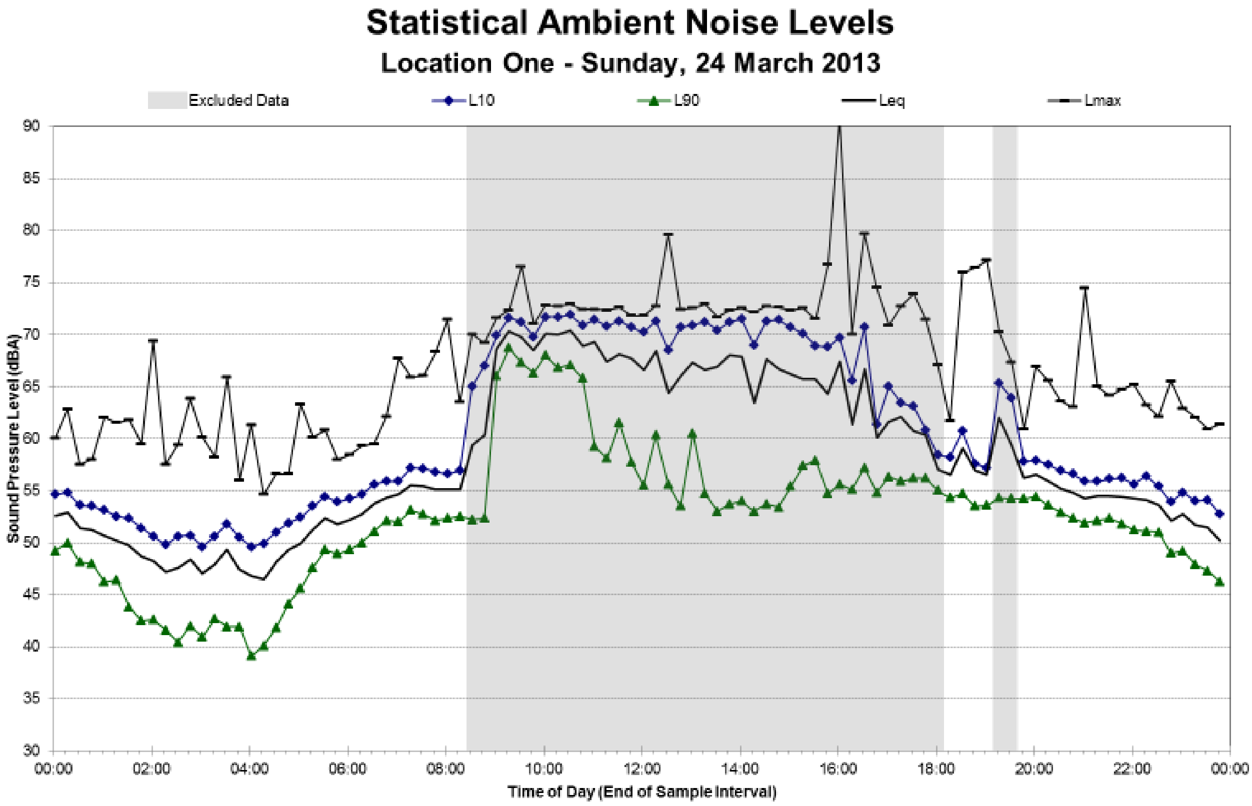


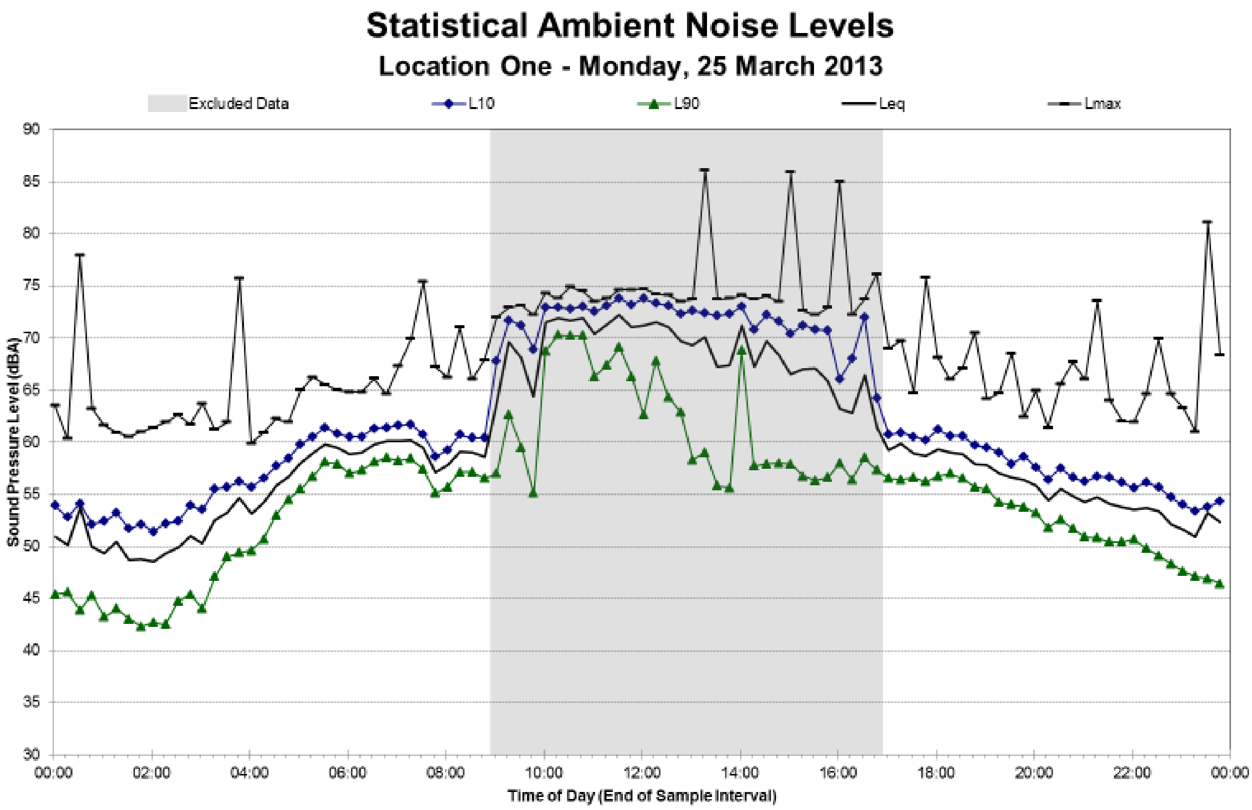
A10 Ambient Noise Monitoring Results



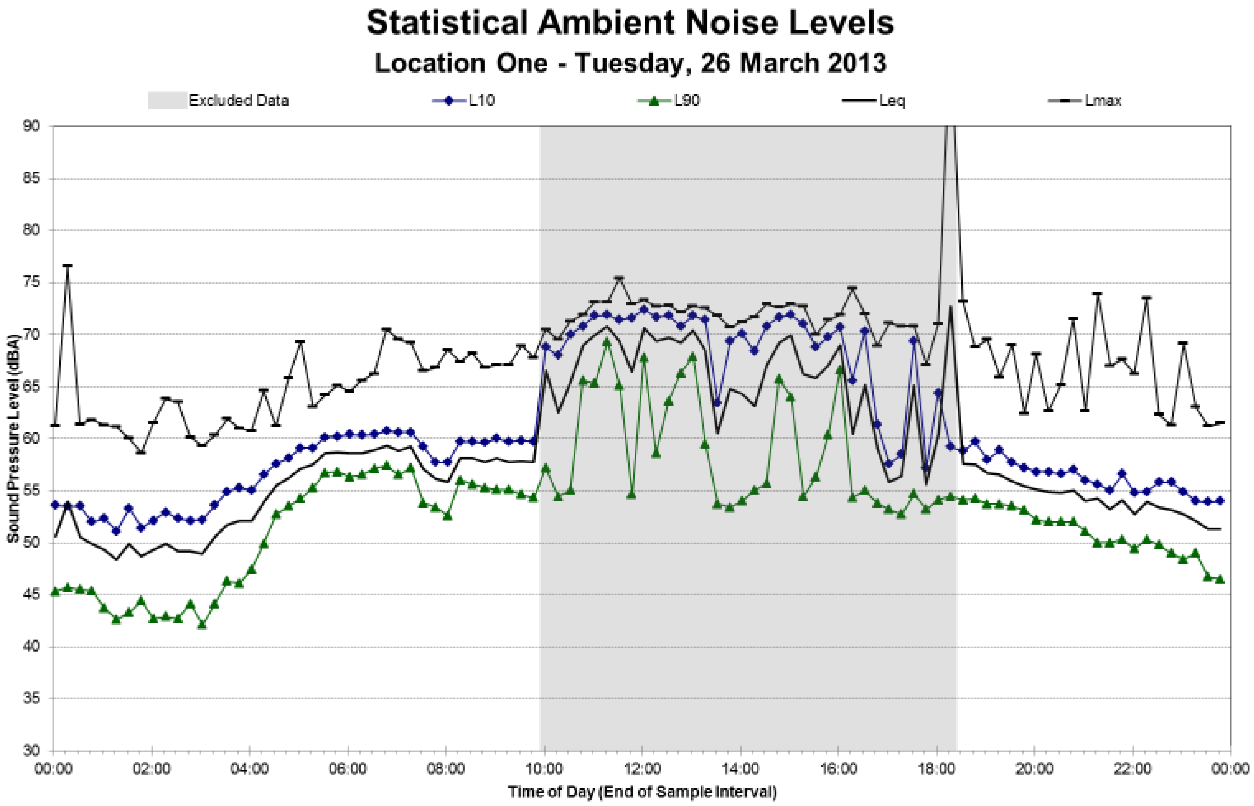


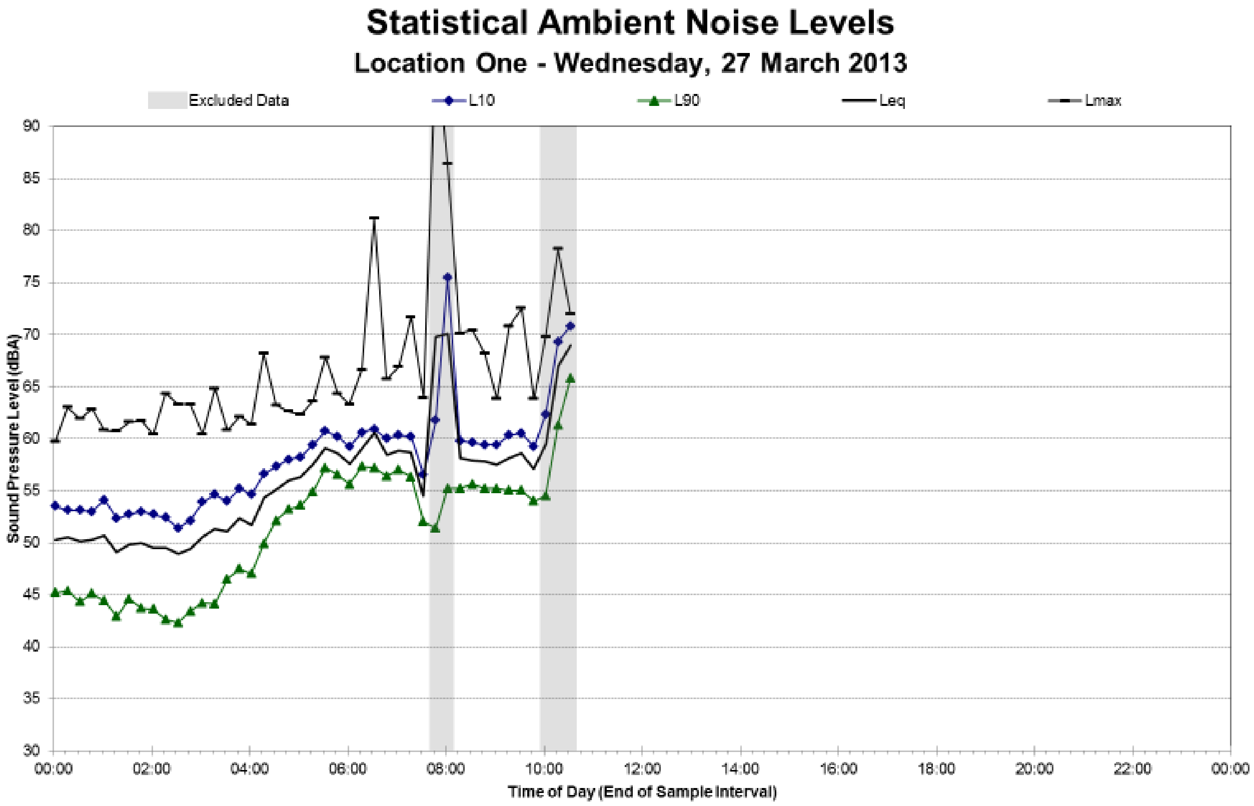
A10 Ambient Noise Monitoring Results





A10 Ambient Noise Monitoring Results





A10 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A10.2**
Noise Monitoring Address:	**29 Kunipipi St, St Clair**

Logger Device Type: Svantek 957
Logger Serial No: 20667

Ambient noise logger deployed at the rear of residential property at address 29 Kunipipi St, St Clair.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated. Road traffic noise from the west-bound off-ramp contributes to peak levels.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 56-68 dBA, Light-vehicle road traffic: ~51-58 dBA, Air traffic: 54 dBA, Dog bark: 75 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	49	55	57	63
Evening	46	53	54	59
Night-time	39	50	51	56

Ambient Noise Logging Results – RNP Defined Time Periods

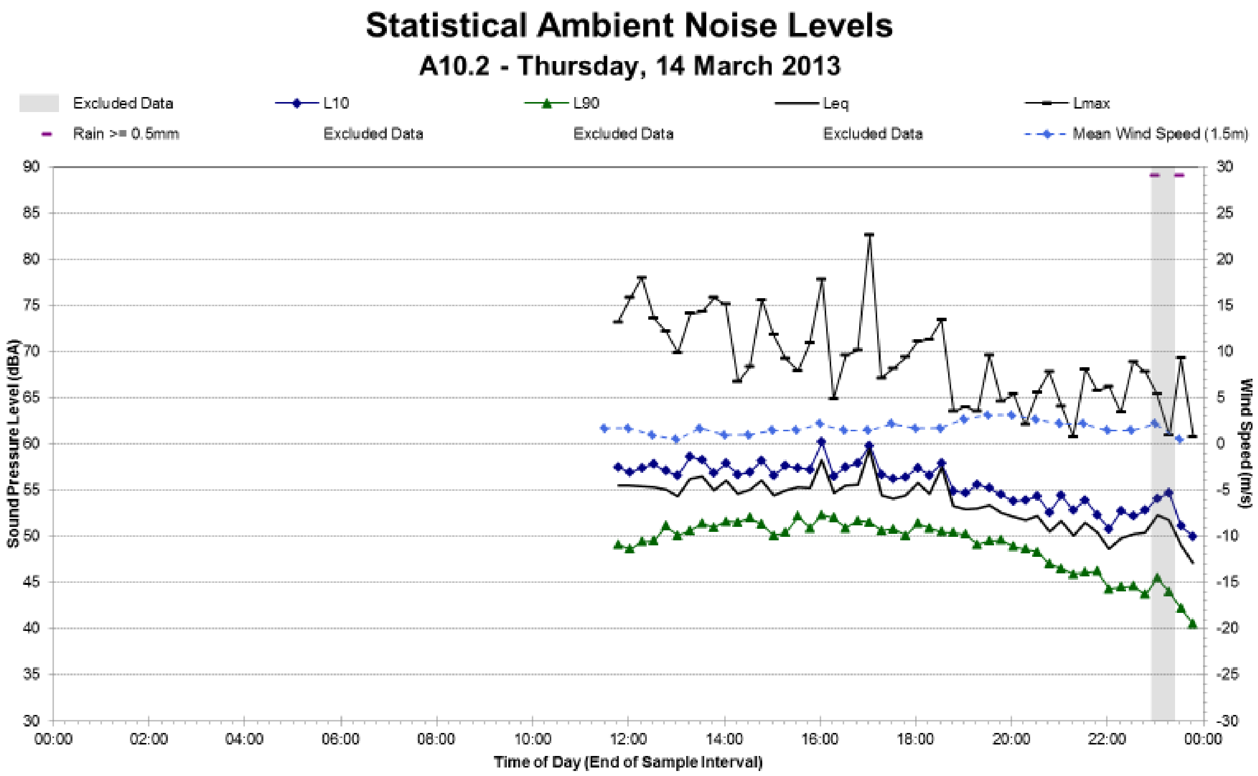
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	8	4	N/A (7 Day Average)
Daytime (7am-10pm)	55	54	55
Night-time (10pm-7am)	51	50	50

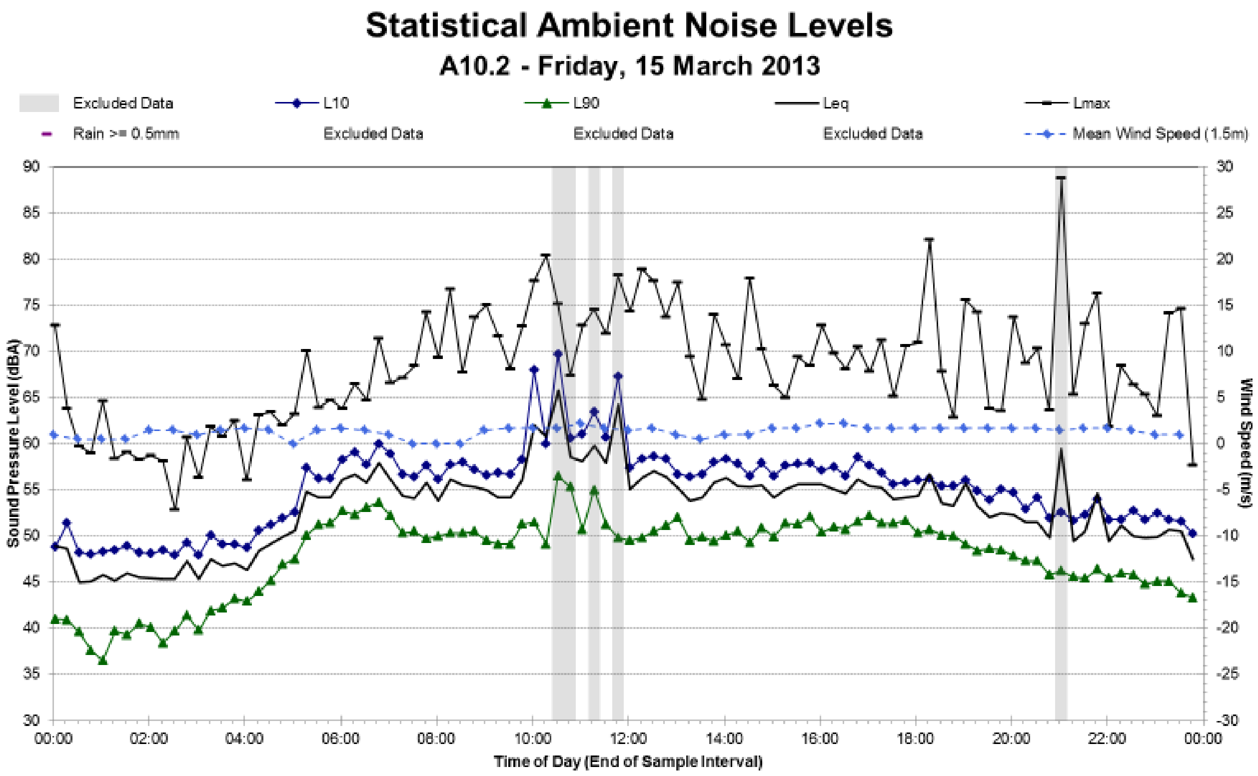
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
14/03/2013	11:05	49	54	75

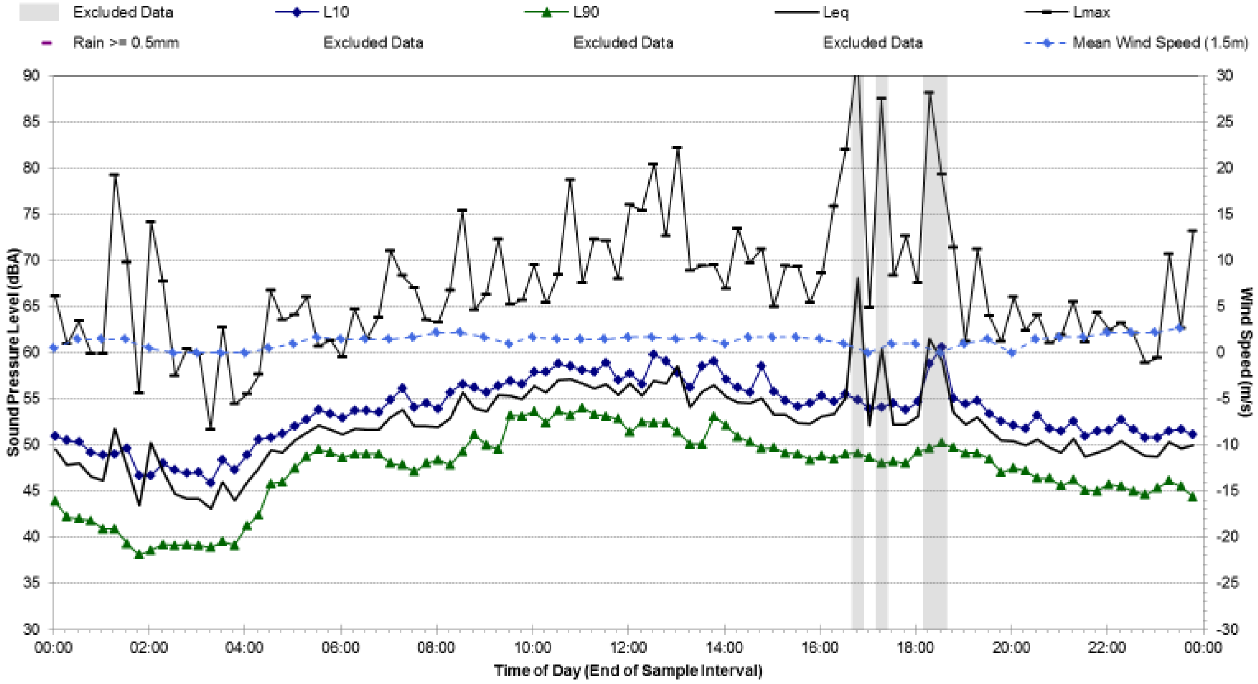
Photo of Noise Monitoring Location

A10 Ambient Noise Monitoring Results

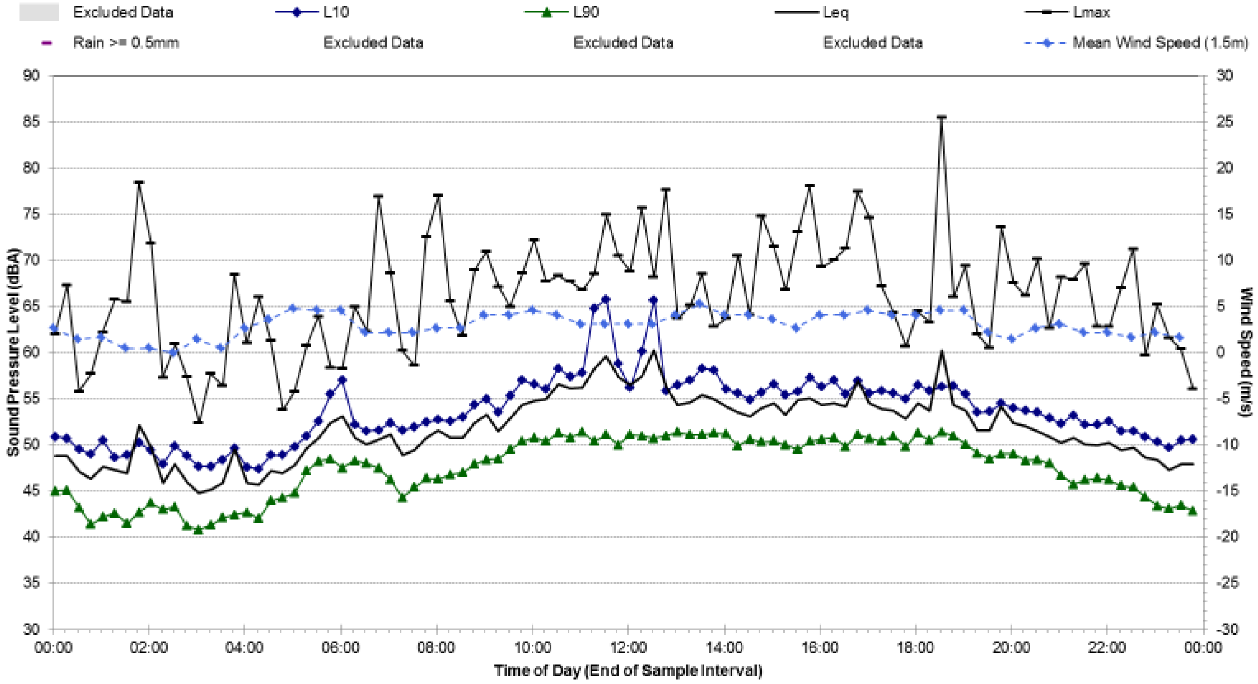


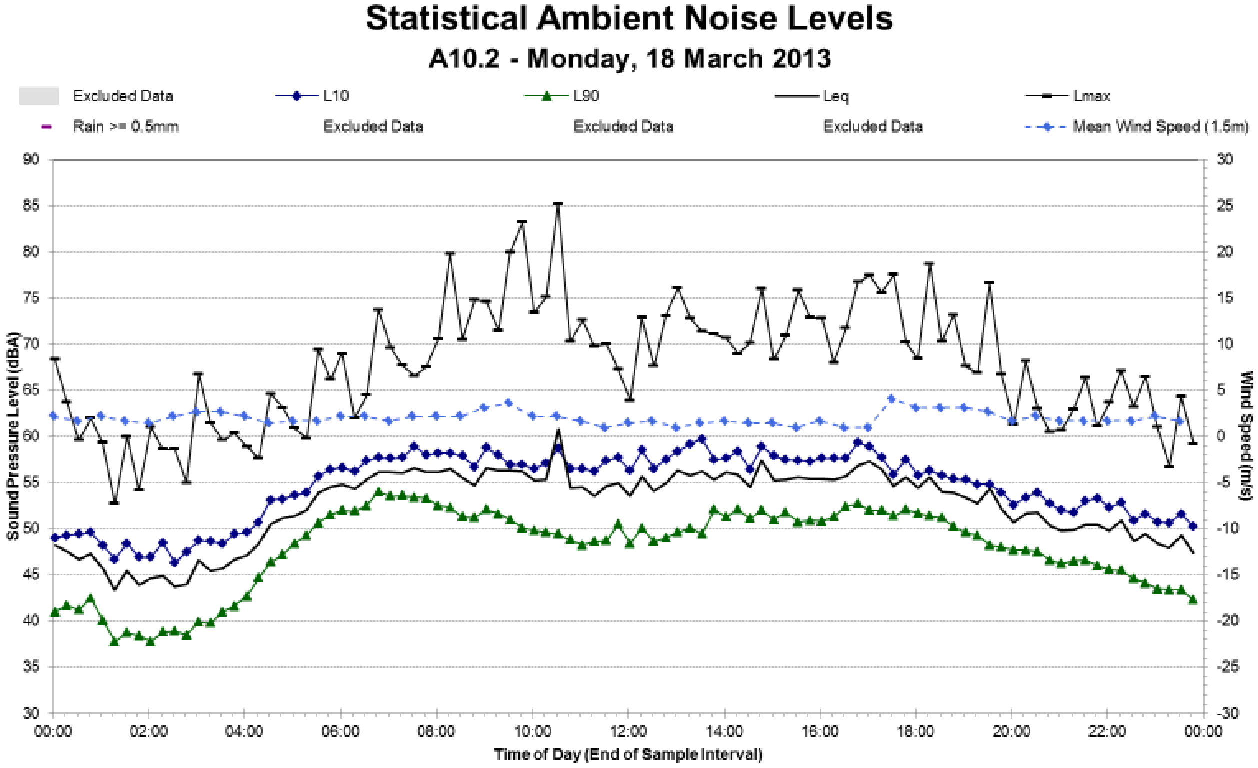


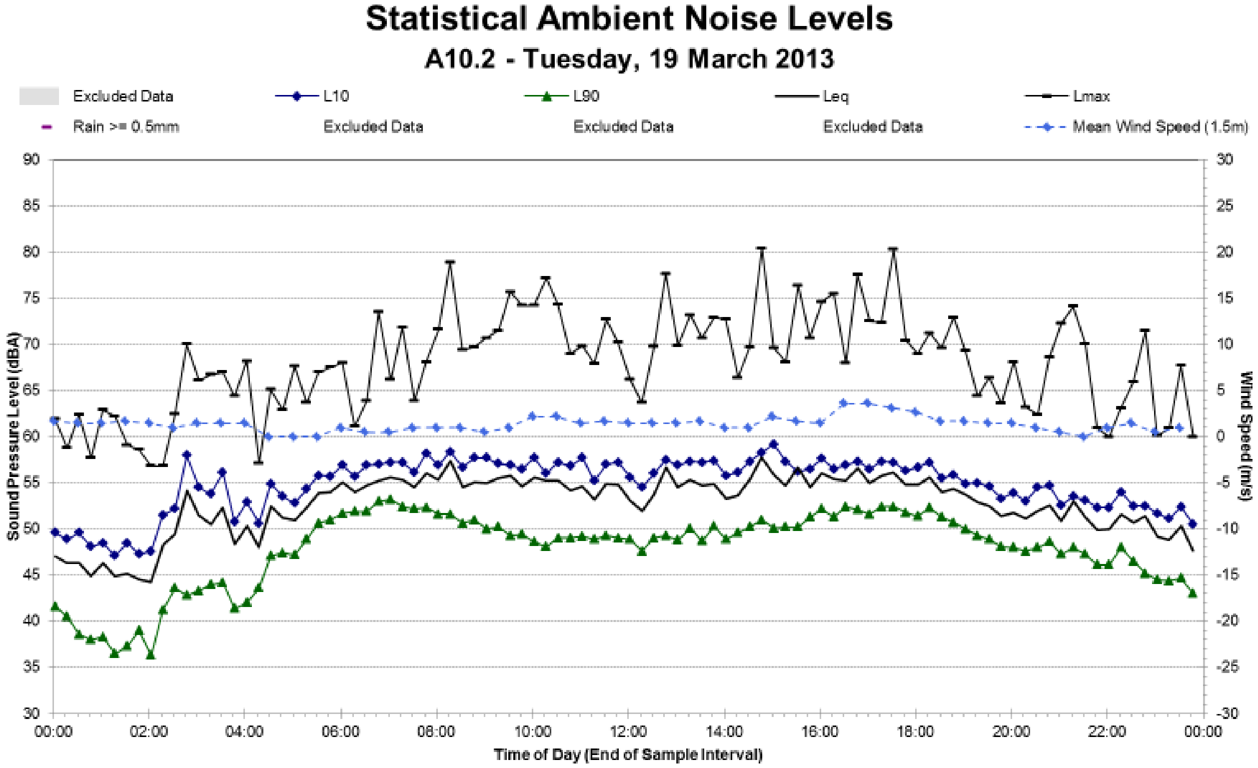
Statistical Ambient Noise Levels
A10.2 - Saturday, 16 March 2013

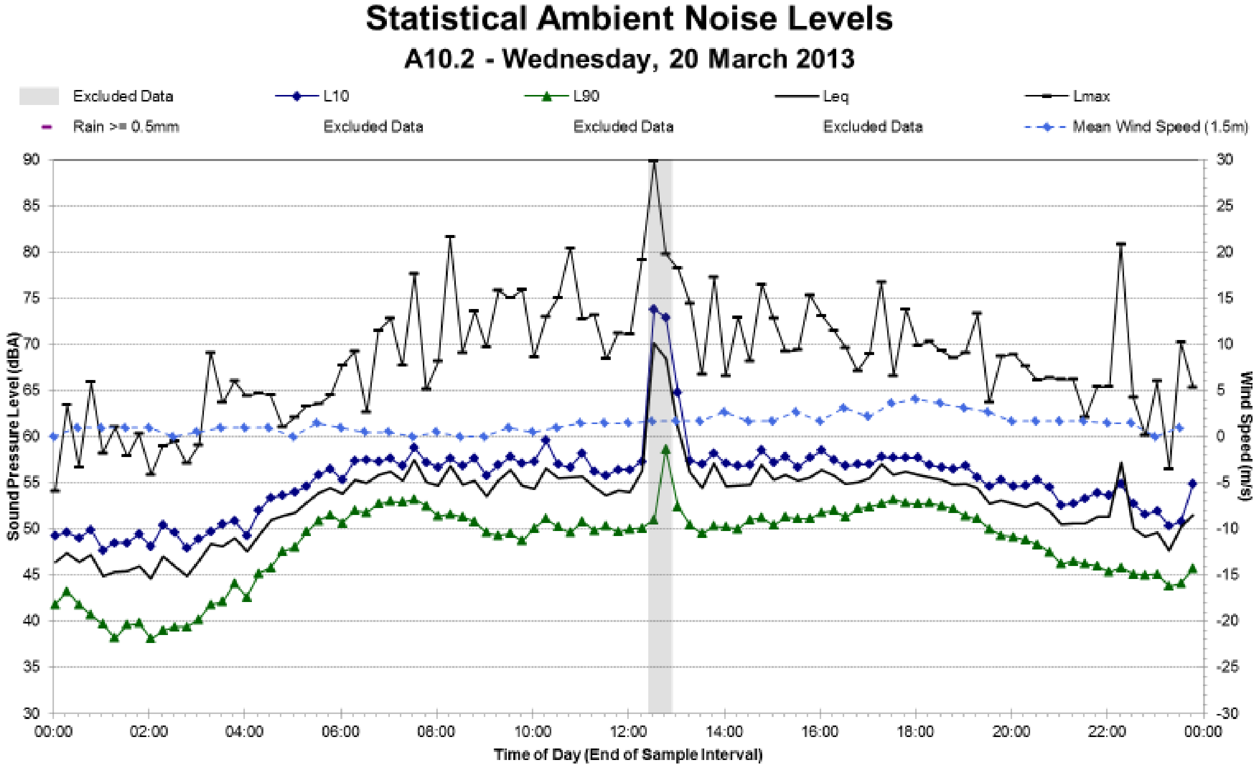


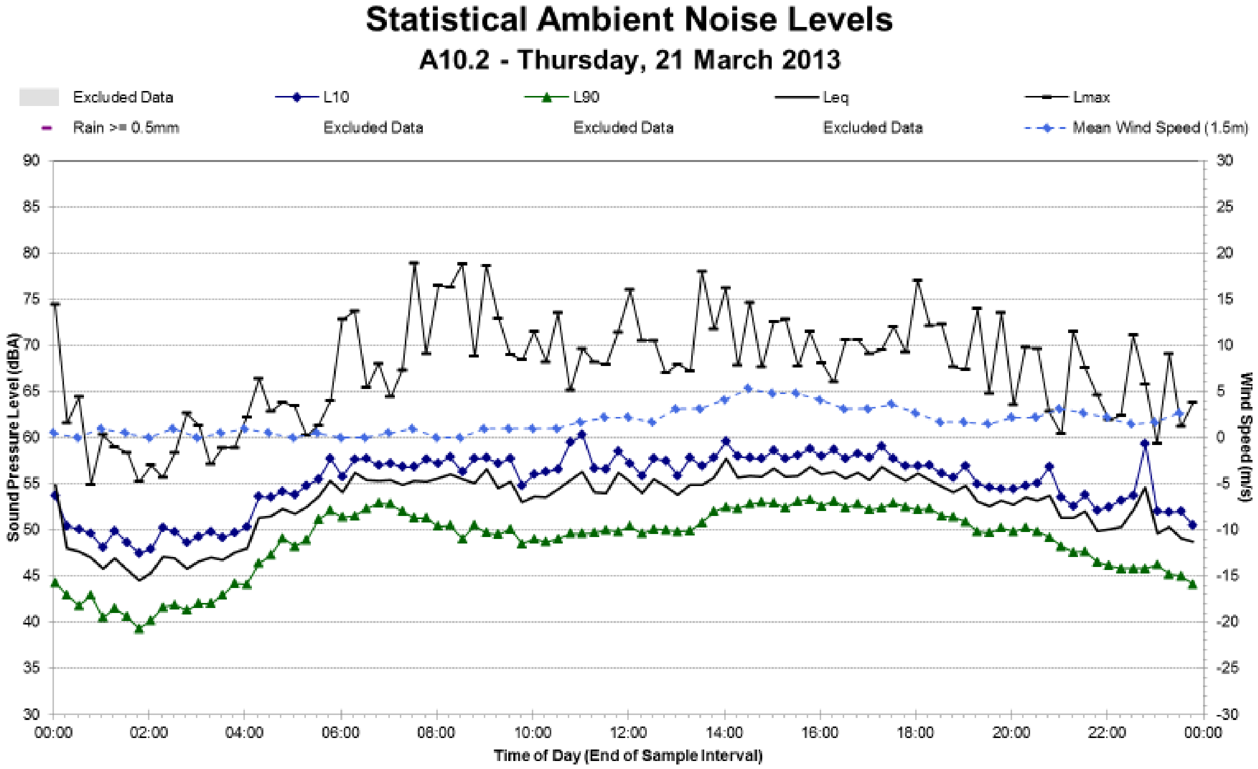
Statistical Ambient Noise Levels
A10.2 - Sunday, 17 March 2013

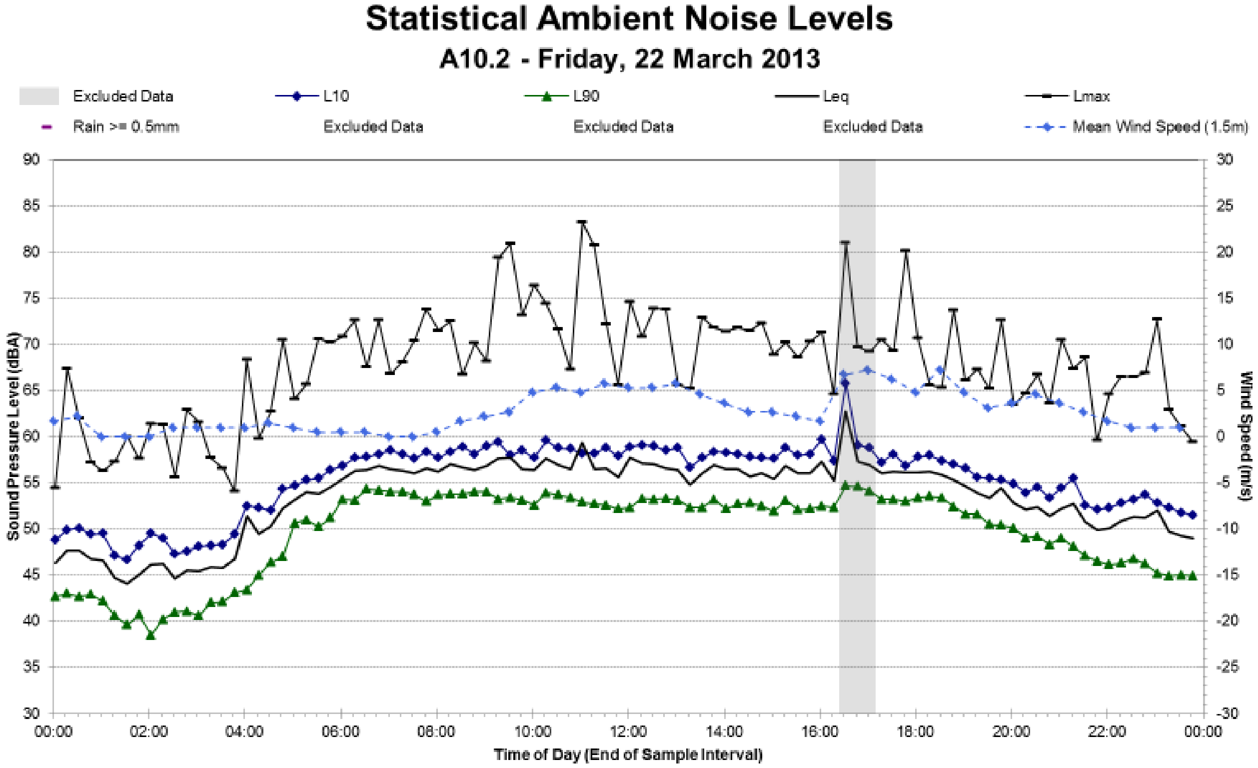



Statistical Ambient Noise Levels
A10.2 - Monday, 18 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

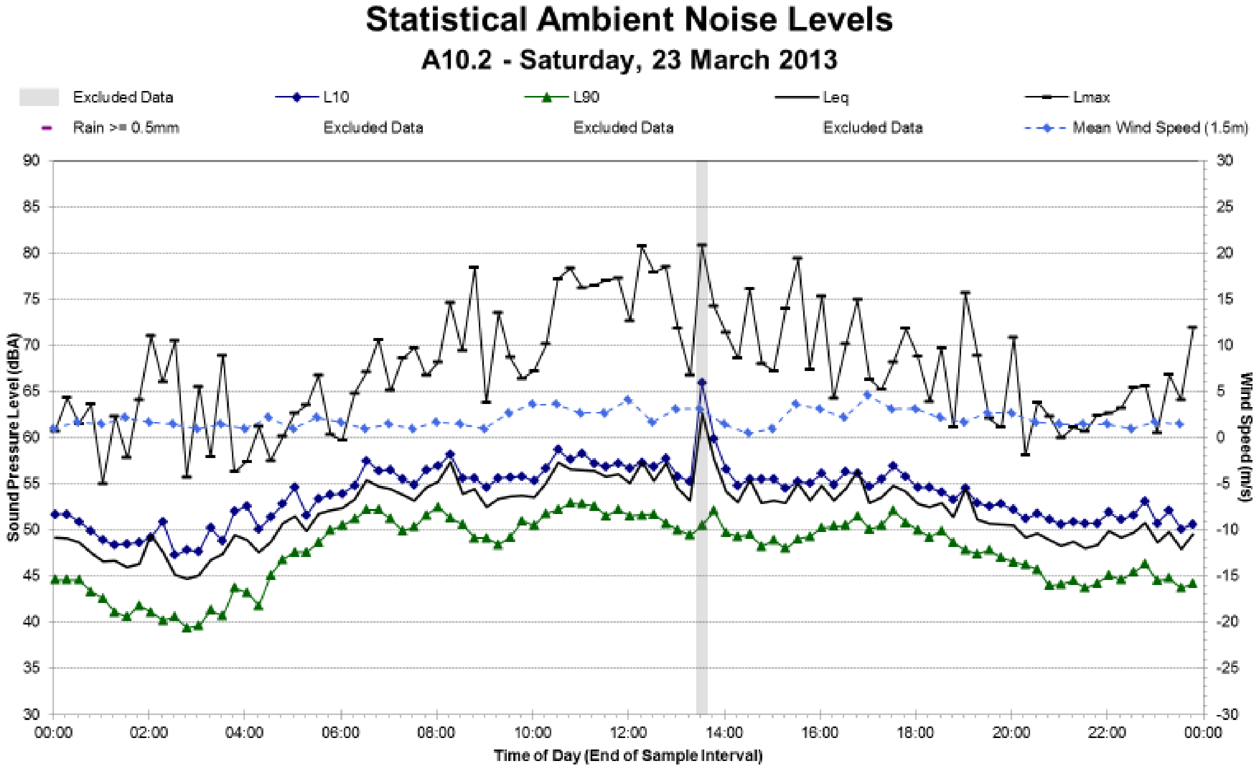

Statistical Ambient Noise Levels
A10.2 - Tuesday, 19 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A10.2 - Wednesday, 20 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A10.2 - Thursday, 21 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

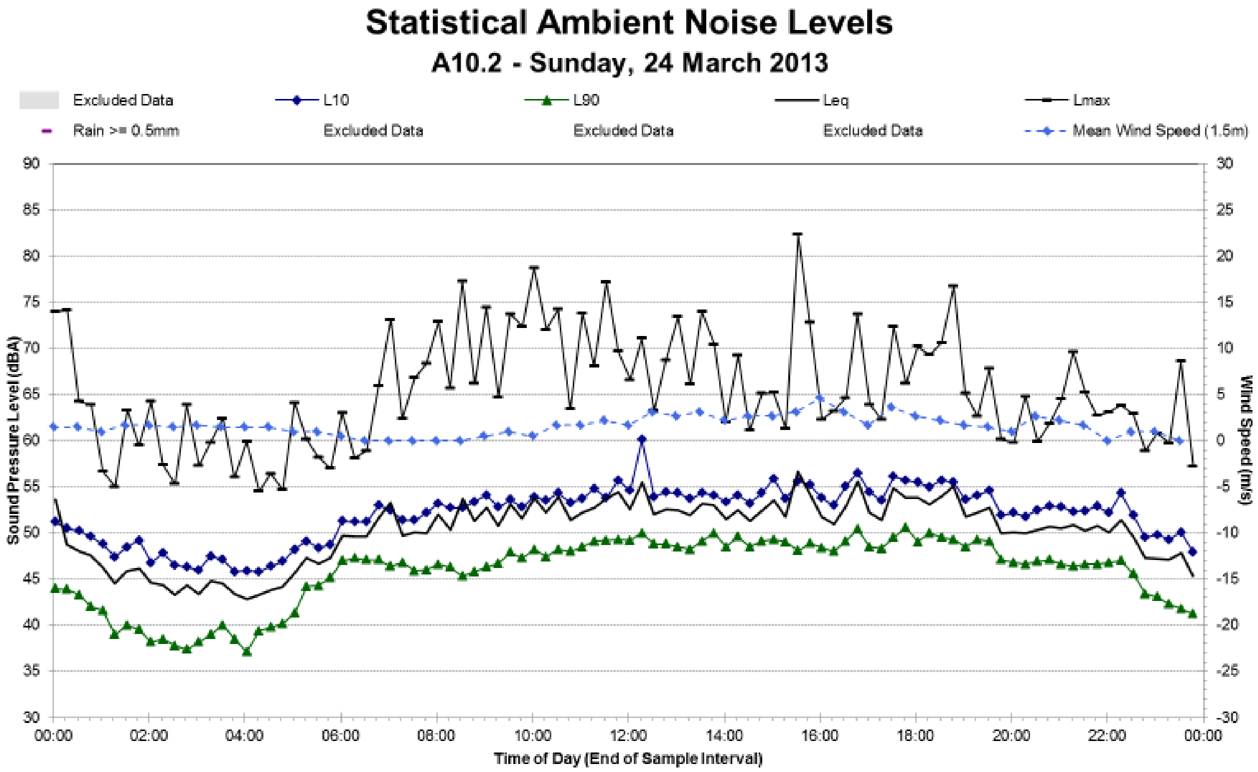


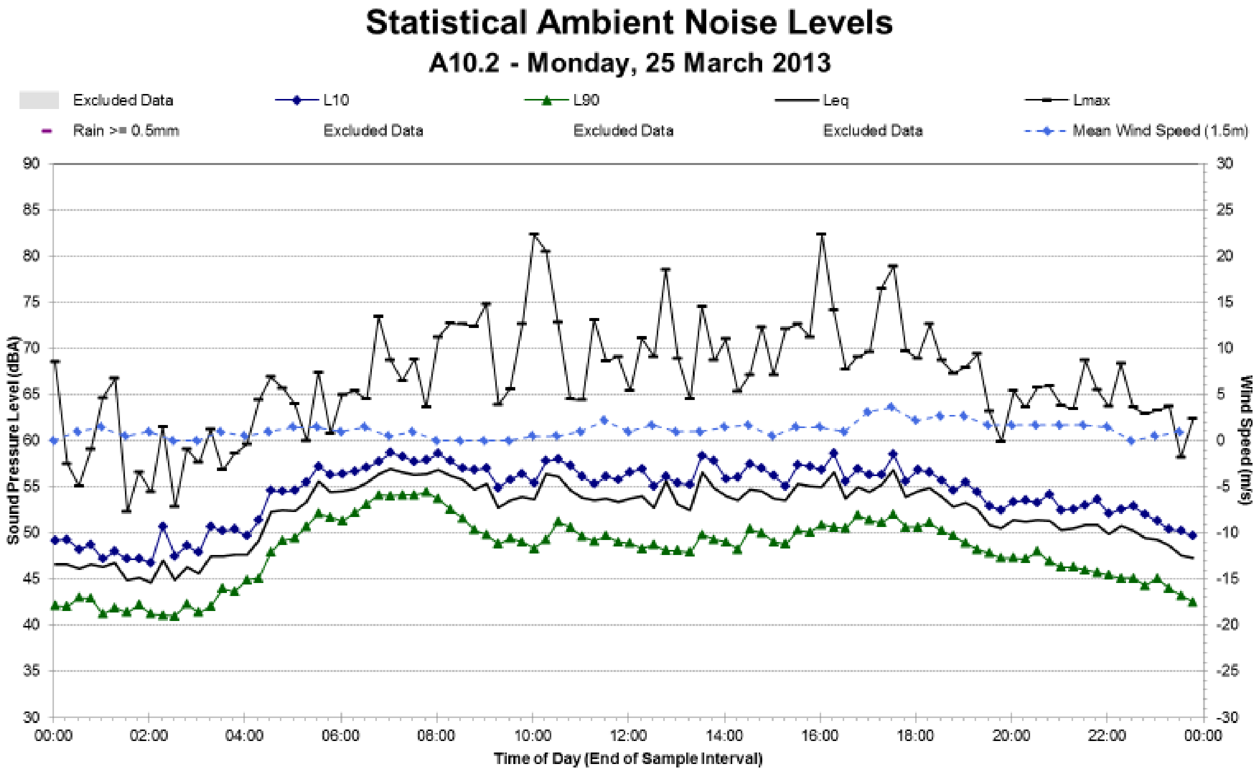
Statistical Ambient Noise Levels
A10.2 - Friday, 22 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

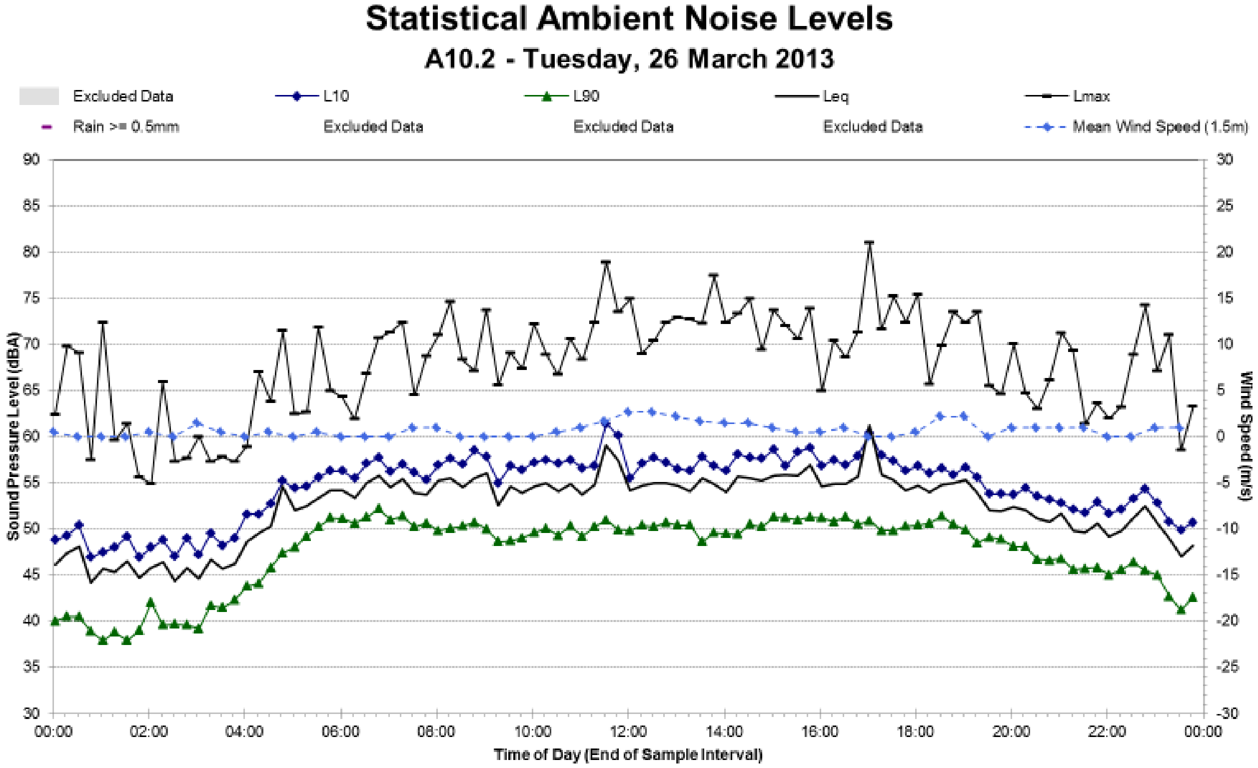


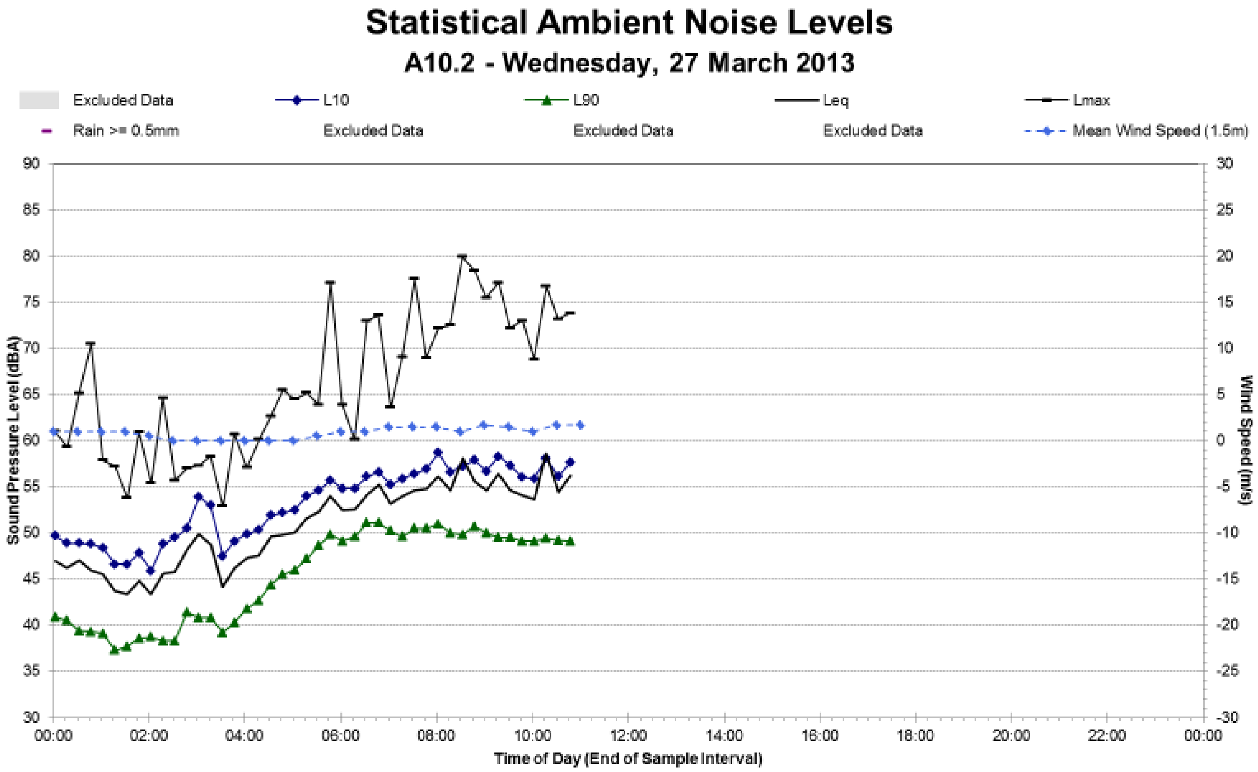
Statistical Ambient Noise Levels
A10.2 - Saturday, 23 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A10 Ambient Noise Monitoring Results






Statistical Ambient Noise Levels
A10.2 - Tuesday, 26 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
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
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
A10.2 - Wednesday, 27 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A11 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A11.1**
Noise Monitoring Address:	**289 Homestead Rd, Orchard Hills**

Logger Device Type: Svantek 957
Logger Serial No: 23814

Ambient noise logger deployed at rear of residential address 289 Homestead Rd, Orchard Hills approximately 75 m from the nearest M4 carriageway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated. During attended measurements it was observed that heavy vehicle movements contribute significantly to the noise environment.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 60-71 dBA, Light-vehicle road traffic: ~56 dBA, Insects: <55 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	58	63	66	69
Evening	54	61	63	67
Night-time	43	58	61	66

Ambient Noise Logging Results – RNP Defined Time Periods

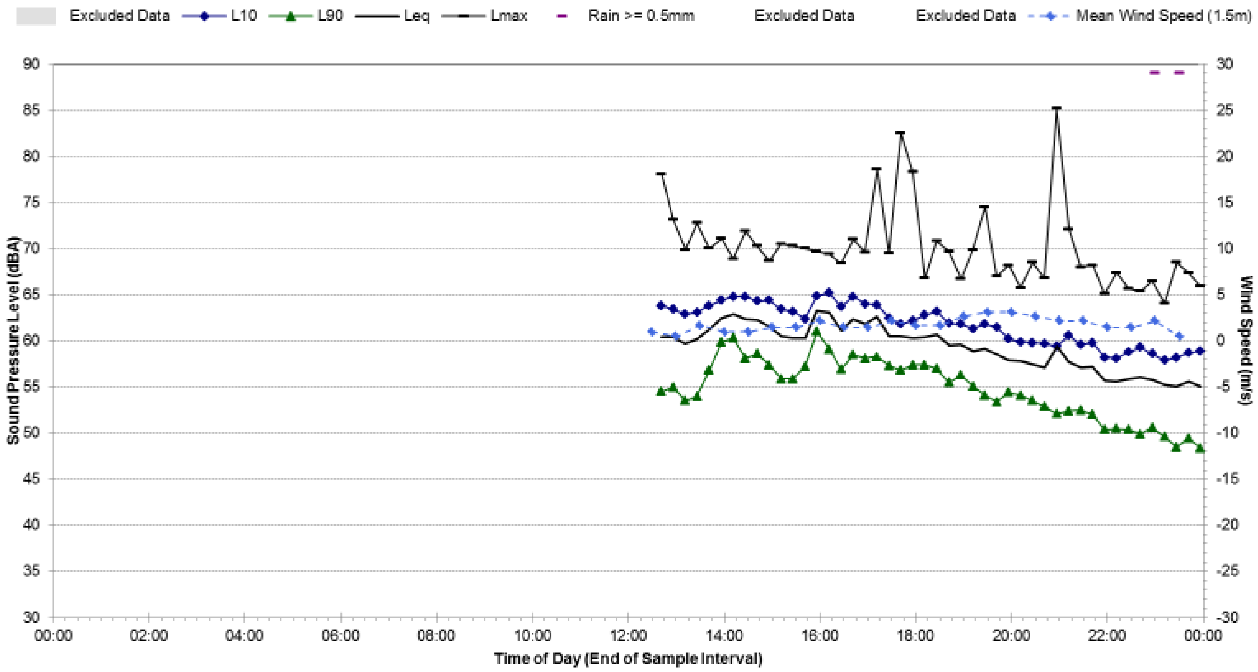
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	8	3	N/A (7 Day Average)
Daytime (7am-10pm)	63	62	63
Night-time (10pm-7am)	59	57	58

Attended Noise Measurement Results

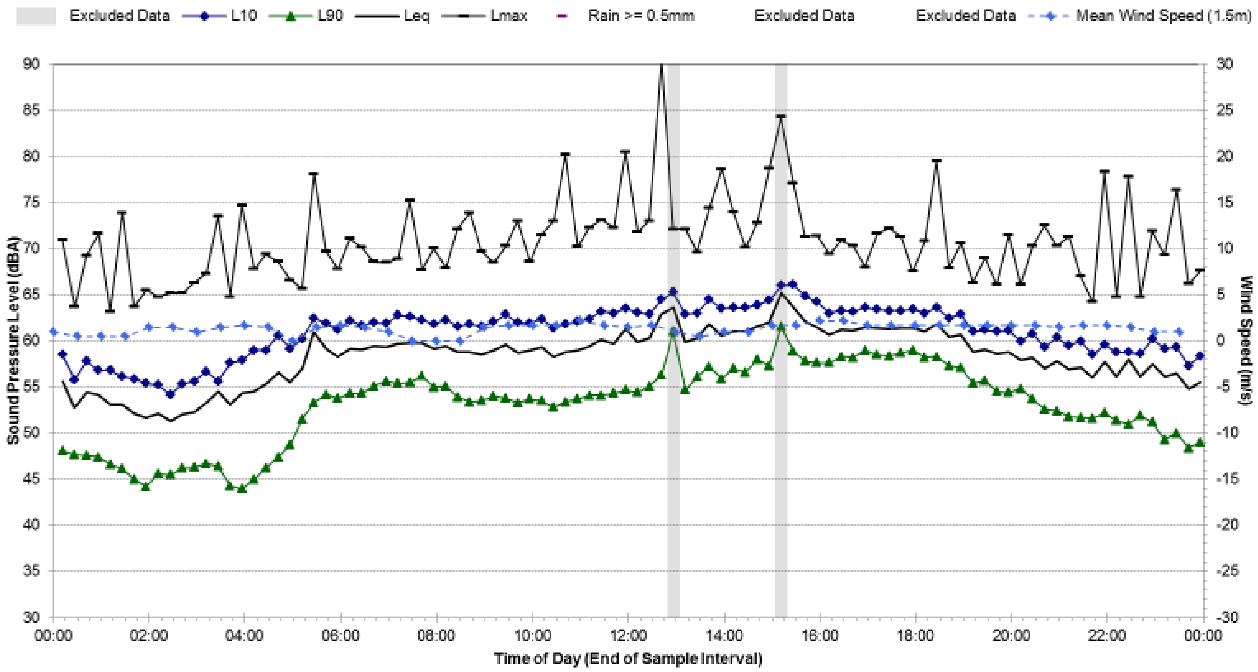
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
14/03/2013	12:15	55	61	71

Photo of Noise Monitoring Location

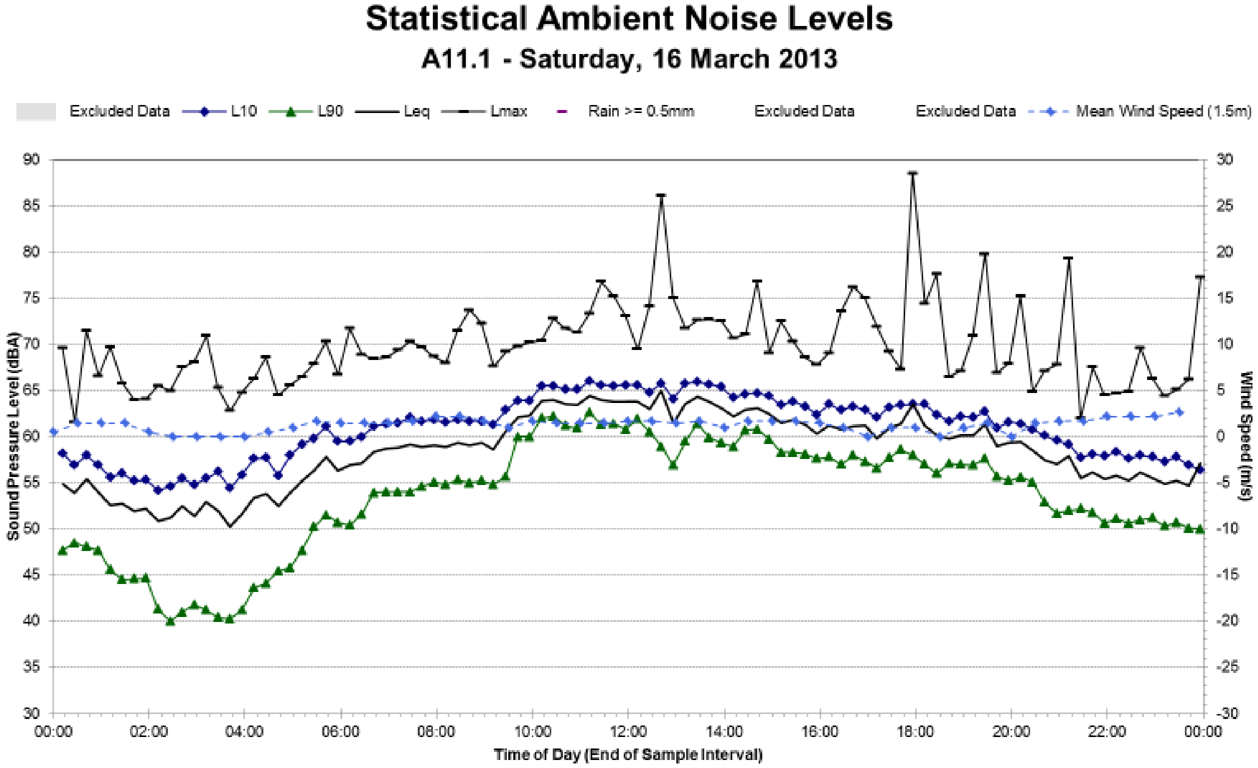
Statistical Ambient Noise Levels
A11.1 - Thursday, 14 March 2013

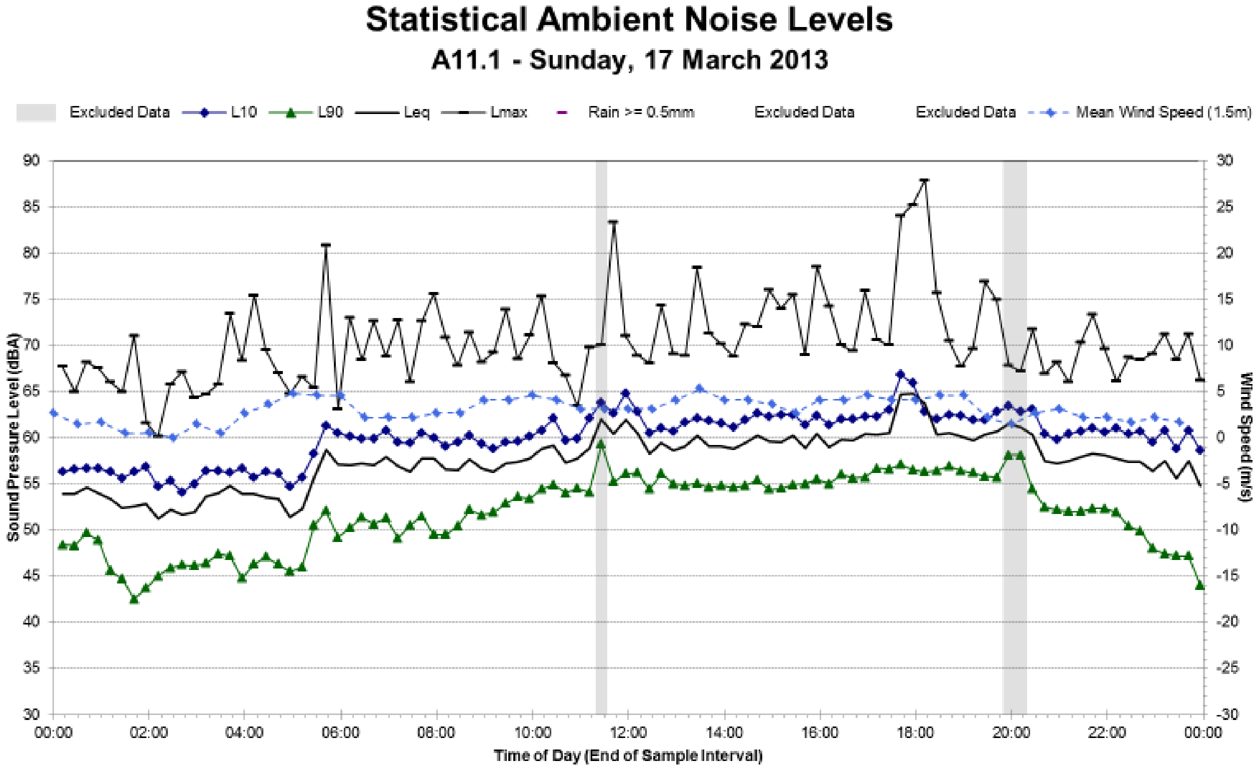


Statistical Ambient Noise Levels
A11.1 - Friday, 15 March 2013

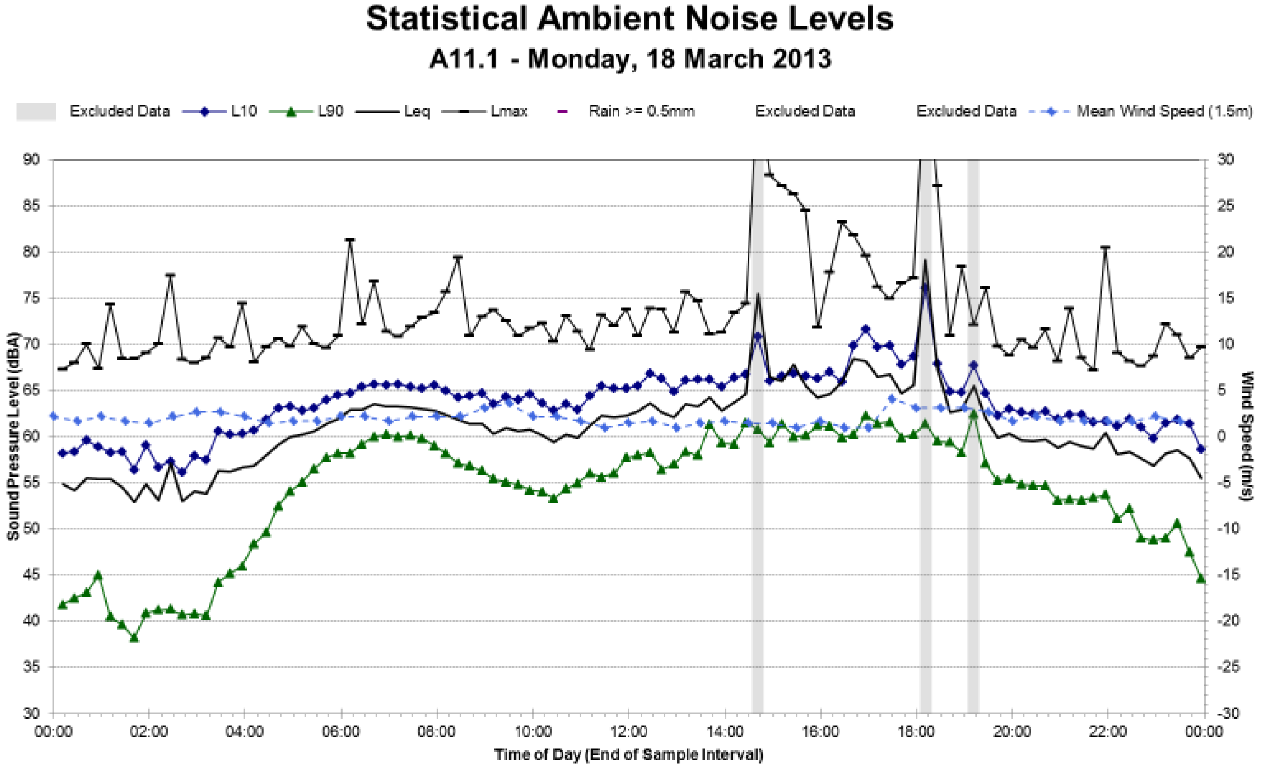


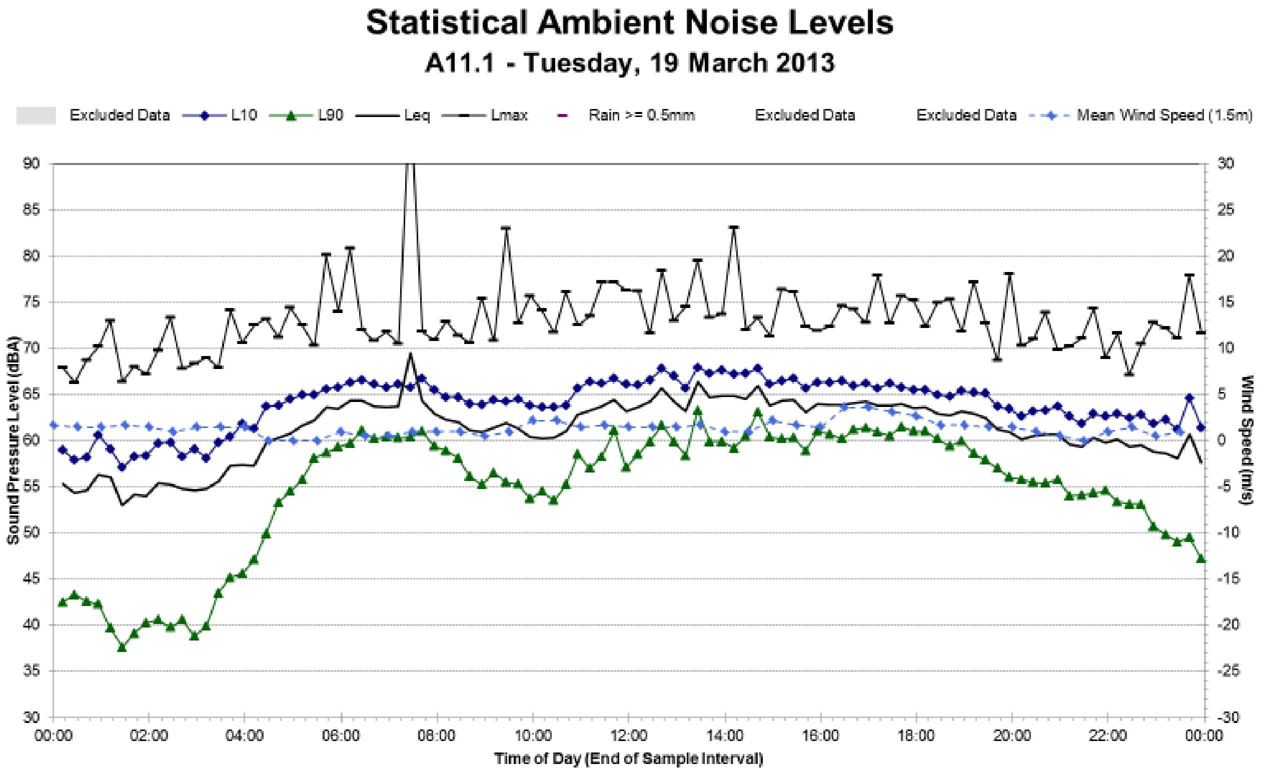
A11 Ambient Noise Monitoring Results





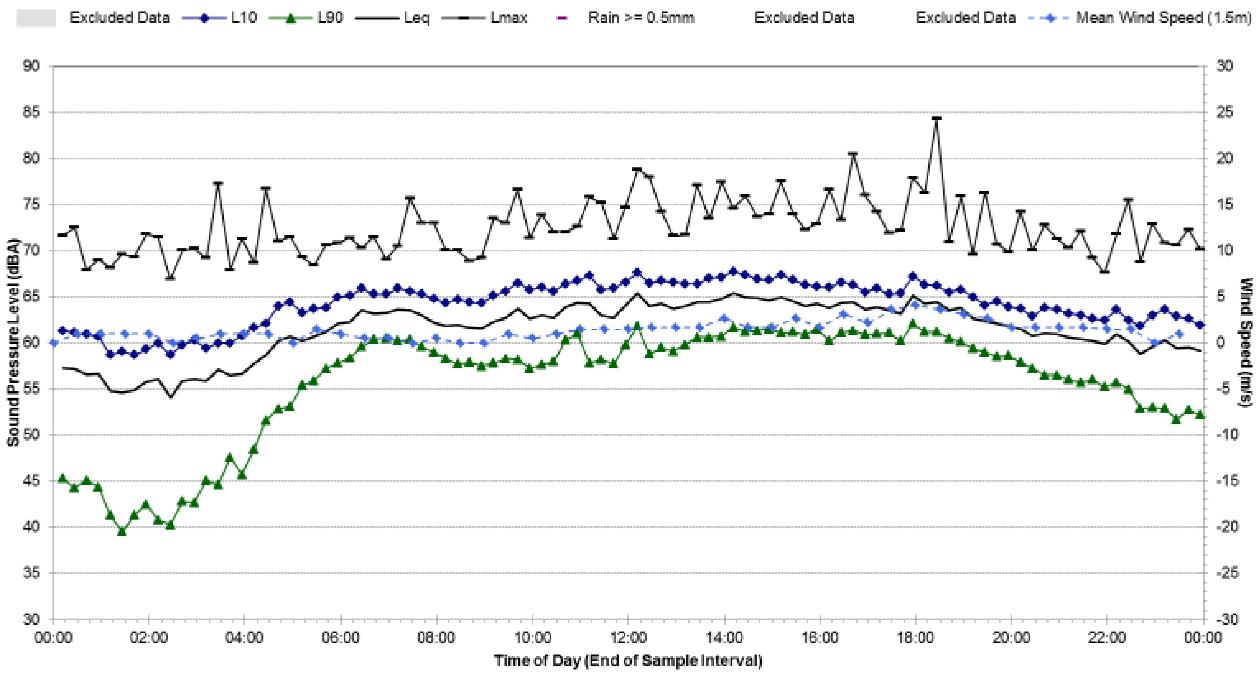
A11 Ambient Noise Monitoring Results



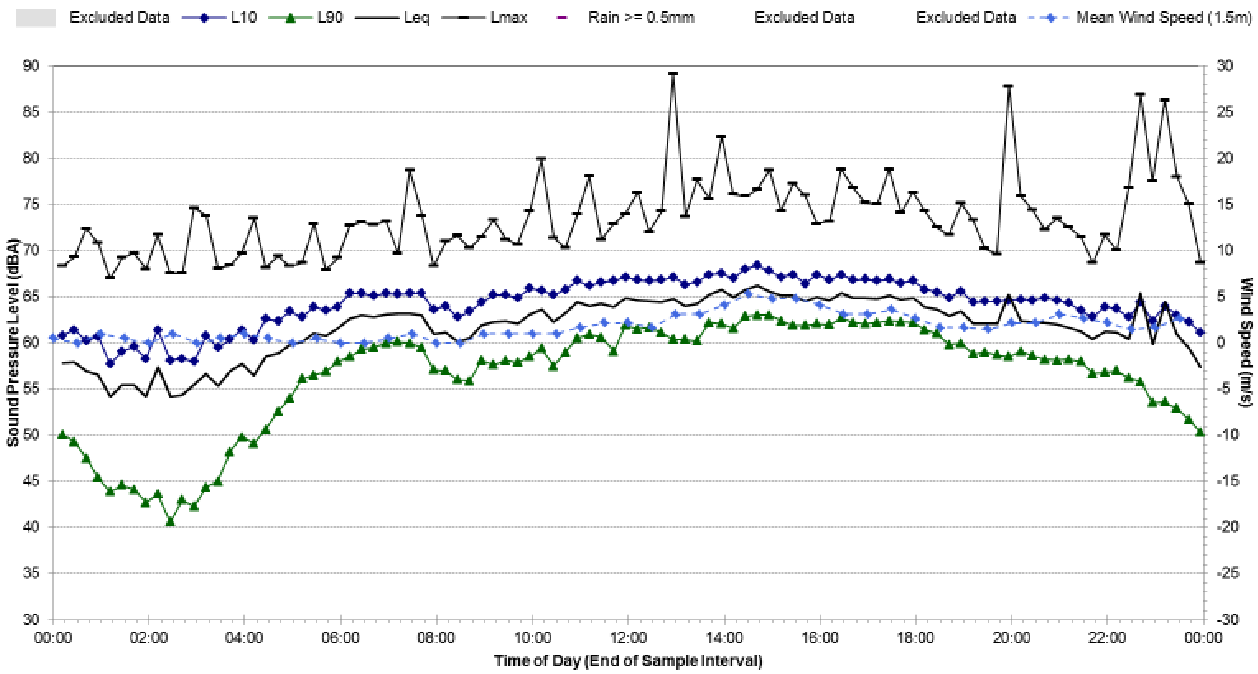


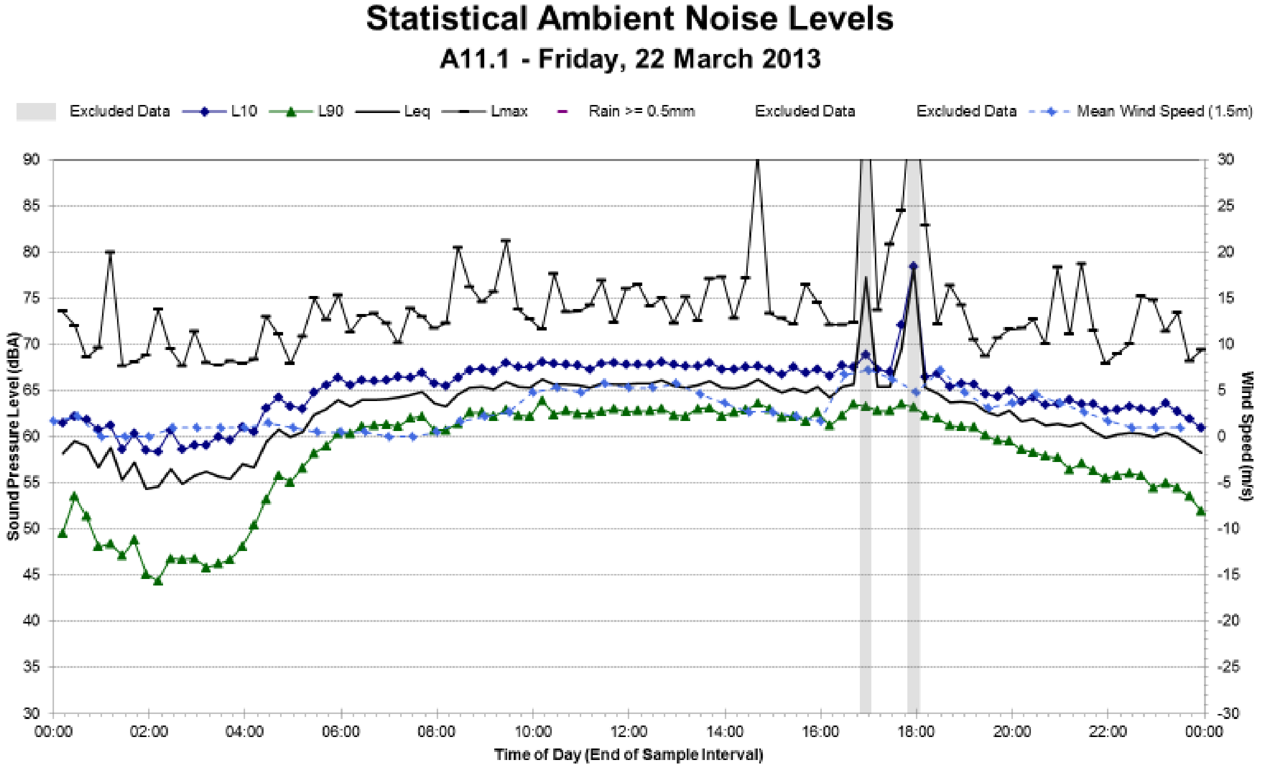
A11 Ambient Noise Monitoring Results

Statistical Ambient Noise Levels
A11.1 - Wednesday, 20 March 2013



Statistical Ambient Noise Levels
A11.1 - Thursday, 21 March 2013




Statistical Ambient Noise Levels
A11.1 - Friday, 22 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
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
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20:00
22:00
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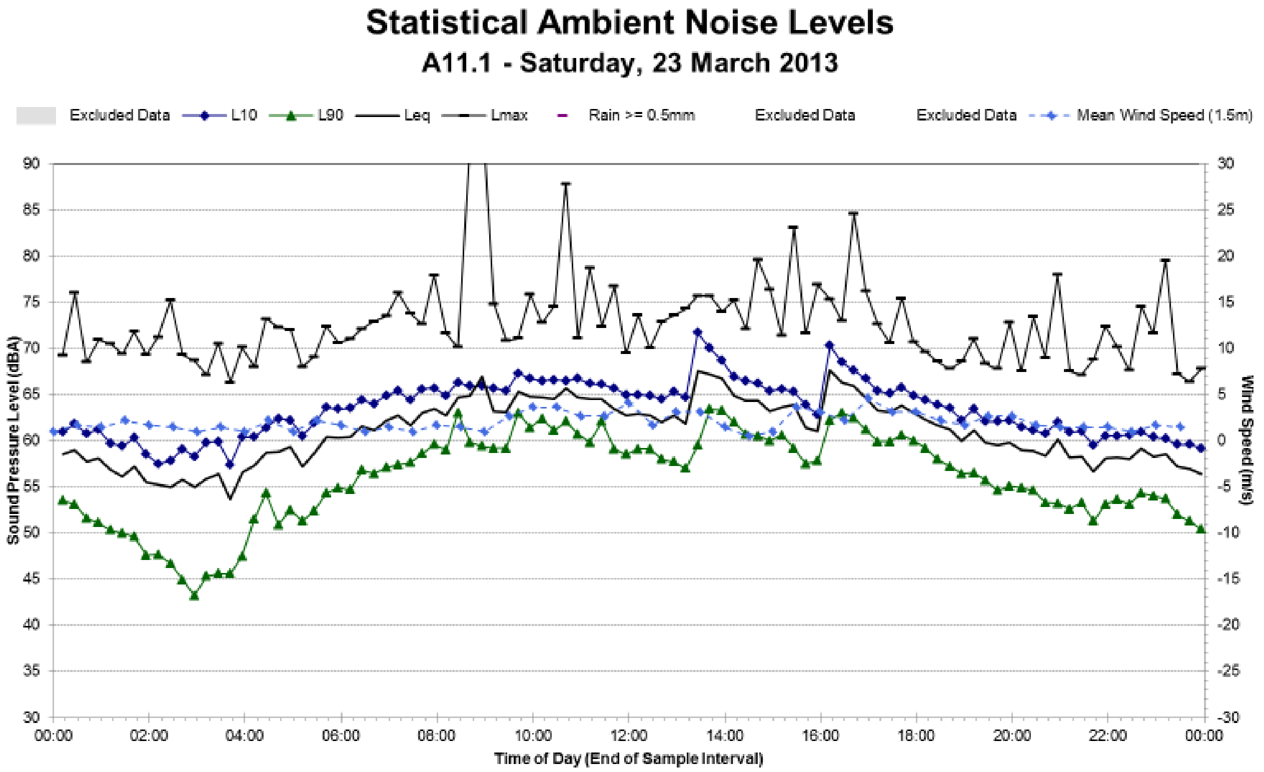
Statistical Ambient Noise Levels
A11.1 - Saturday, 23 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
00:00
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22:00
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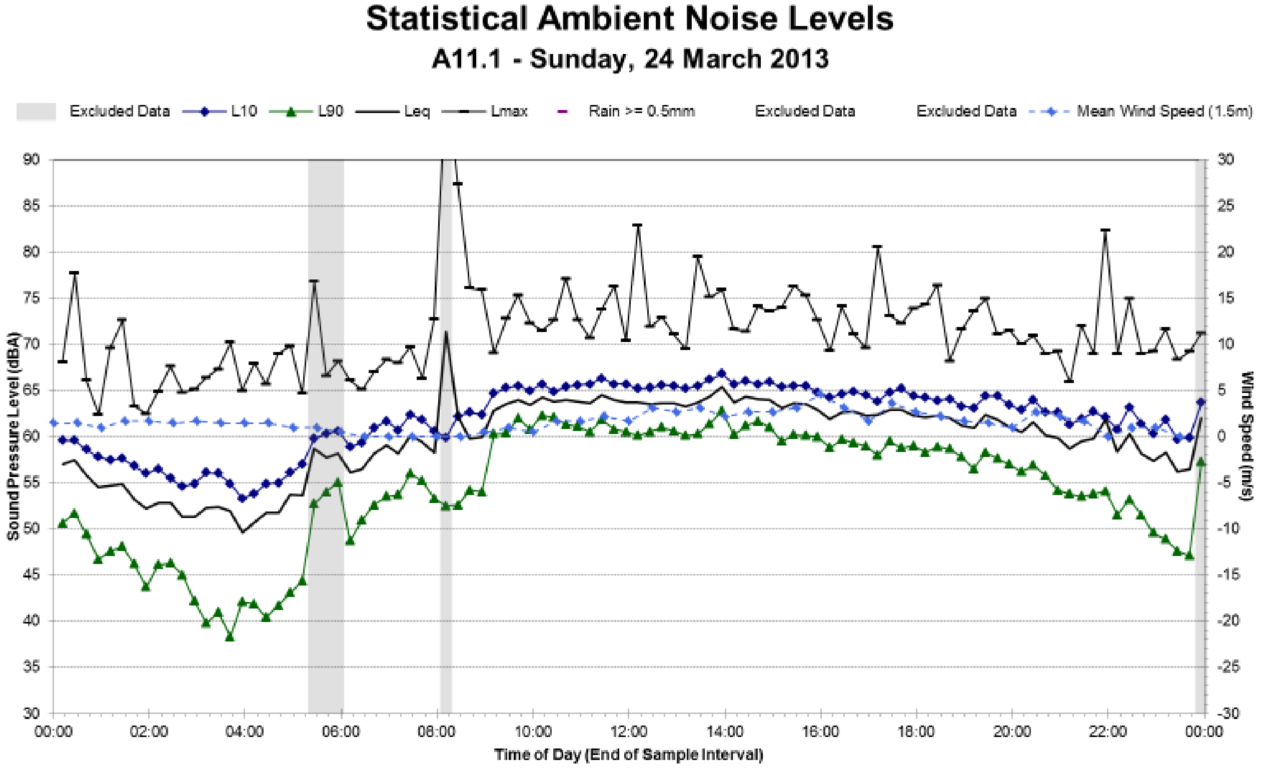
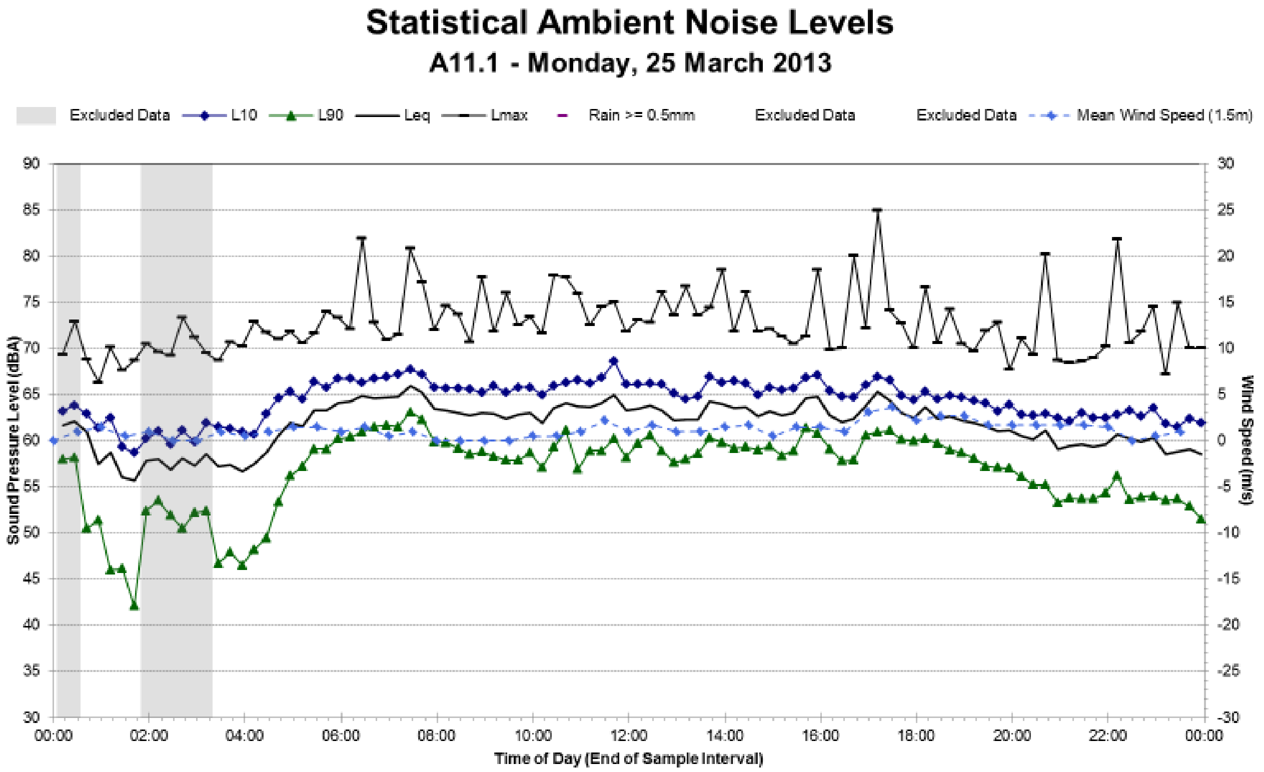
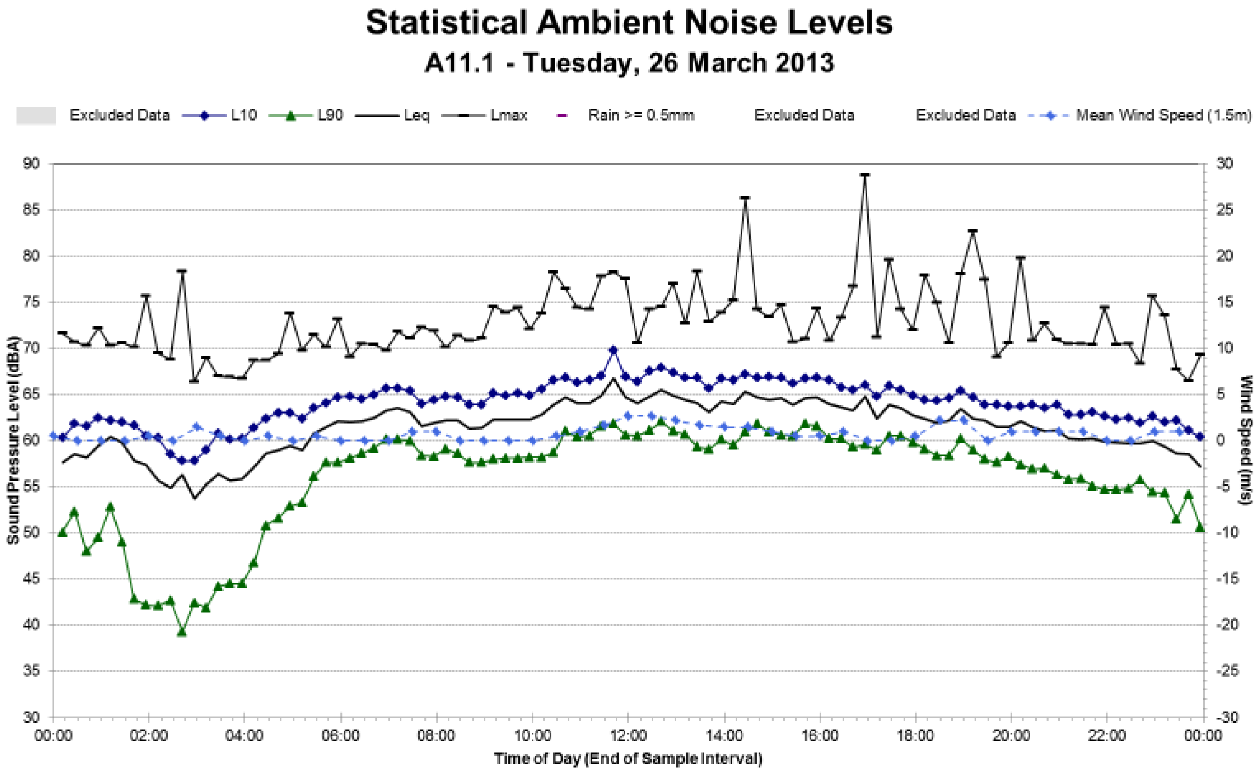
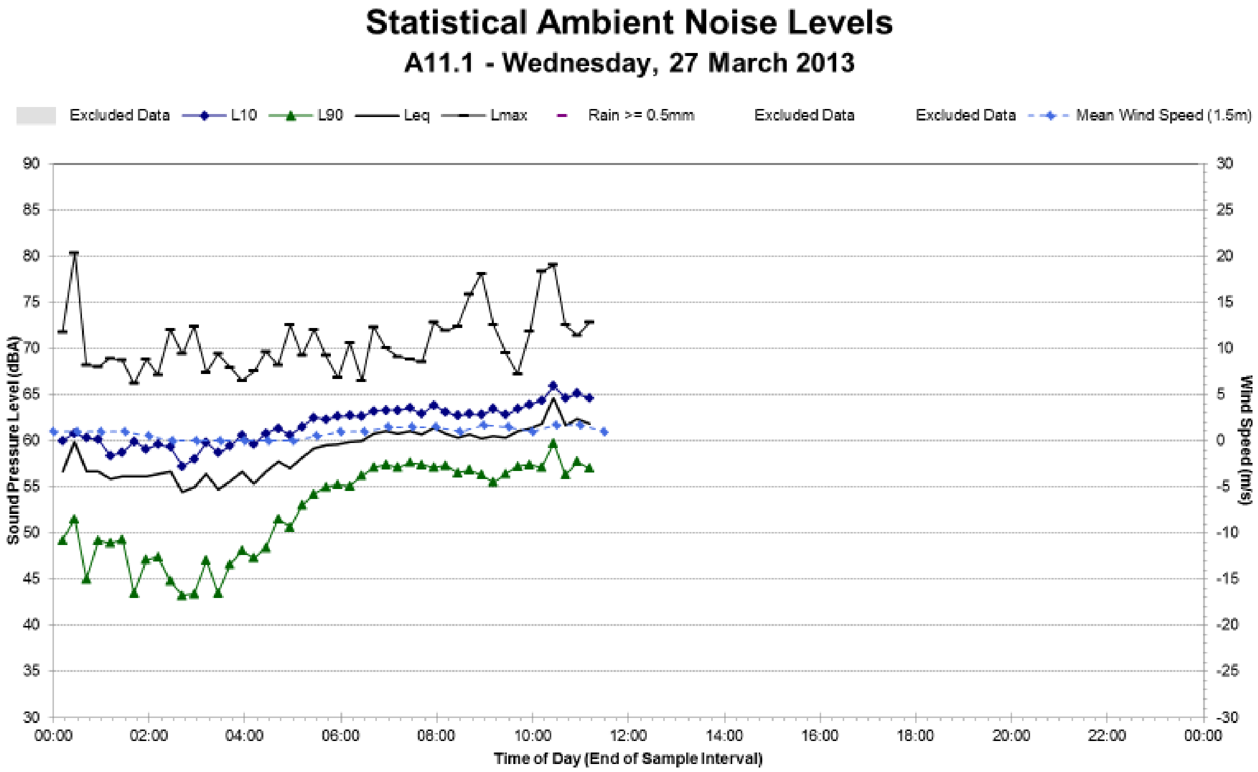

Statistical Ambient Noise Levels
A11.1 - Sunday, 24 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00


Statistical Ambient Noise Levels
A11.1 - Monday, 25 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
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
A11.1 - Tuesday, 26 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A11.1 - Wednesday, 27 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A11 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A11.2**
Noise Monitoring Address:	**9 Pebworth Pl, South Penrith**

Logger Device Type: Svantek 957
Logger Serial No: 20670

Ambient noise logger deployed at rear of residential address 9 Pebworth Pl, South Penrith.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 52-71 dBA, Light-vehicle road traffic: ~52 dBA, Birds: 47-52 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	45	53	54	60
Evening	44	52	53	59
Night-time	36	47	48	55

Ambient Noise Logging Results – RNP Defined Time Periods

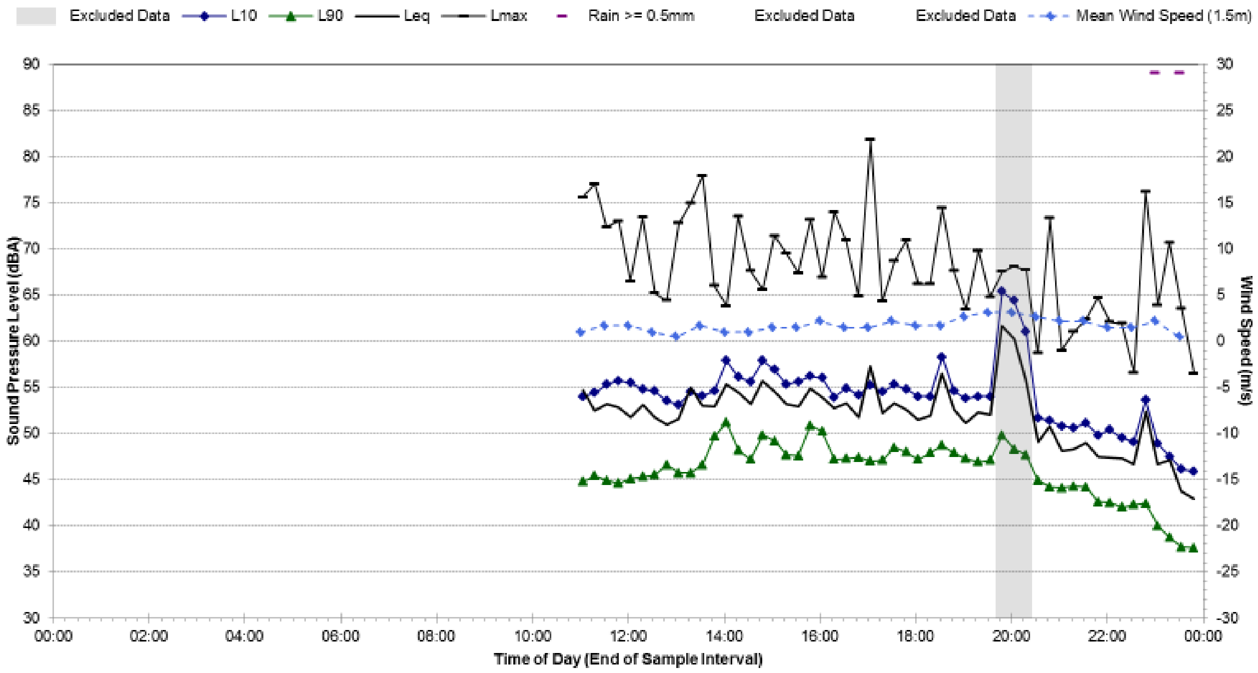
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	4	N/A (7 Day Average)
Daytime (7am-10pm)	53	52	53
Night-time (10pm-7am)	47	47	47

Attended Noise Measurement Results

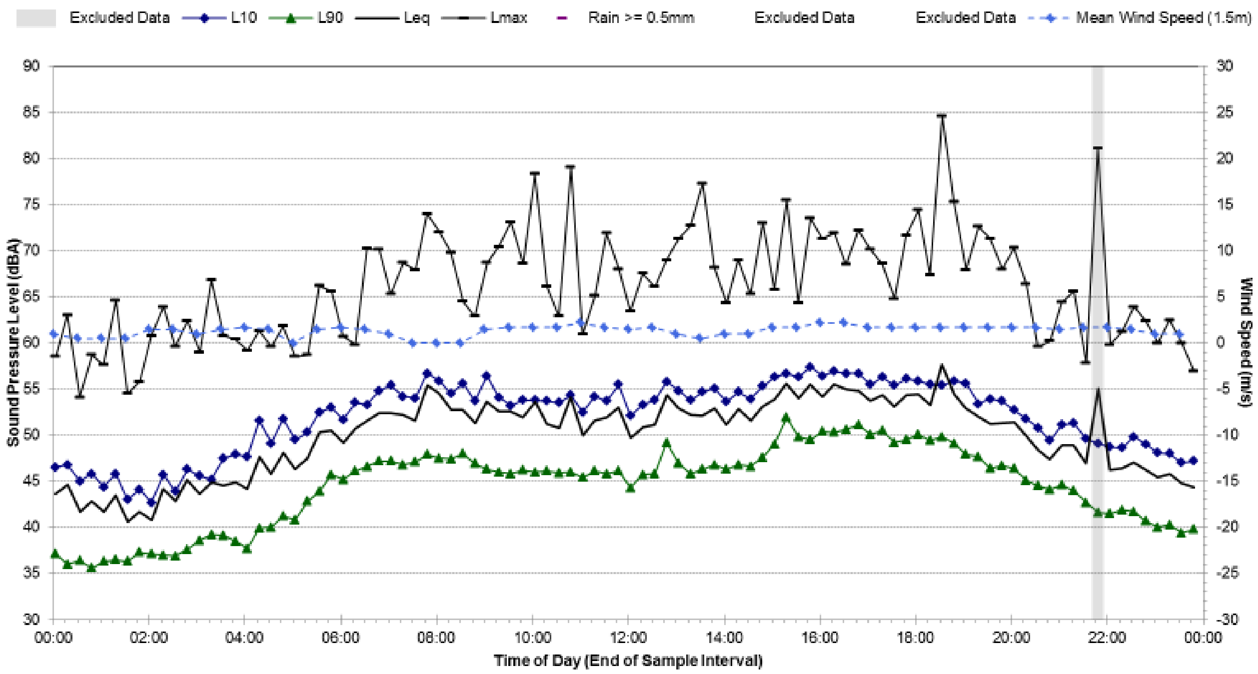
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
14/03/2013	11:00	45	53	72

Photo of Noise Monitoring Location

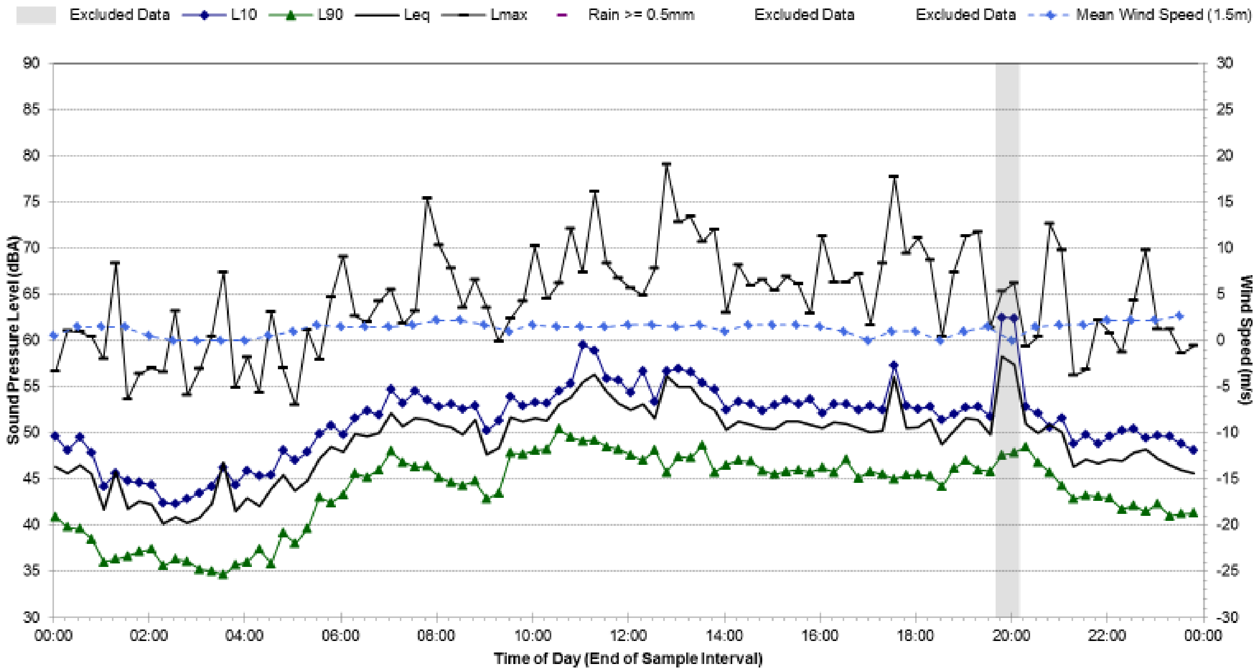
Statistical Ambient Noise Levels
A11.2 - Thursday, 14 March 2013



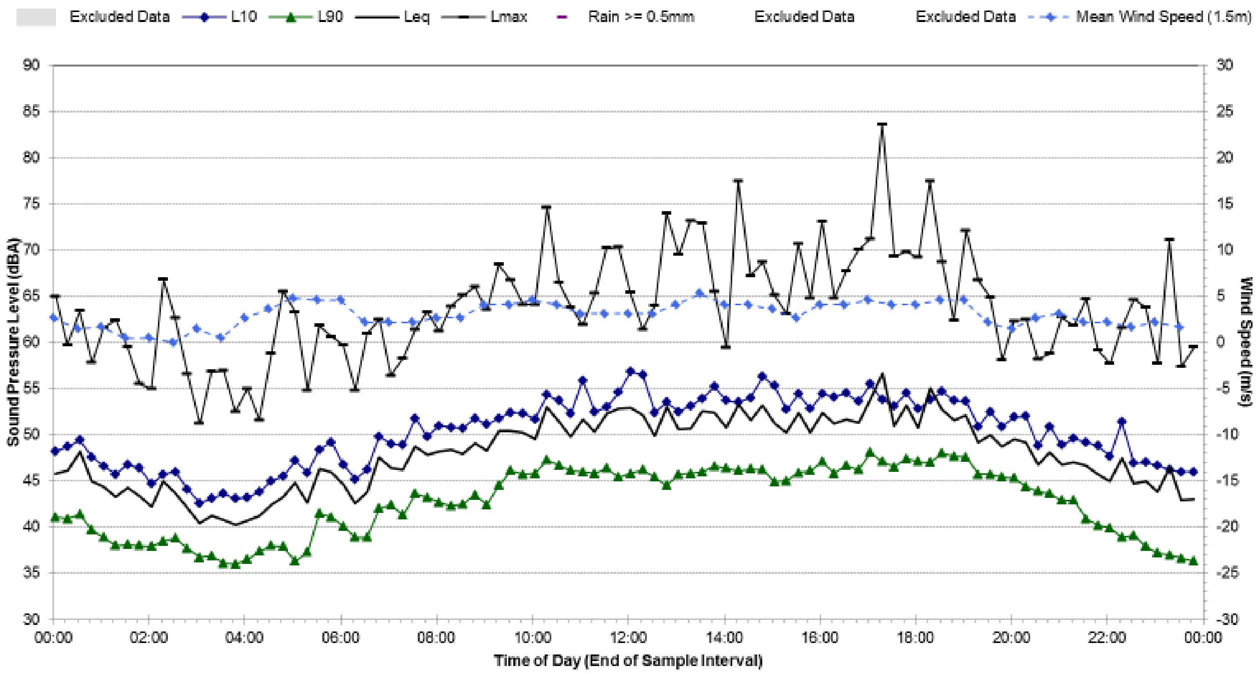
Statistical Ambient Noise Levels
A11.2 - Friday, 15 March 2013



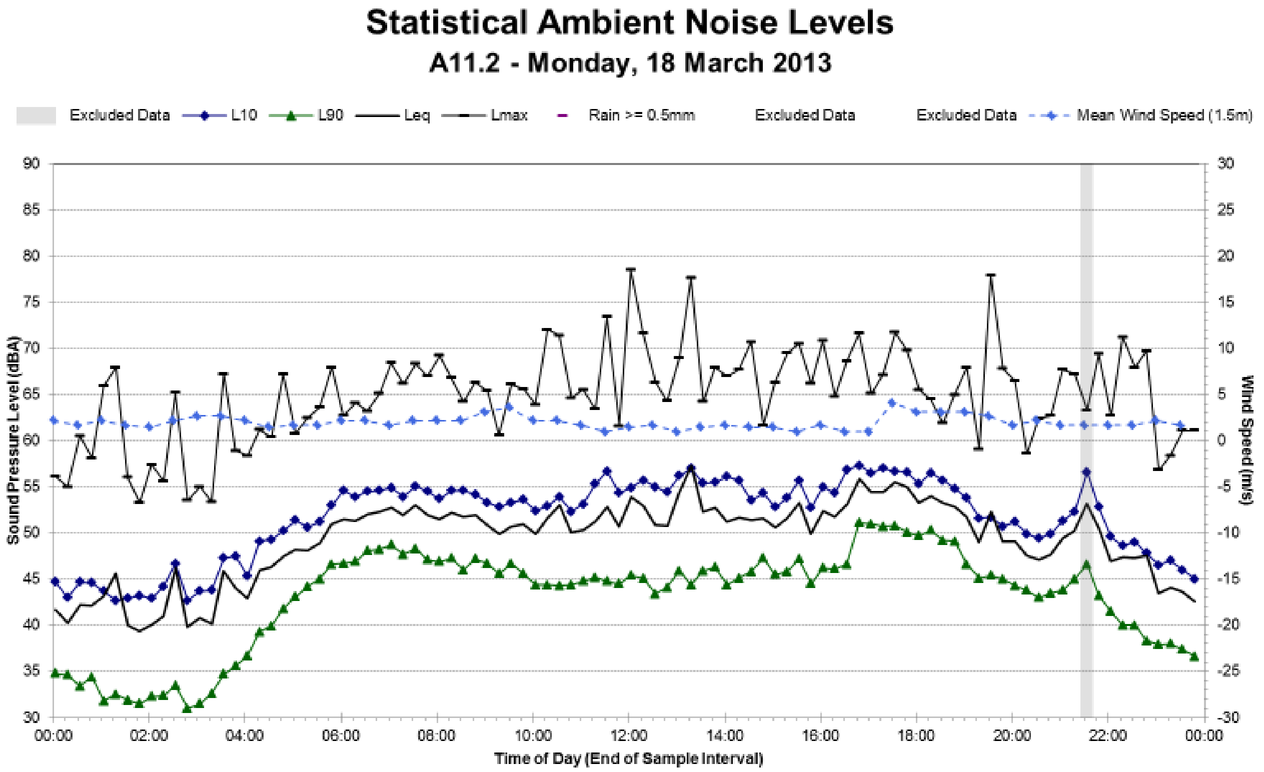
Statistical Ambient Noise Levels
A11.2 - Saturday, 16 March 2013

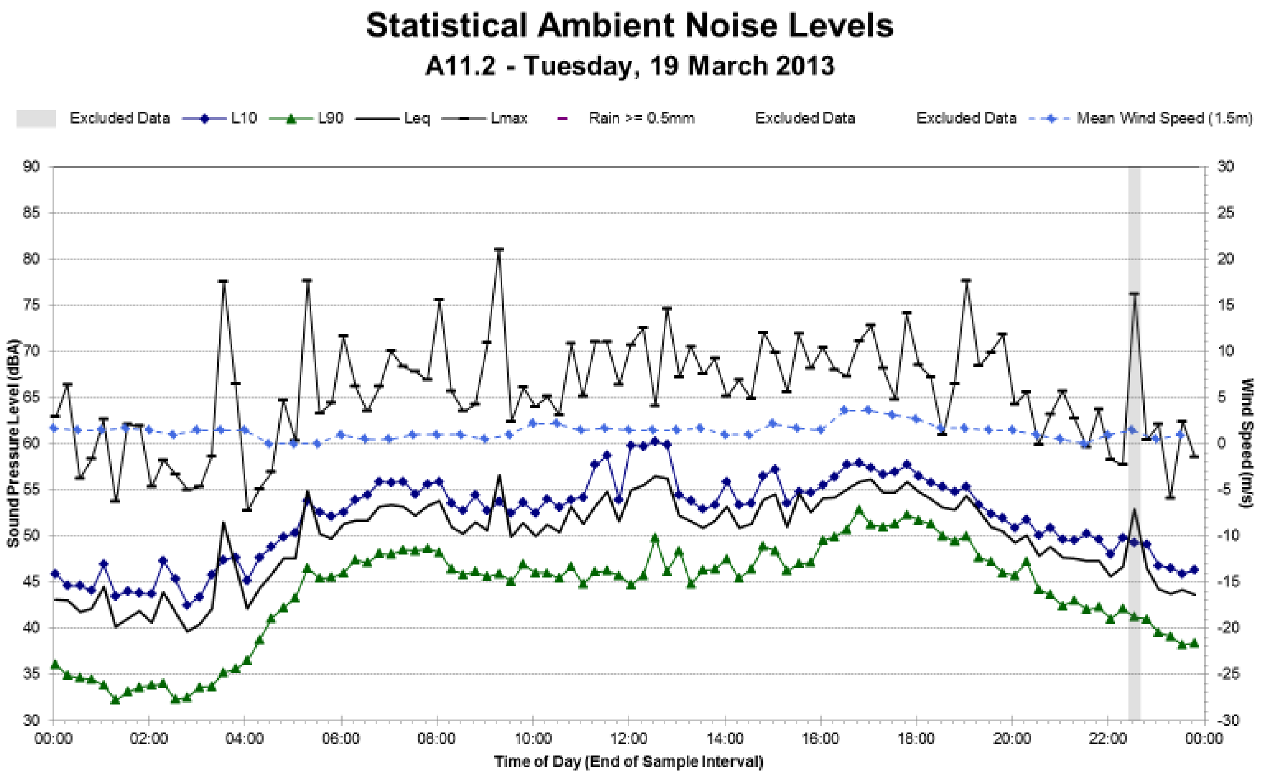


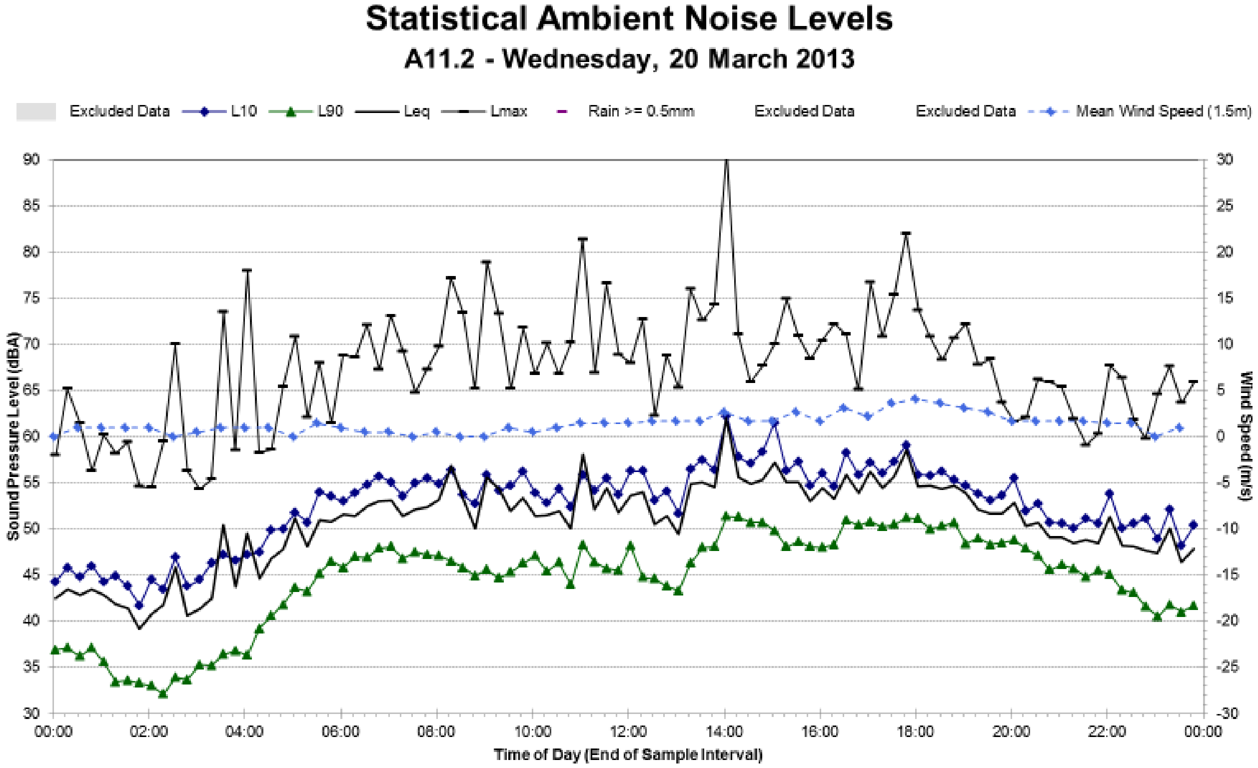
Statistical Ambient Noise Levels
A11.2 - Sunday, 17 March 2013

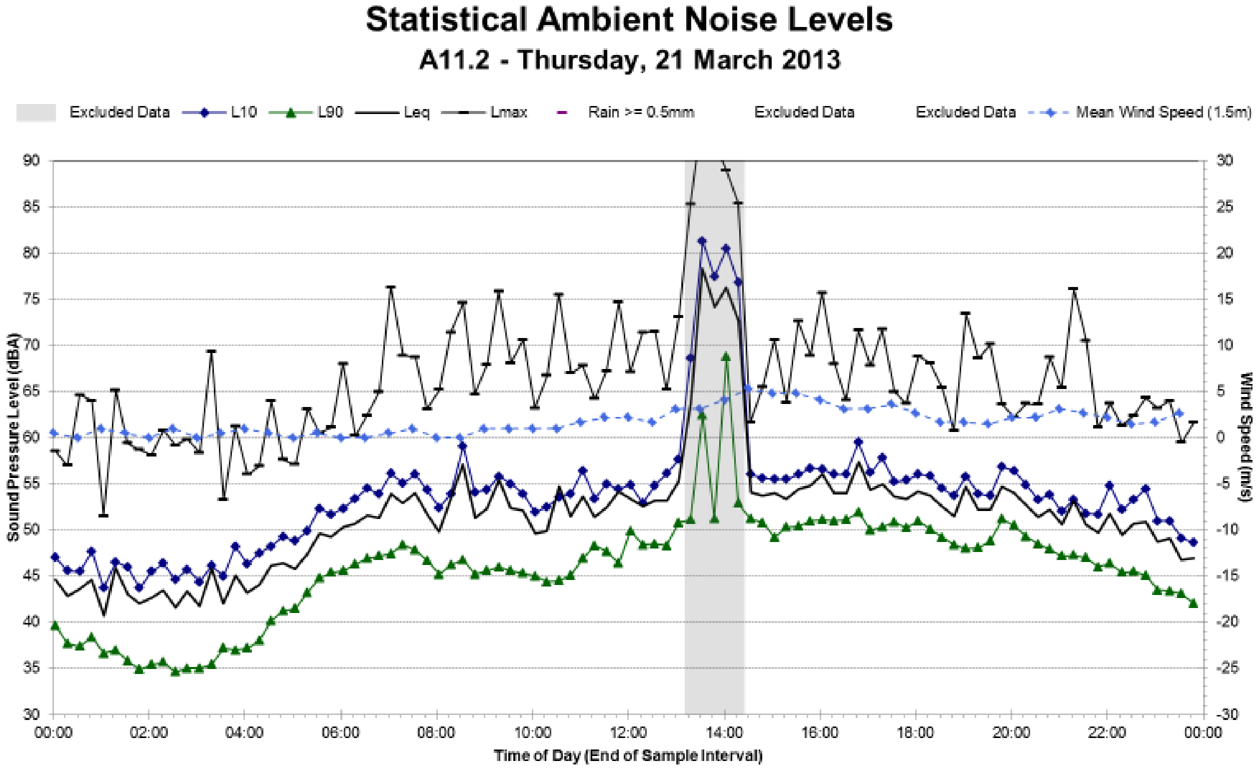


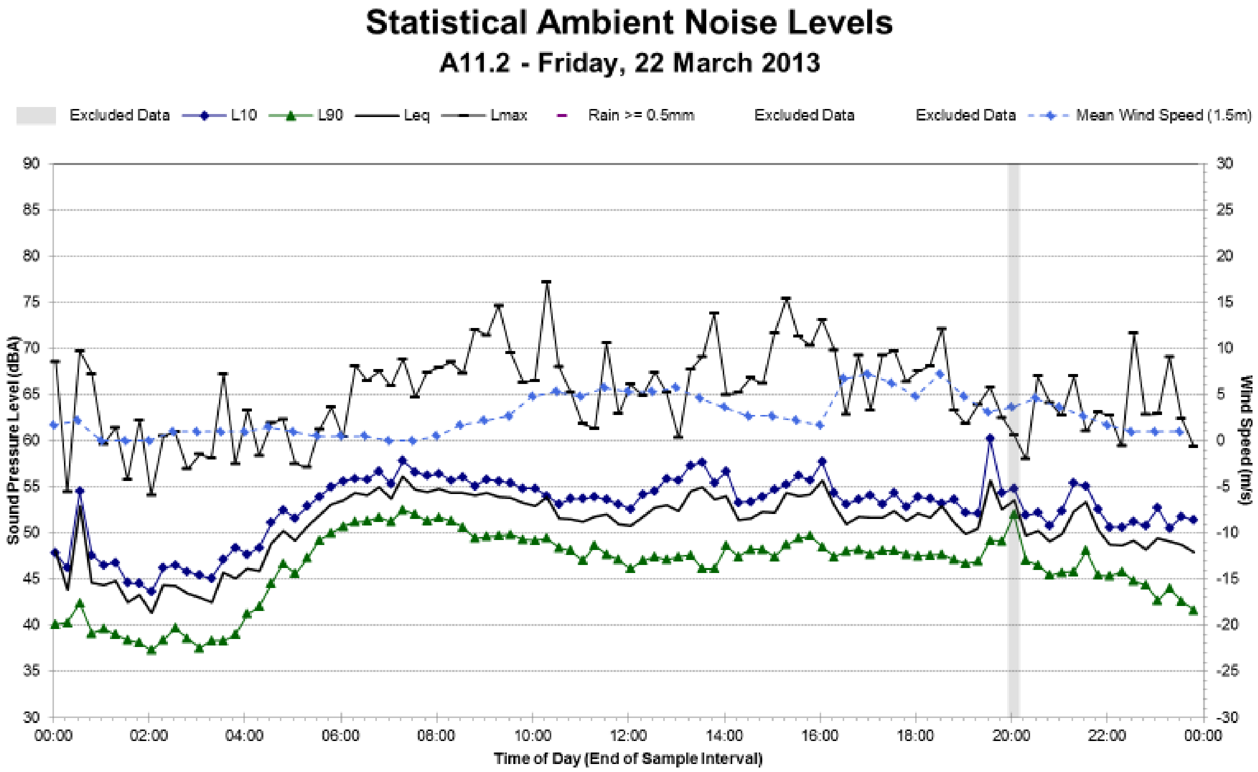
A11 Ambient Noise Monitoring Results






Statistical Ambient Noise Levels
A11.2 - Wednesday, 20 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A11.2 - Thursday, 21 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
A11.2 - Friday, 22 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
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
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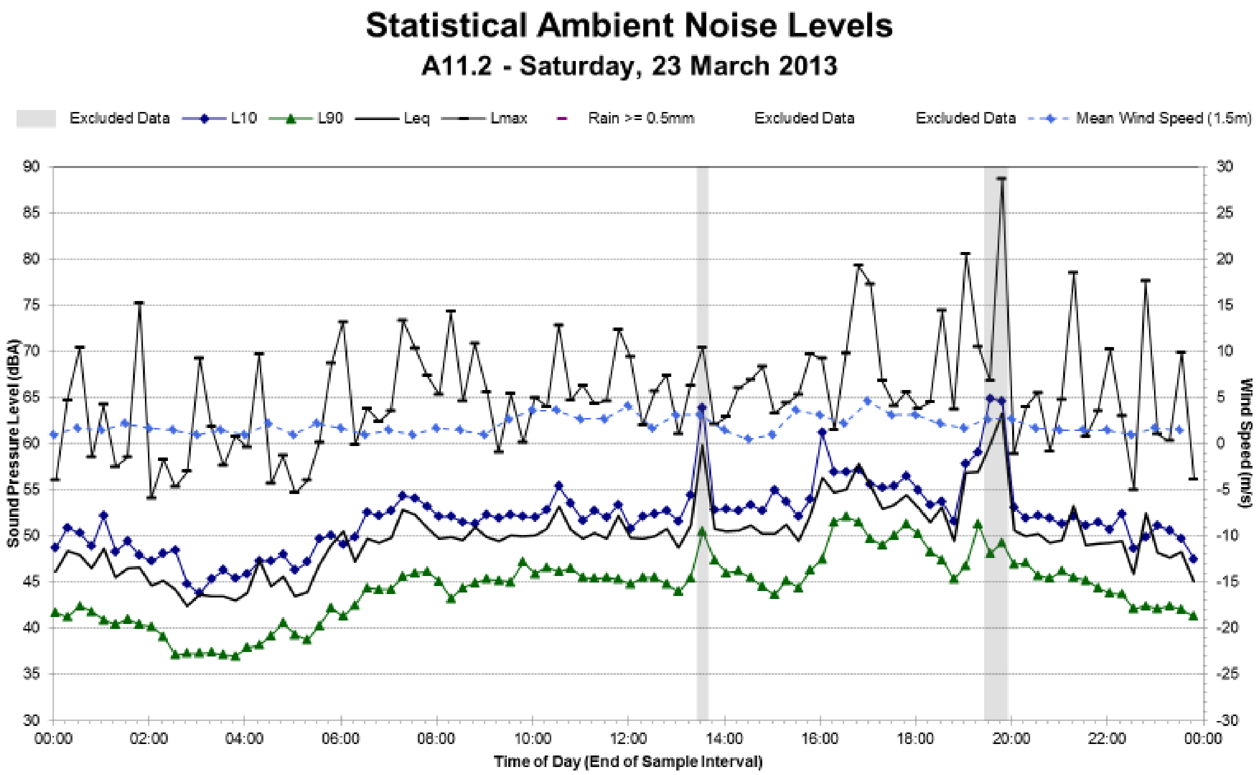
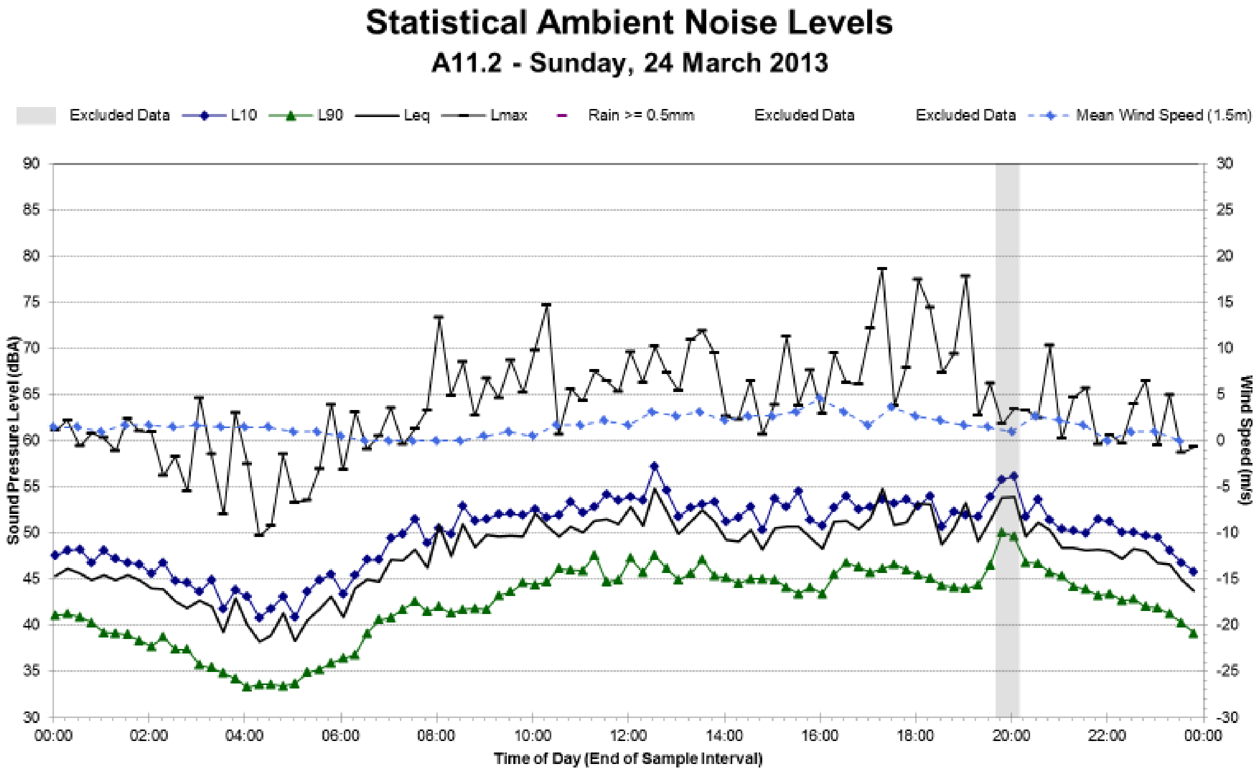
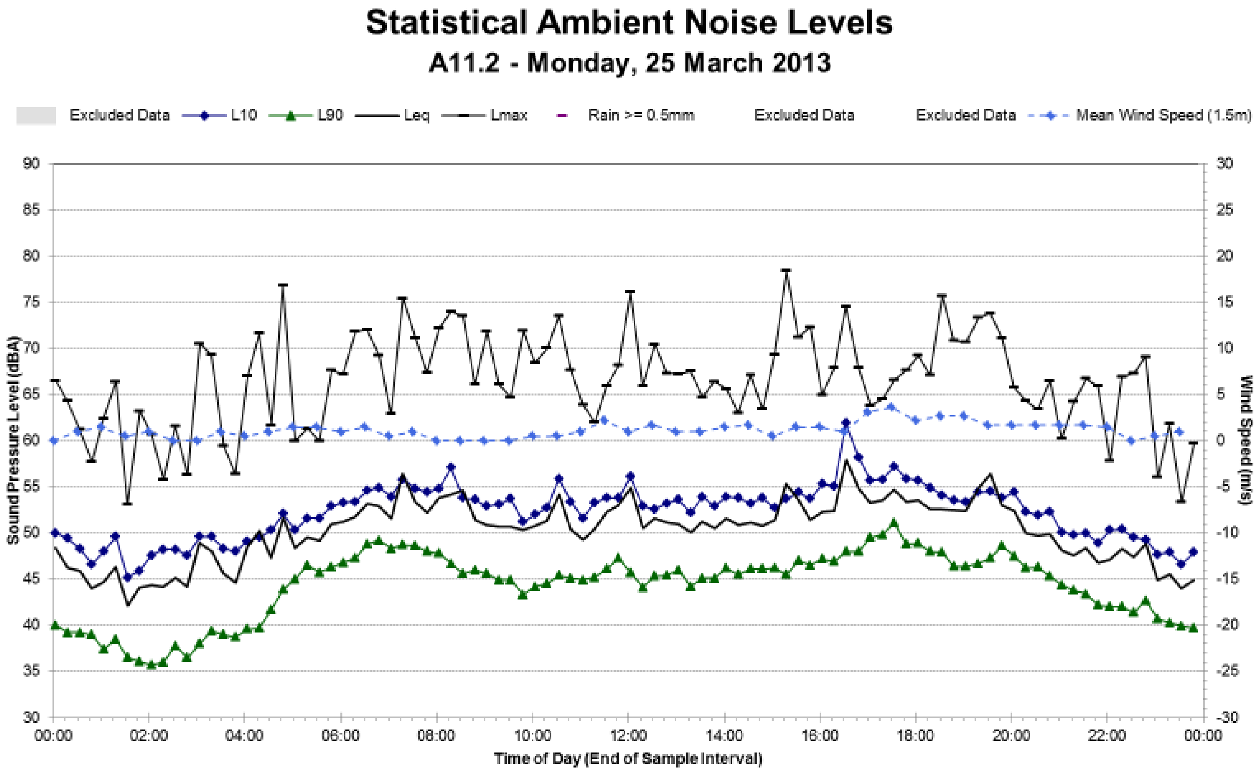
14:00
16:00
18:00
20:00
22:00
00:00

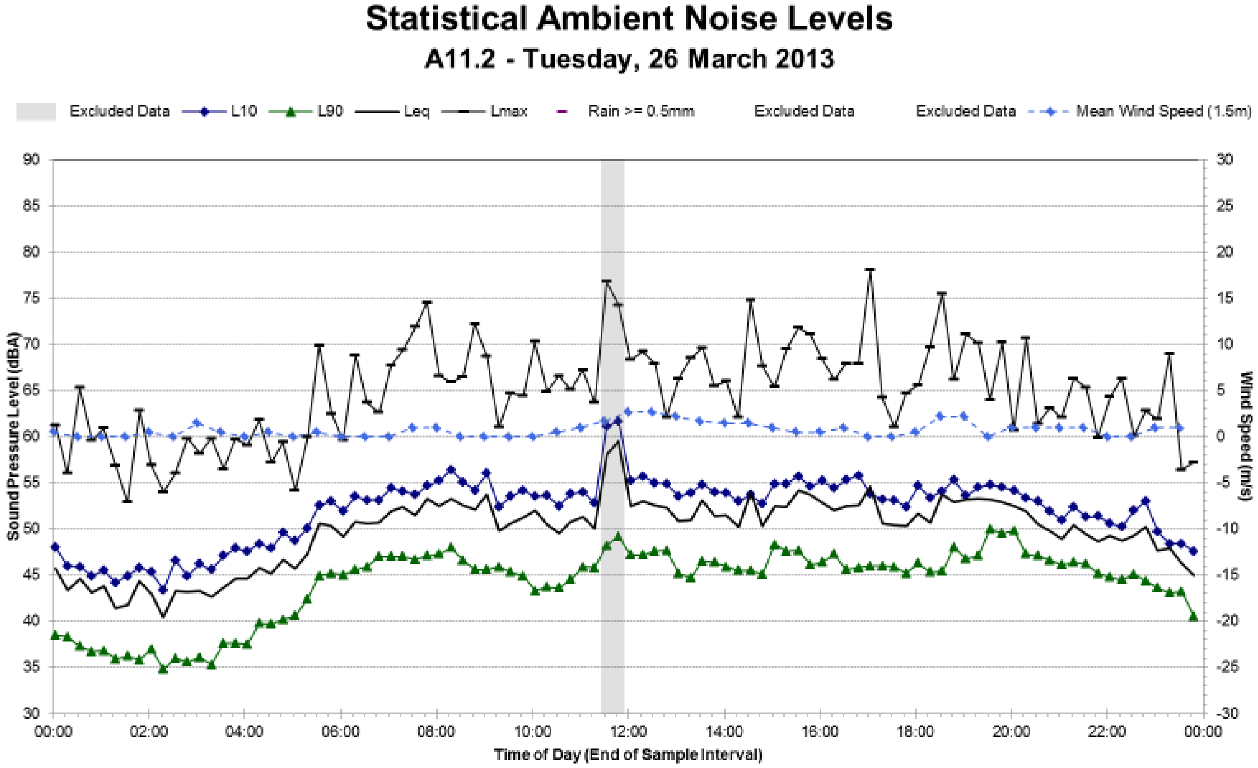


Statistical Ambient Noise Levels
A11.2 - Saturday, 23 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-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

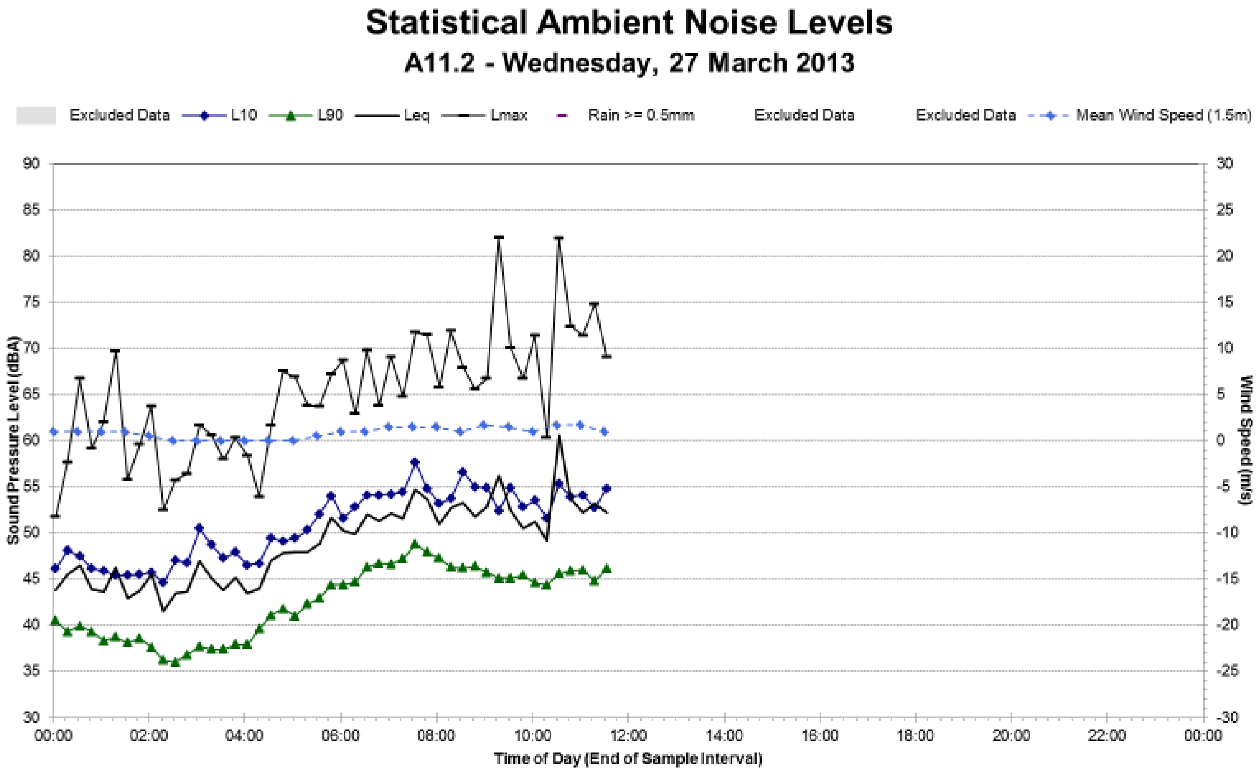
A11 Ambient Noise Monitoring Results







Statistical Ambient Noise Levels
A11.2 - Tuesday, 26 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
A11.2 - Wednesday, 27 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A11 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A11.3**
Noise Monitoring Address:	**20 South St, Glenmore Park**

Logger Device Type: Svantek 957
Logger Serial No: 23244

Ambient noise logger deployed in front yard of residential address 20 South St, Glenmore Park.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 58-63 dBA, Light-vehicle road traffic: 50-58 dBA, Insects: ~55 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	51	58	59	64
Evening	48	56	57	62
Night-time	39	53	55	60

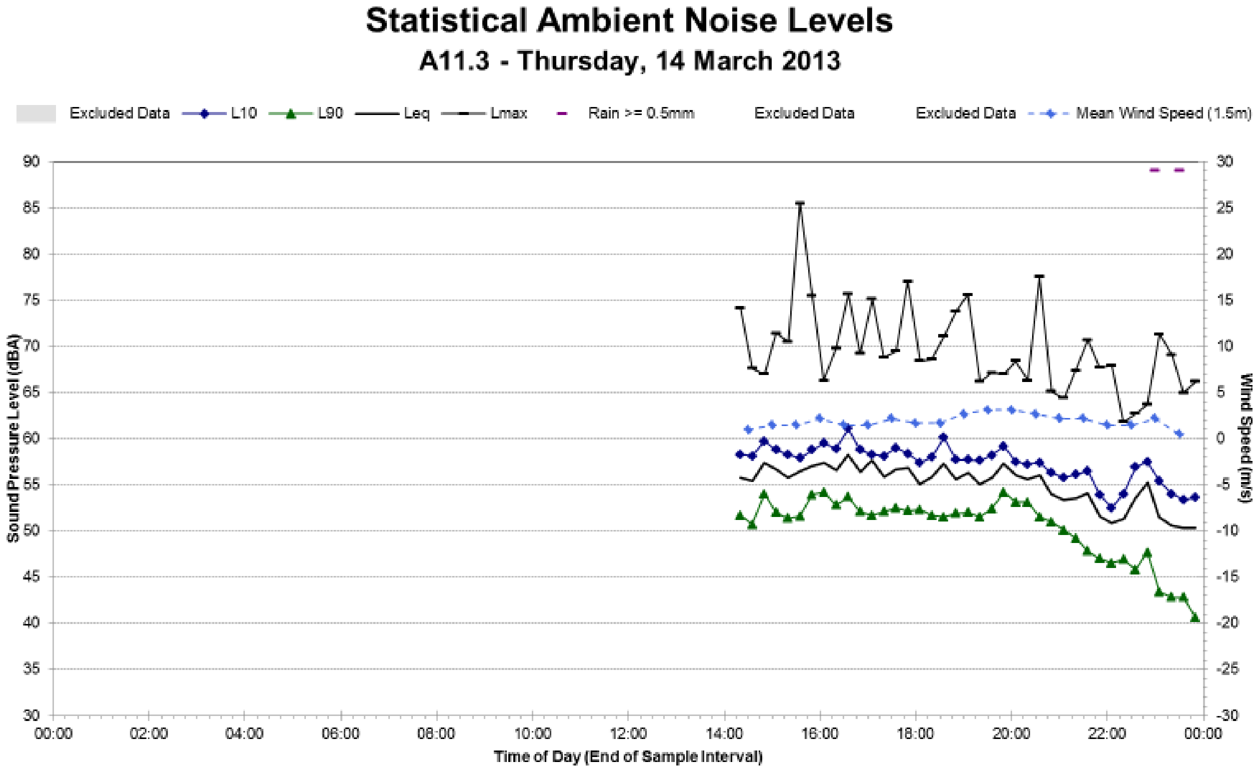
Ambient Noise Logging Results – RNP Defined Time Periods

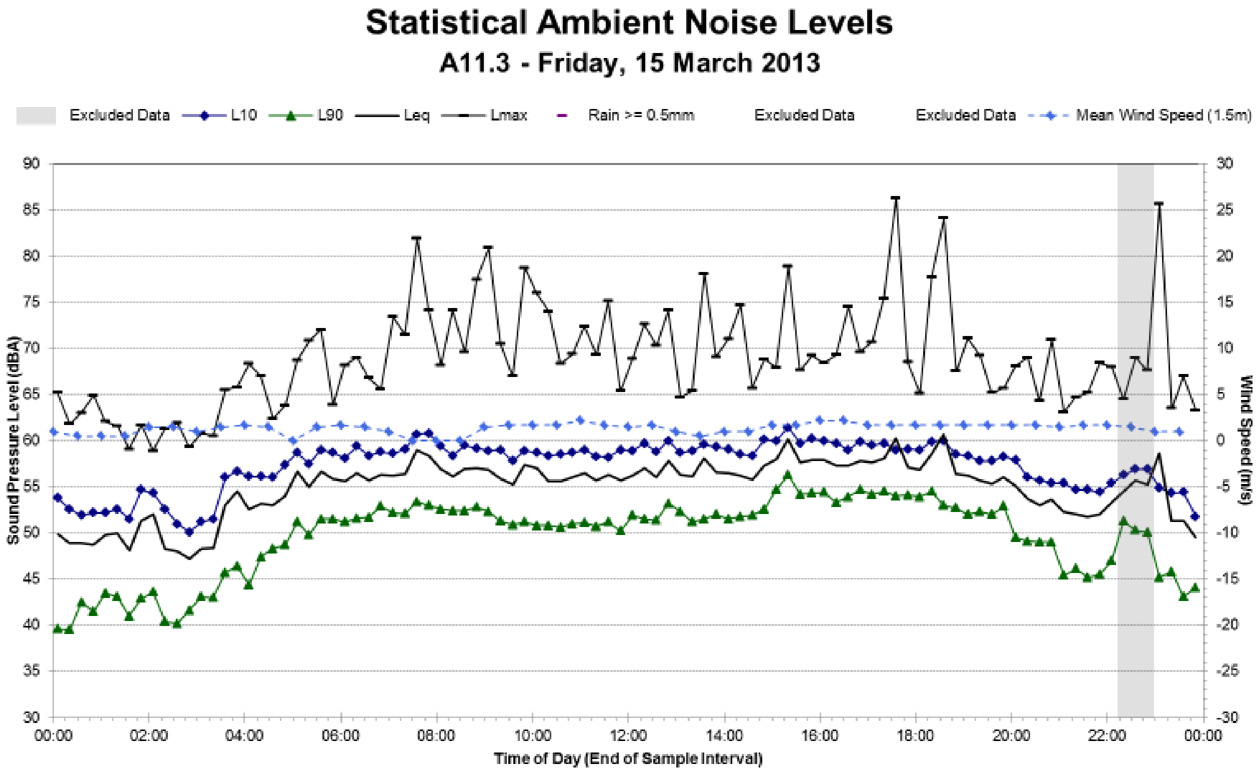
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	8	4	N/A (7 Day Average)
Daytime (7am-10pm)	57	56	57
Night-time (10pm-7am)	53	52	53

Attended Noise Measurement Results

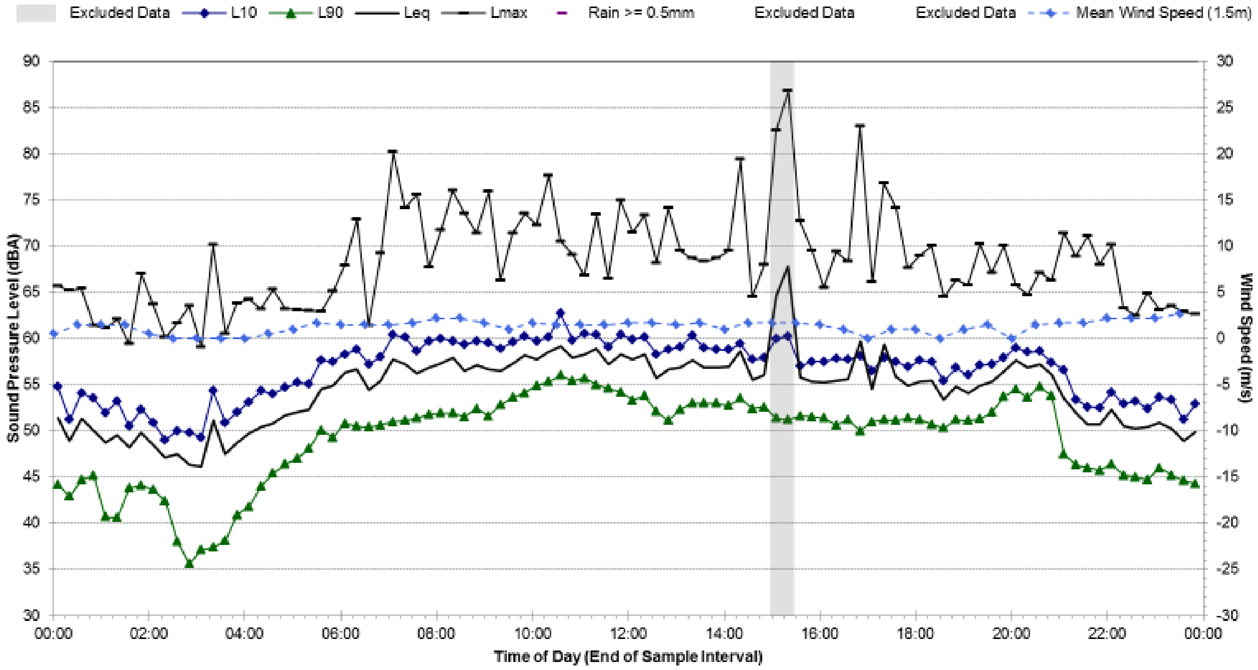
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
14/03/2013	13:55	51	56	66

Photo of Noise Monitoring Location

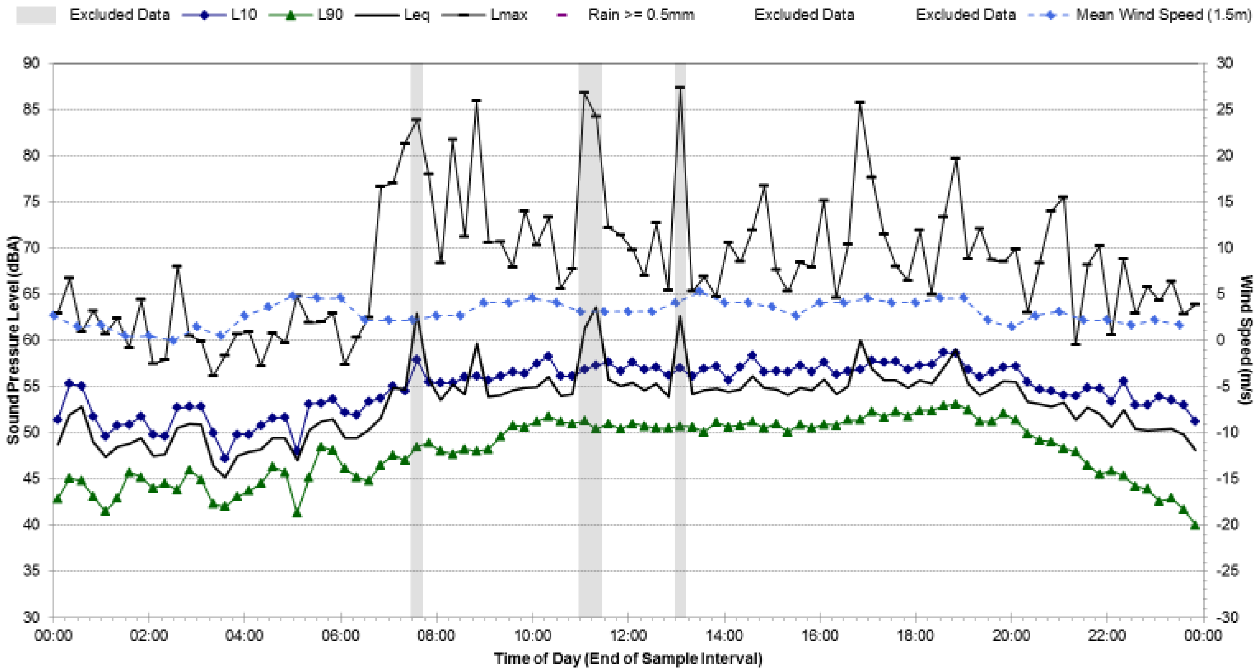

Statistical Ambient Noise Levels
A11.3 - Thursday, 14 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

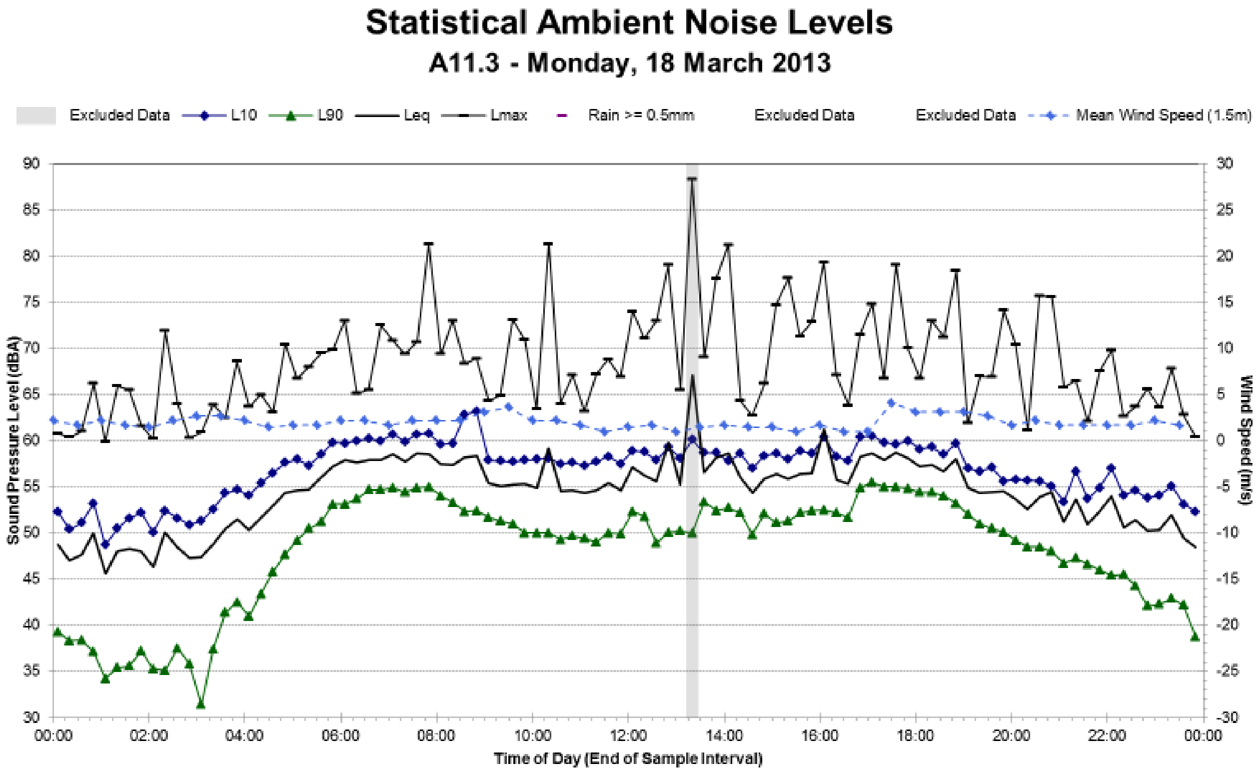

Statistical Ambient Noise Levels
A11.3 - Friday, 15 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Statistical Ambient Noise Levels
A11.3 - Saturday, 16 March 2013

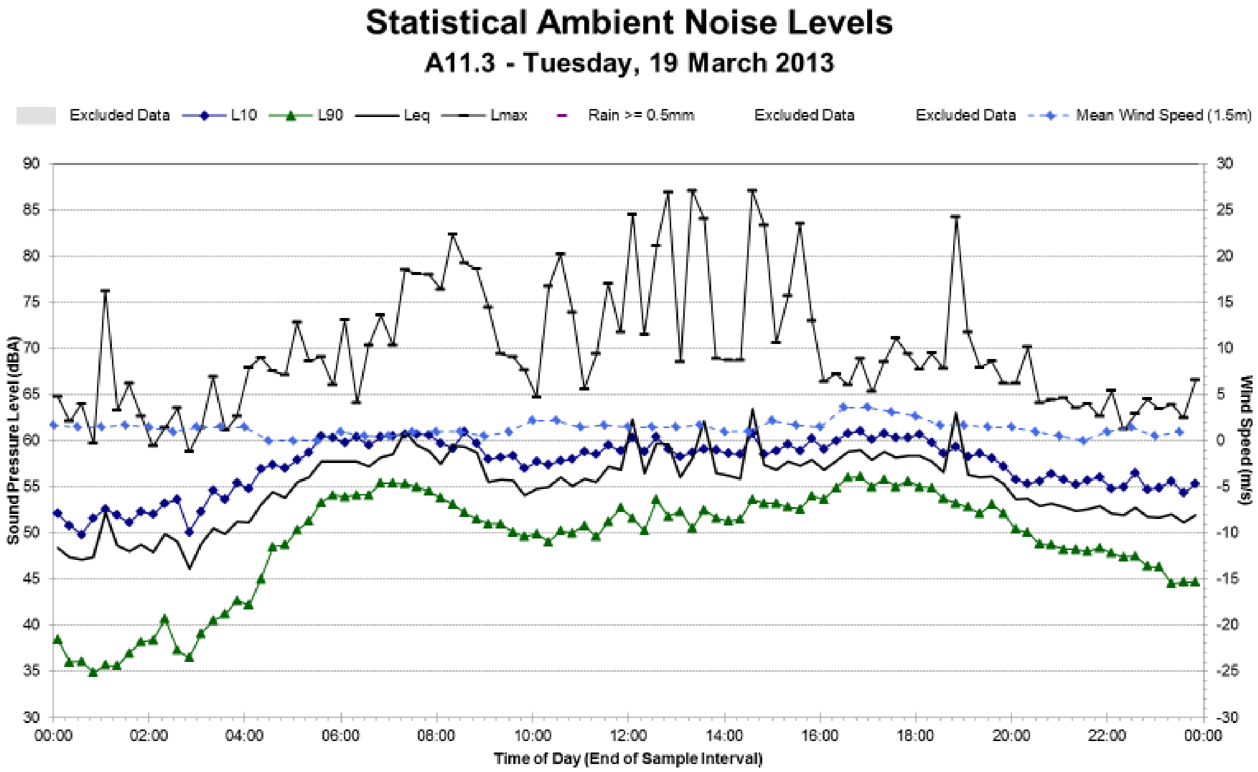


Statistical Ambient Noise Levels
A11.3 - Sunday, 17 March 2013

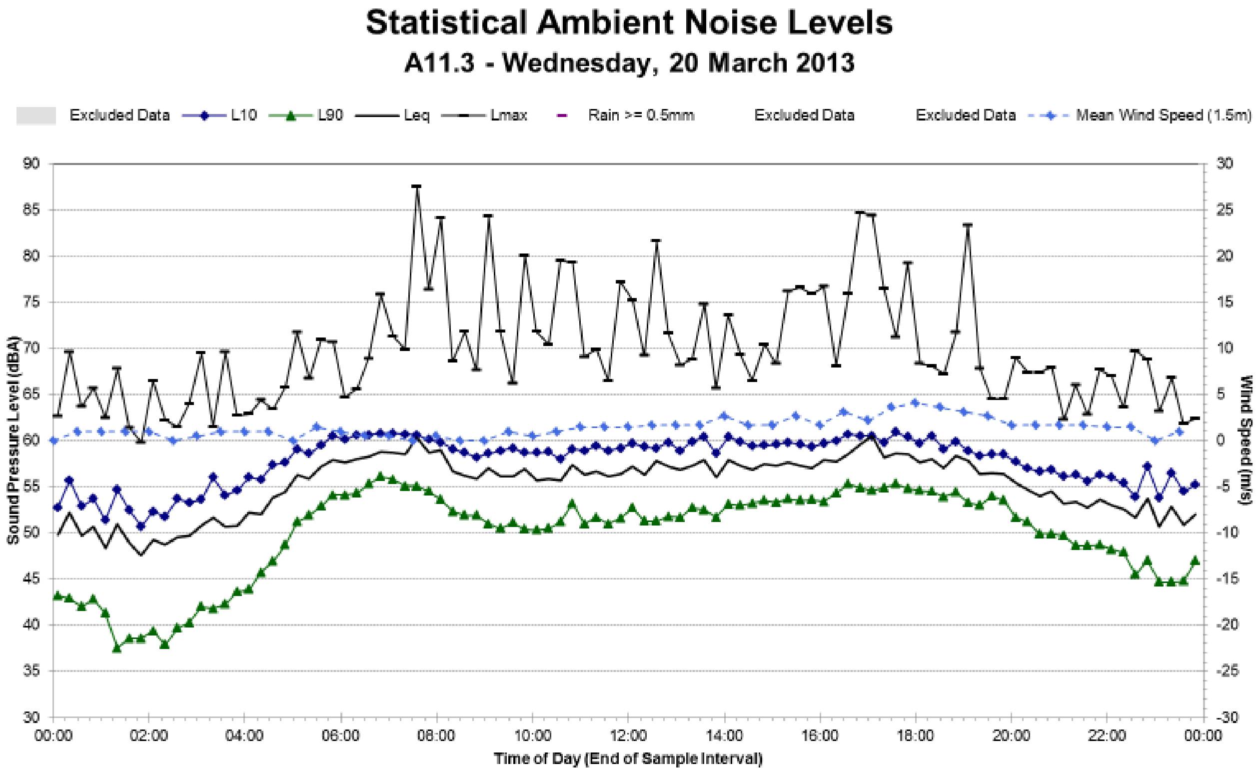


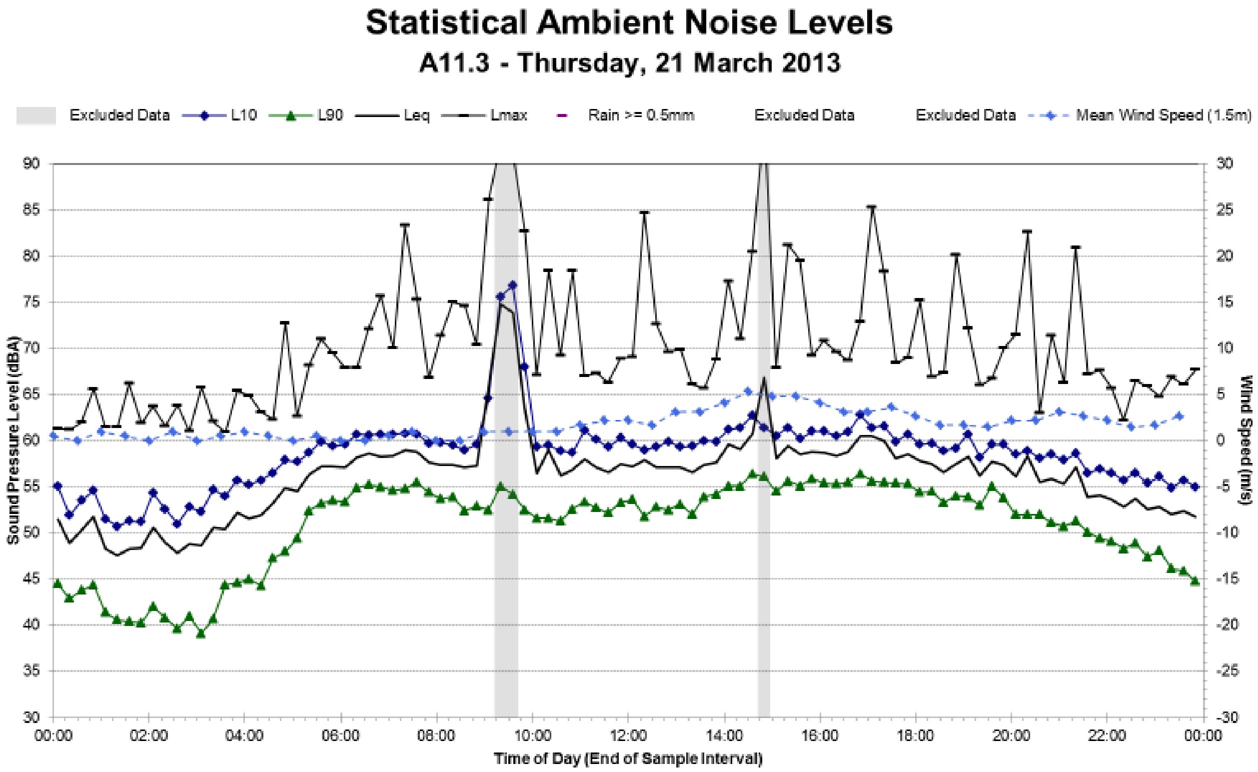


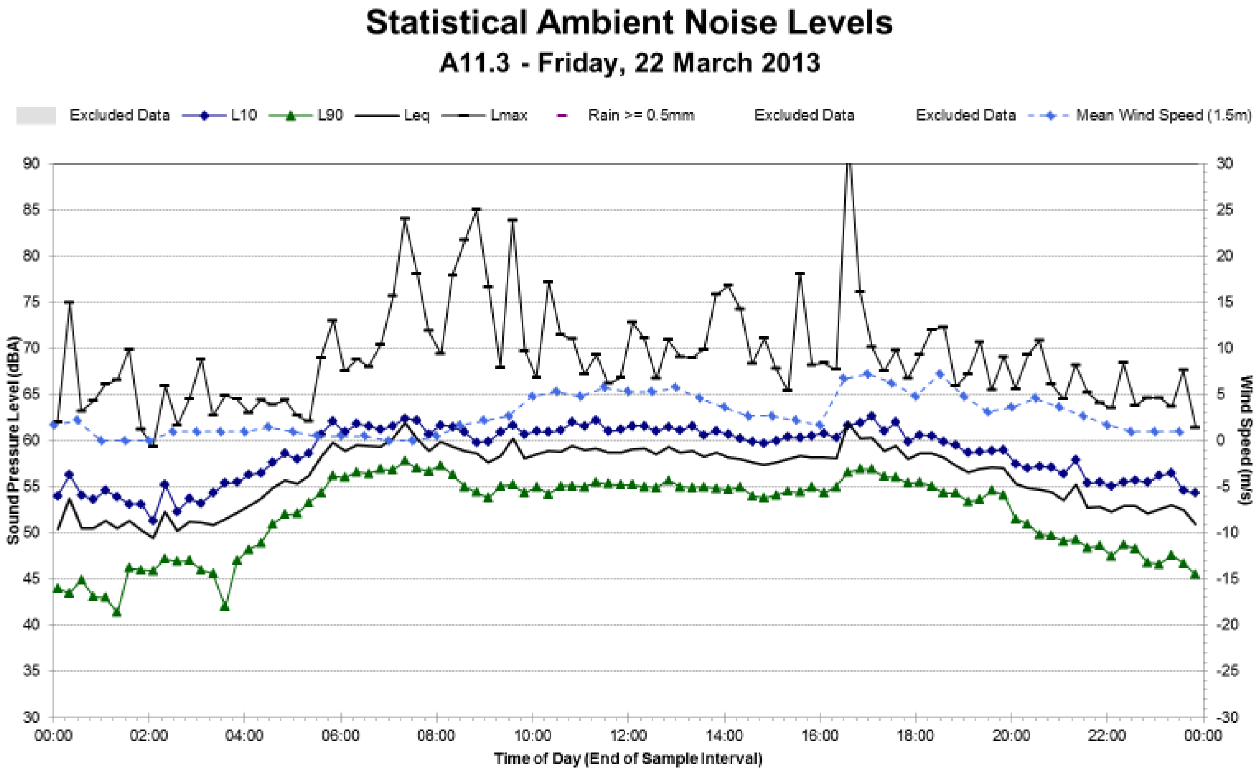
Statistical Ambient Noise Levels
A11.3 - Monday, 18 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

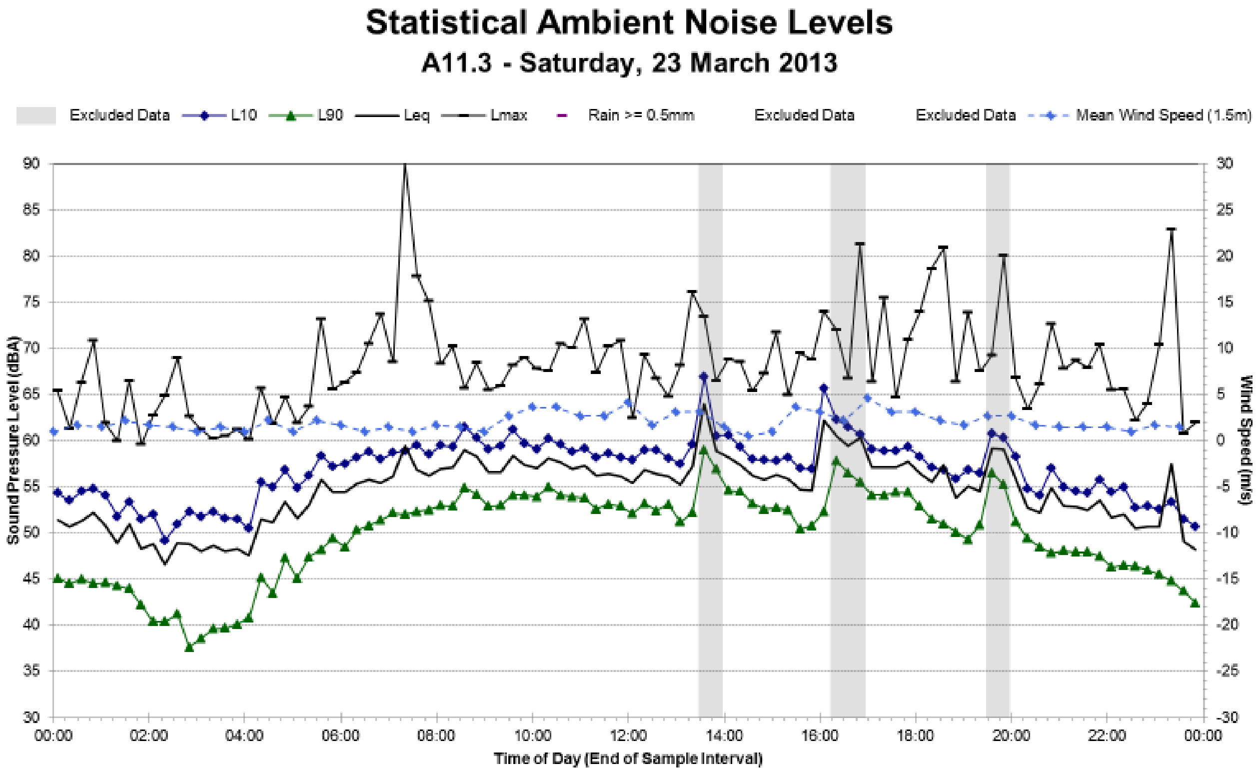


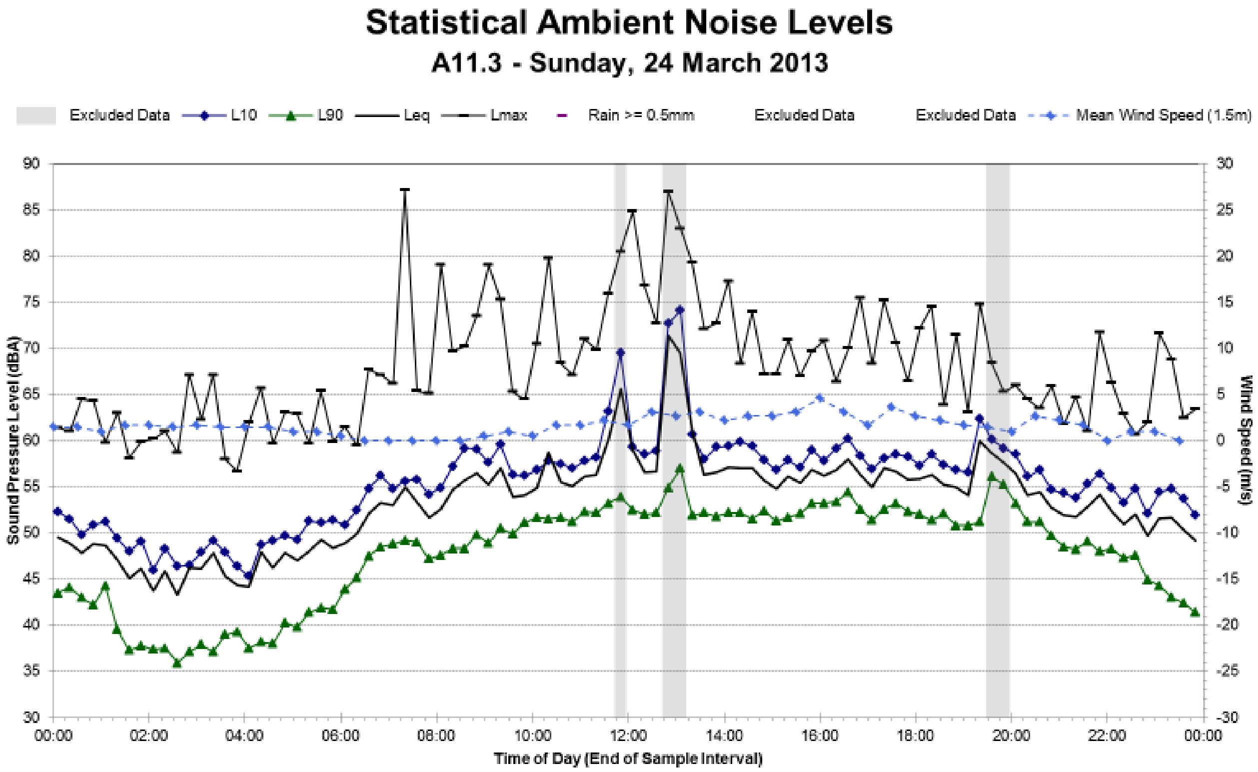
Statistical Ambient Noise Levels
A11.3 - Tuesday, 19 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

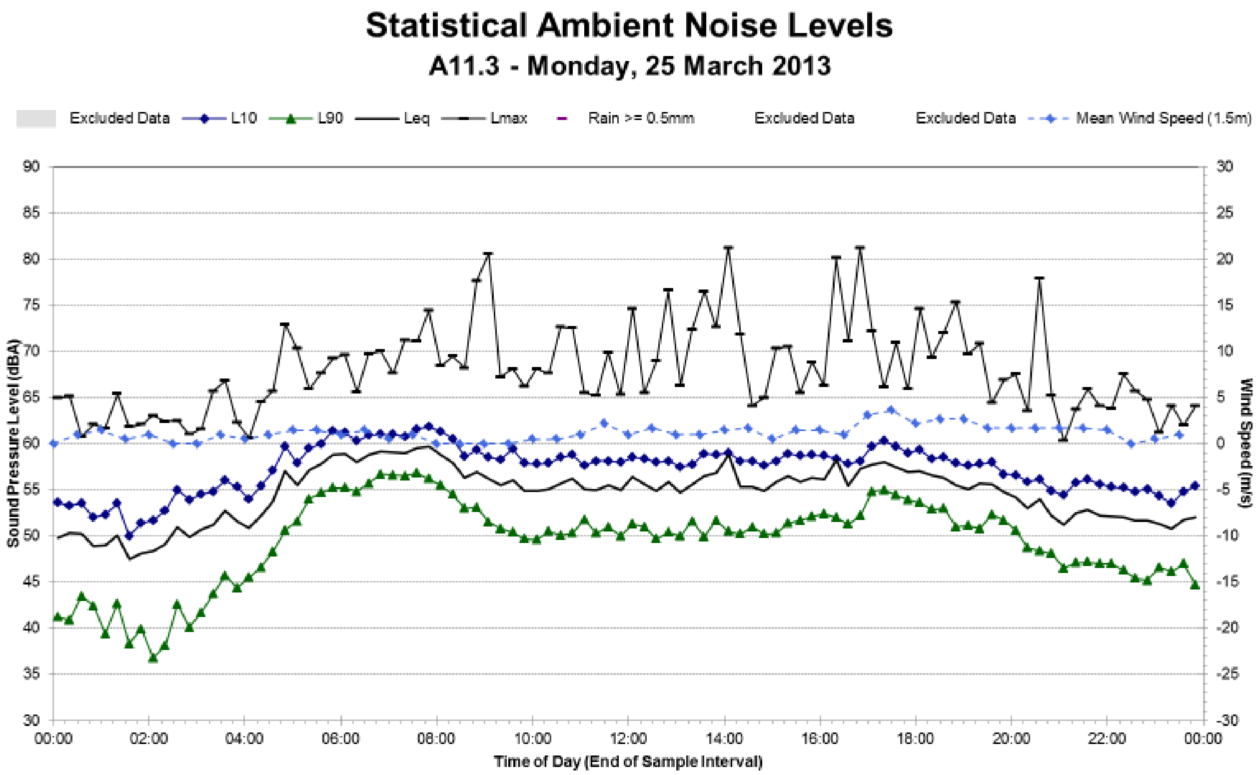

Statistical Ambient Noise Levels
A11.3 - Wednesday, 20 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

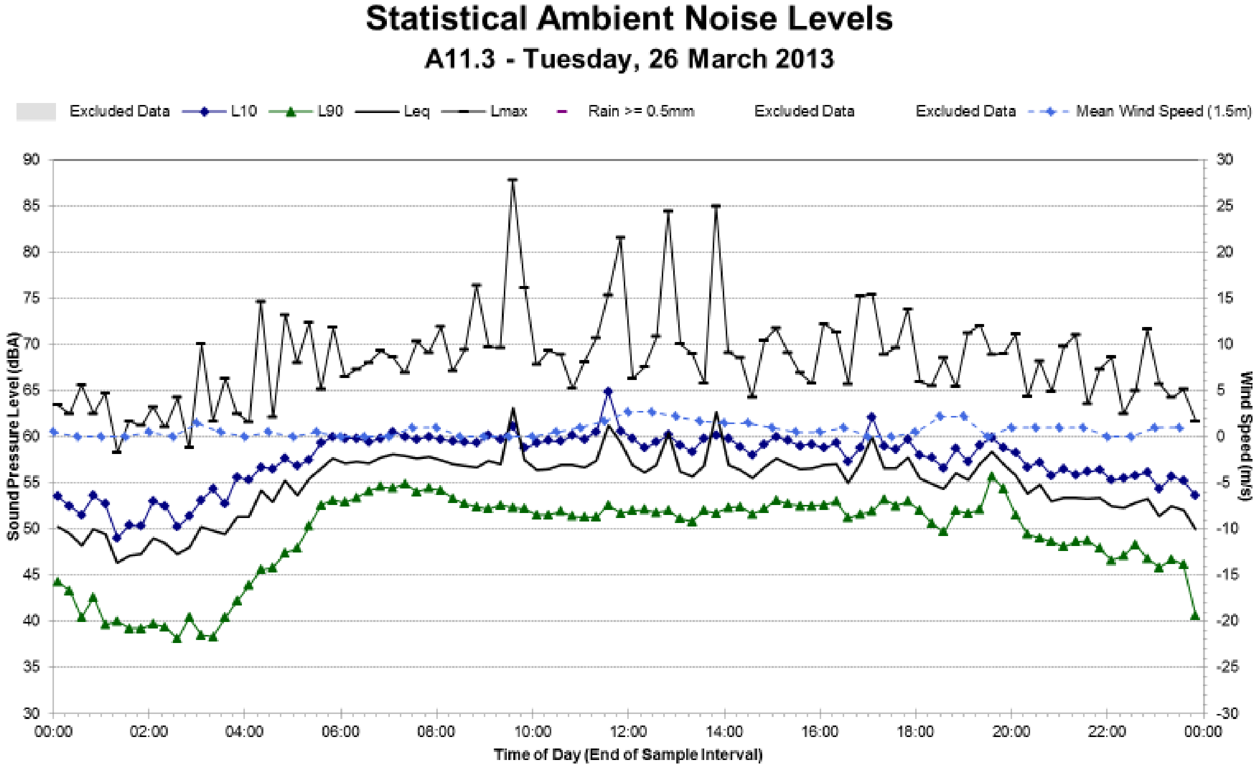

Statistical Ambient Noise Levels
A11.3 - Thursday, 21 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A11.3 - Friday, 22 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

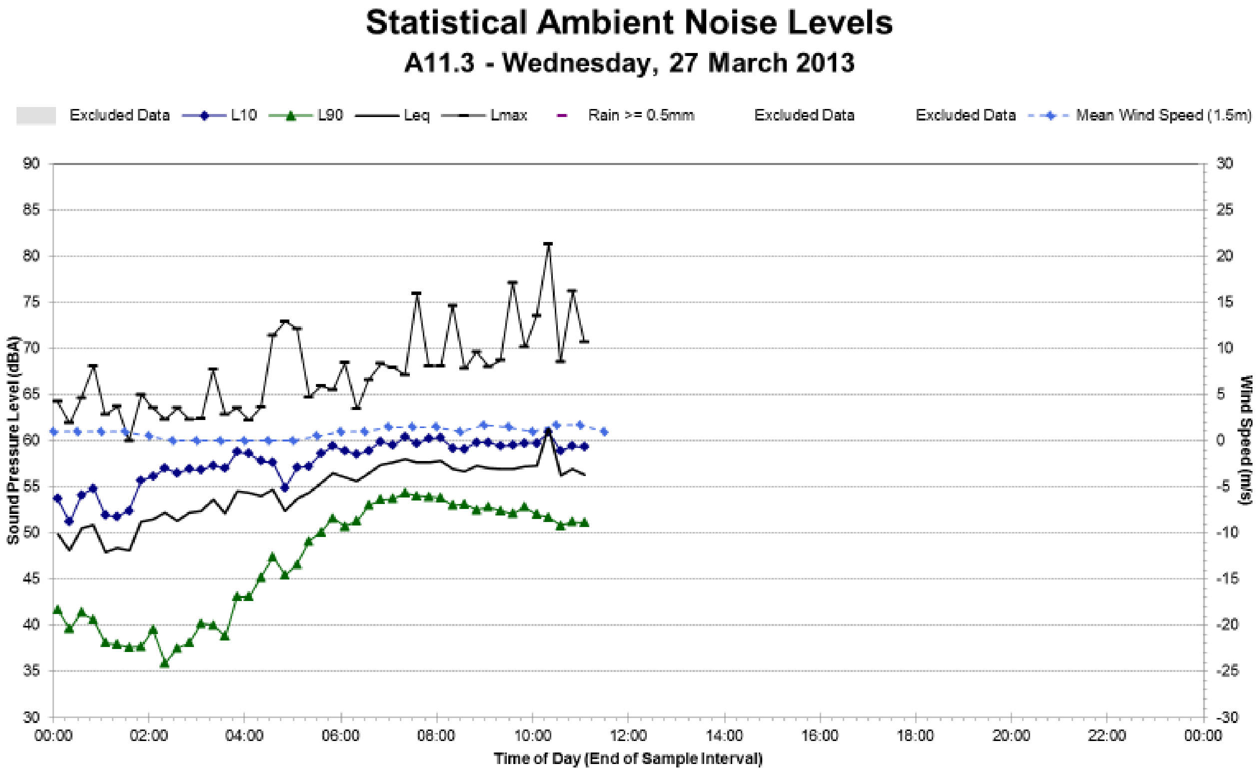

Statistical Ambient Noise Levels
A11.3 - Saturday, 23 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A11.3 - Sunday, 24 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A11.3 - Monday, 25 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
A11.3 - Tuesday, 26 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
A11.3 - Wednesday, 27 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Noise Monitoring Location:	**A11.4**
Noise Monitoring Address:	**Penrith Christian School**

Logger Device Type: Svantek 957
Logger Serial No: 20669

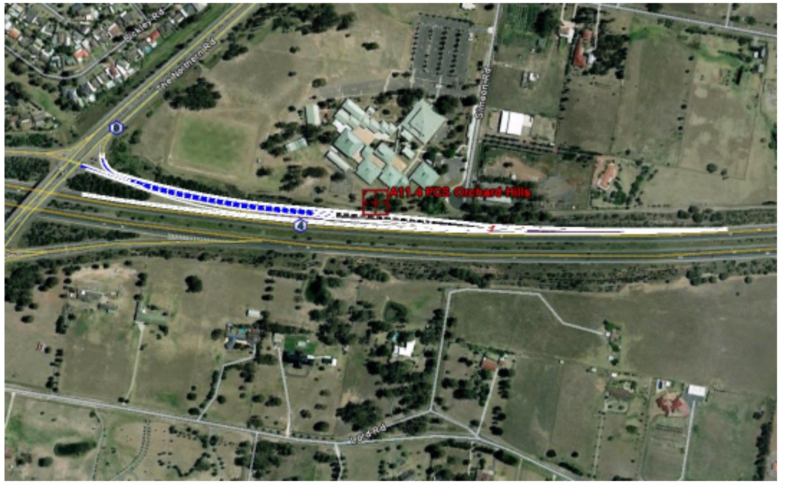
Ambient noise logger deployed near southern boundary of Penrith Christian School approximately 30 m from nearest carriageway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Constant tyre-pavement noise from light-vehicle traffic on M4 ramp can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Unattended noise monitoring was undertaken over a period of approximately 24 hours at this location.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 58-70 dBA, Light-vehicle road traffic: ~55 dBA, School playground: 50-73 dBA

Map of Noise Monitoring Location



Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	56	63	65	71
Evening	50	60	63	70
Night-time	42	59	59	68

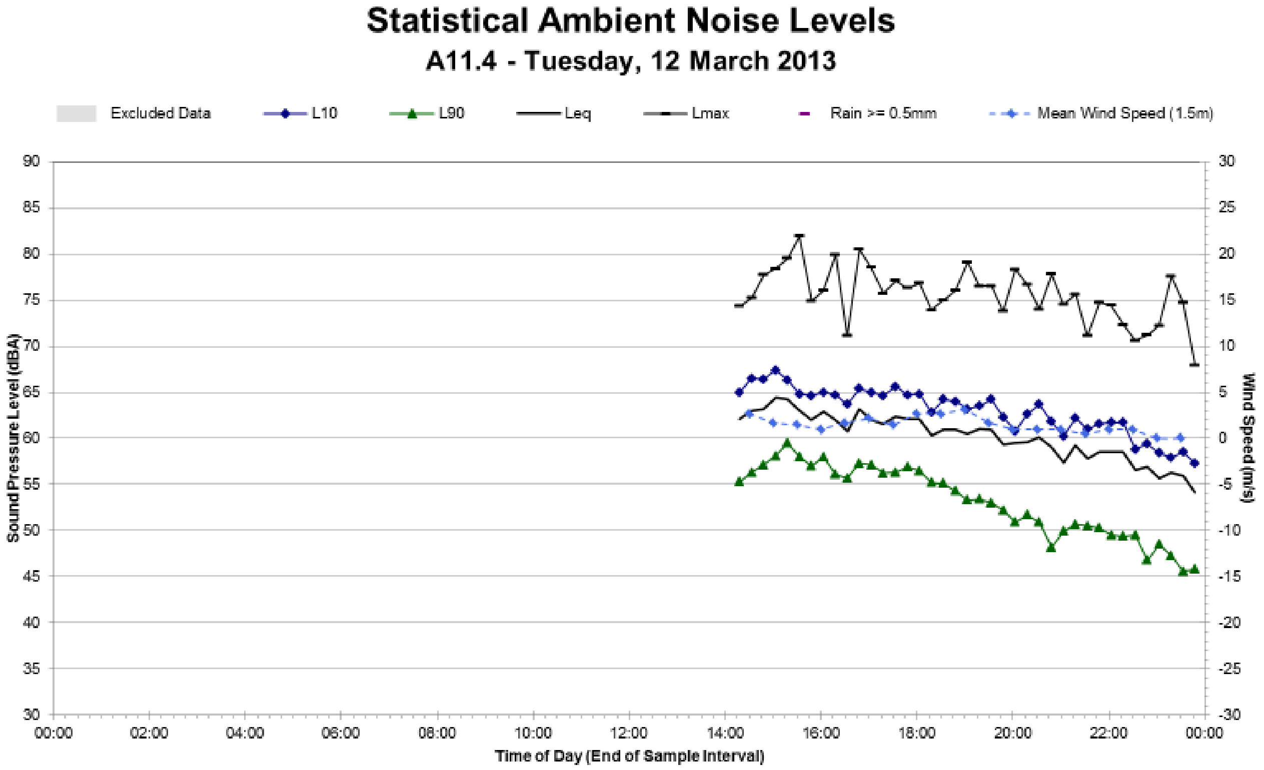
Ambient Noise Logging Results – RNP Defined Time Periods

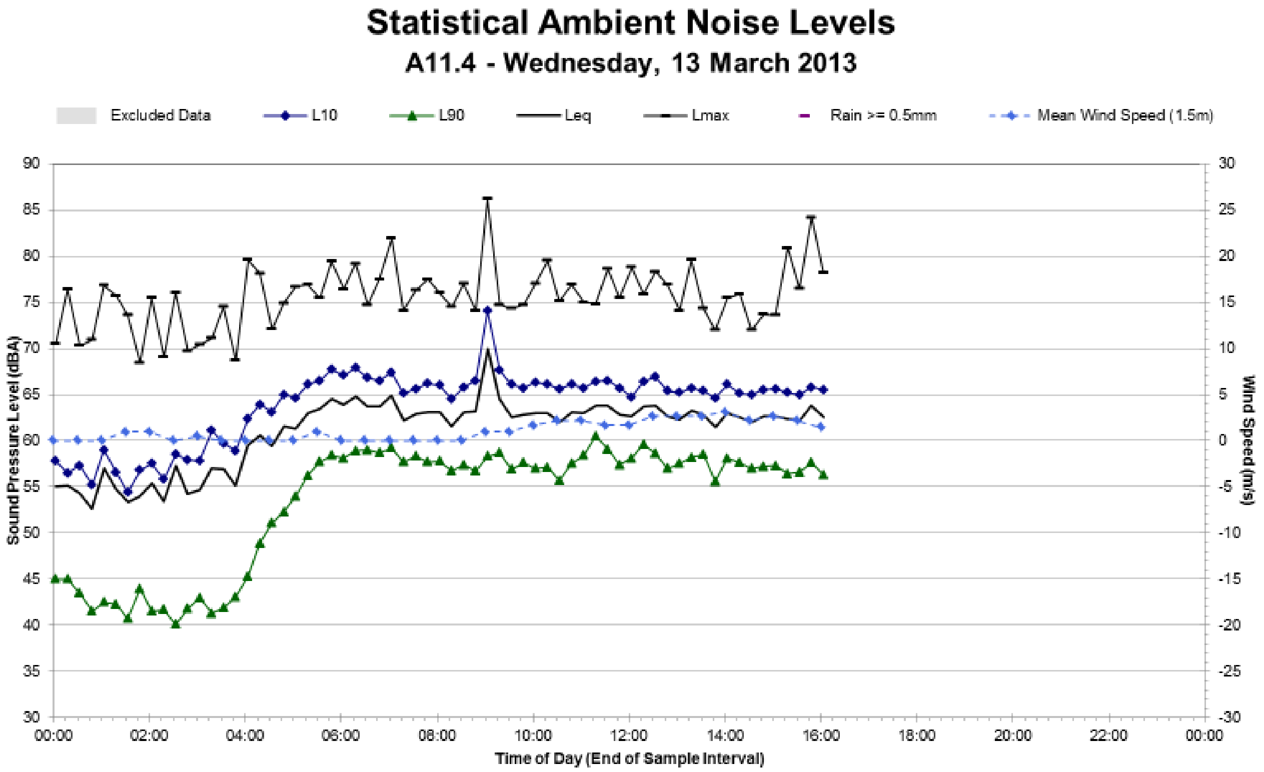
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	1	0	N/A (7 Day Average)
Daytime (7am-10pm)	62	n/a	61
Night-time (10pm-7am)	59	n/a	58

Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
12/03/2013	14:30	55	60	73

Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
A11.4 - Tuesday, 12 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A11.4 - Wednesday, 13 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A12 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A12.1**
Noise Monitoring Address:	**49 Hatchinson Cres, Jamisontown**

Logger Device Type: Svantek 957
Logger Serial No: 23245

Ambient noise logger deployed at rear of residential address 49 Hatchinson Cres, Jamisontown.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4 and insects. Constant tyre-pavement noise from light-vehicle traffic and light vehicle engine noise from traffic on M4 ramp can be heard at this location. During attended measurements it was observed that heavy vehicle movements appear to contribute significantly to the noise environment.

This location appears to be exposed to significant levels of insect noise which are prevalent during the middle of the day. These extraneous noise sources have been removed from the dataset.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 65-73 dBA, Light-vehicle road traffic: ~65 dBA, Insects: <55 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	50	62	63	69
Evening	46	56	58	66
Night-time	36	57	56	67

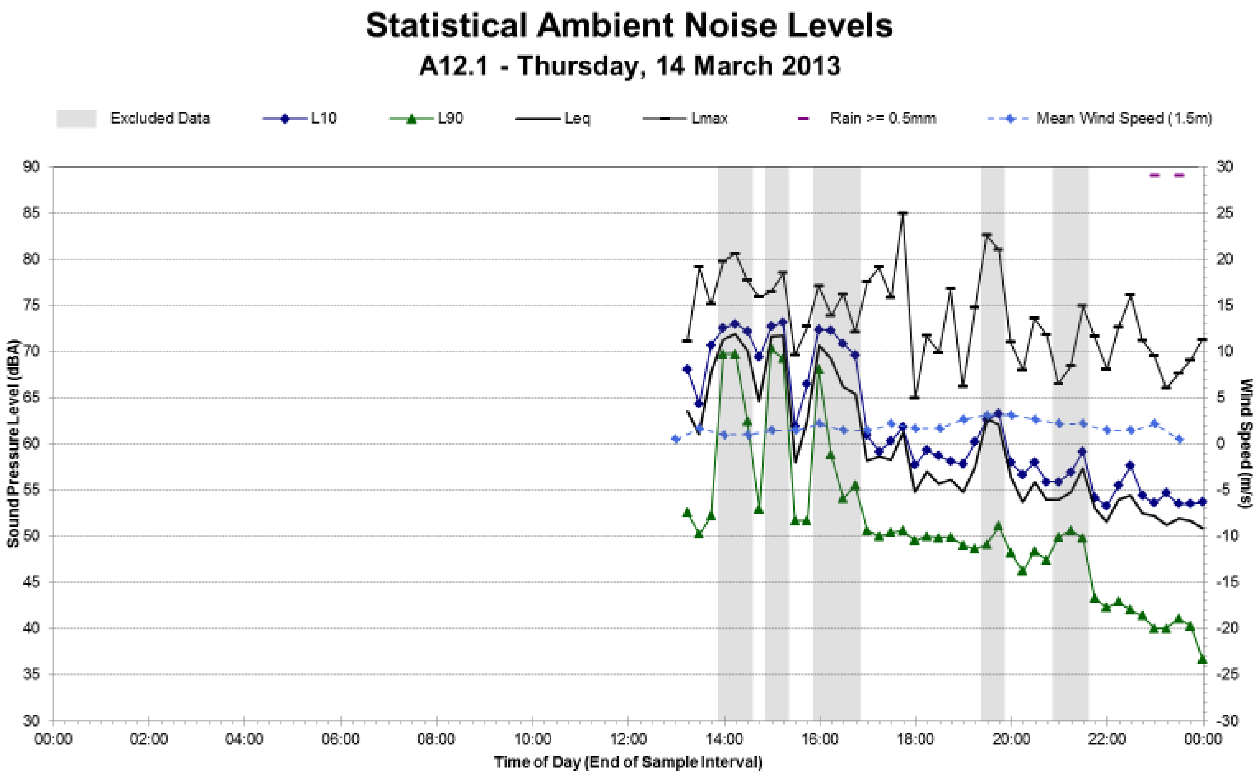
Ambient Noise Logging Results – RNP Defined Time Periods

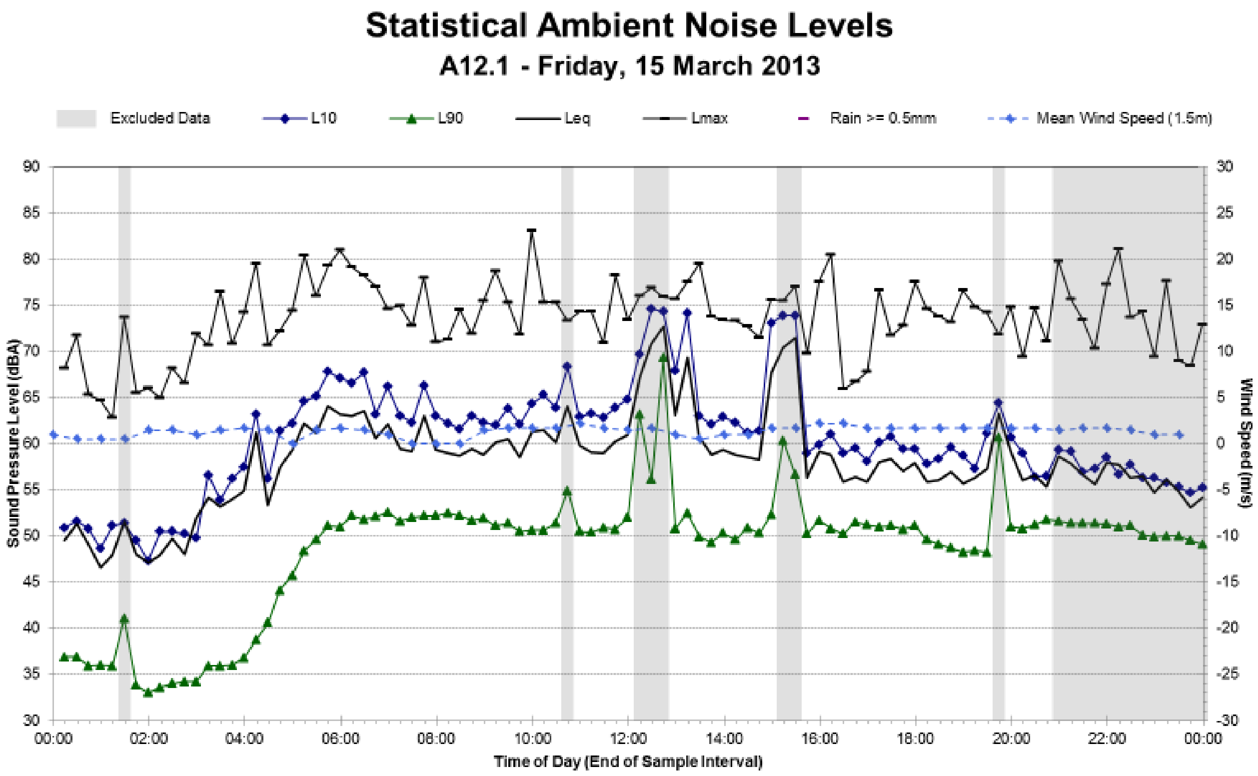
Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	Weekend LAeq(Period)	Weekly LAeq(Period)
Number of Valid Days	4	1	N/A (7 Day Average)
Daytime (7am-10pm)	61	62	61
Night-time (10pm-7am)	58	56	57

Attended Noise Measurement Results

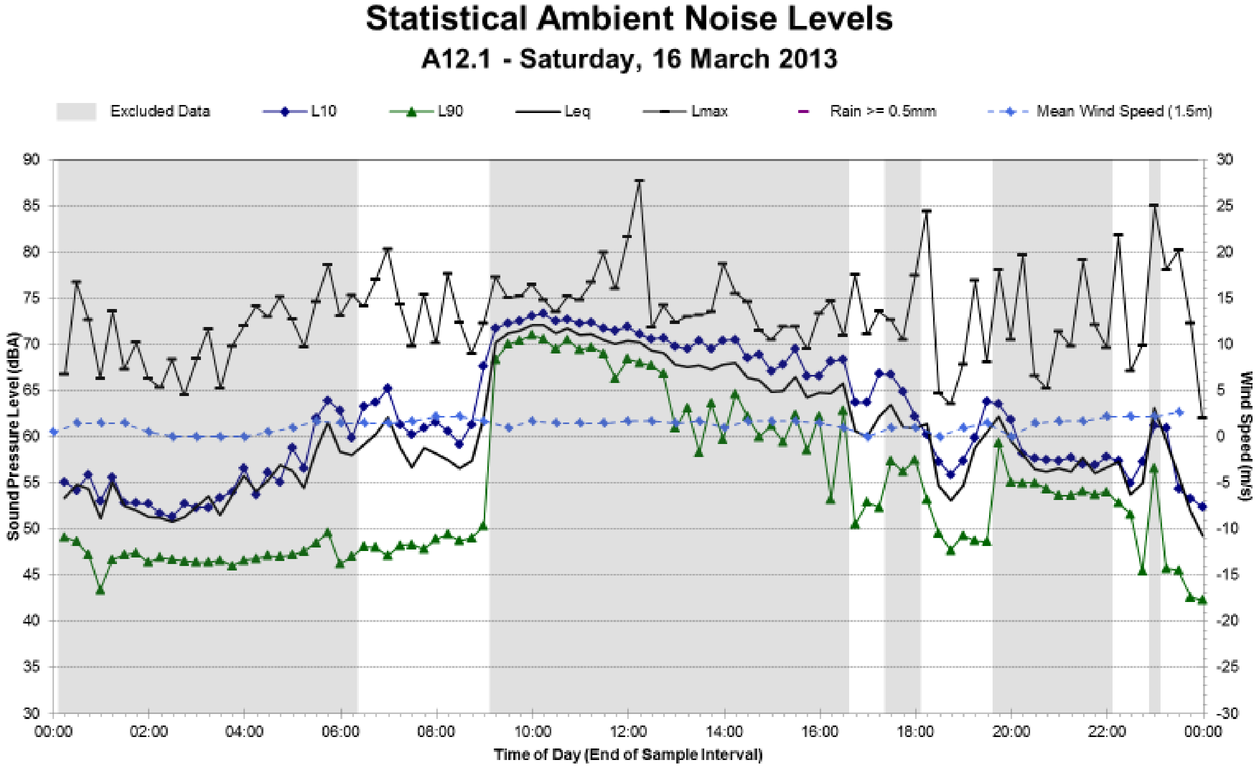
Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
14/03/2013	13:05	58	66	81

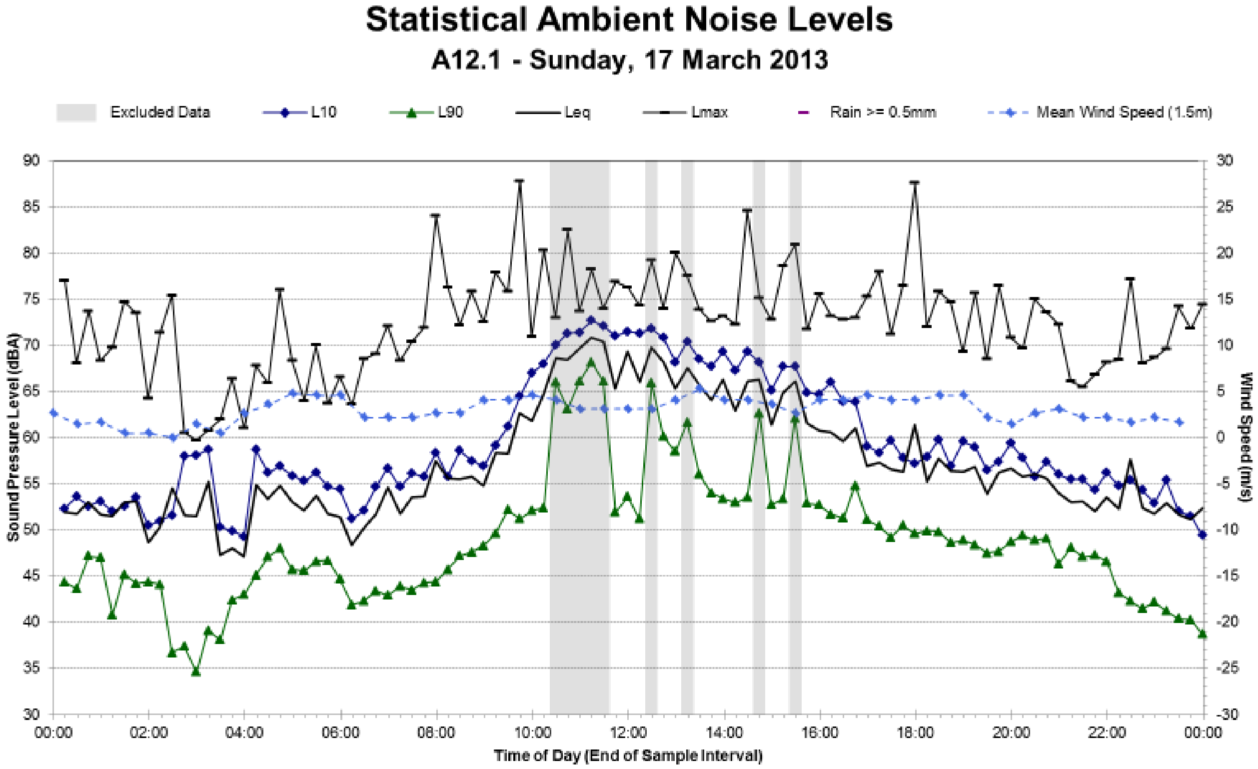
Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
A12.1 - Thursday, 14 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

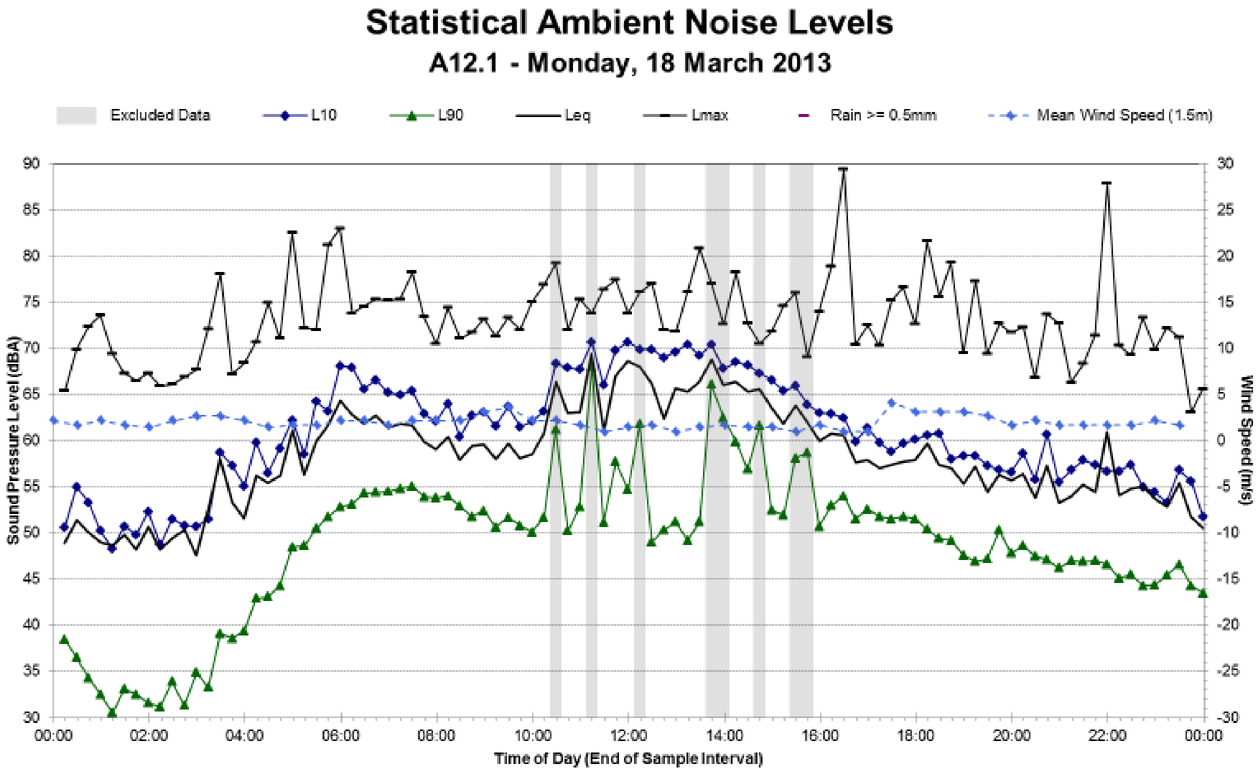

Statistical Ambient Noise Levels
A12.1 - Friday, 15 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

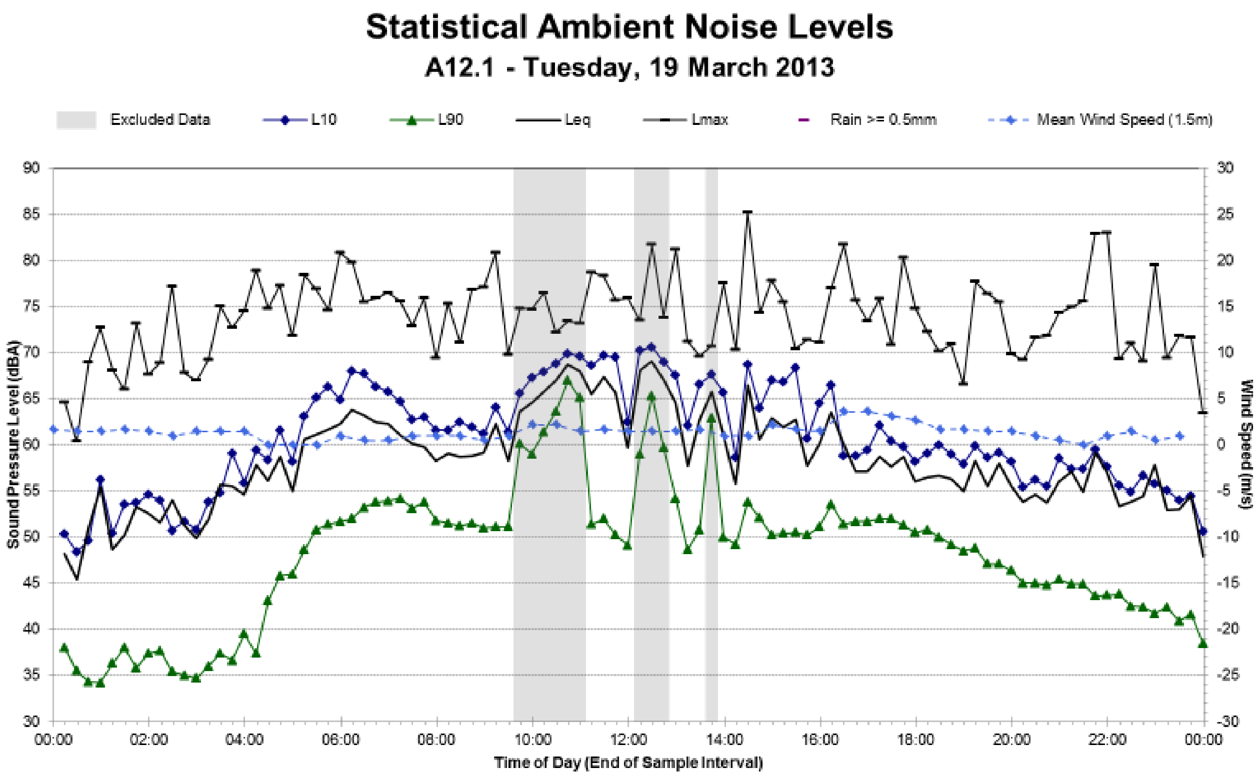
A12 Ambient Noise Monitoring Results



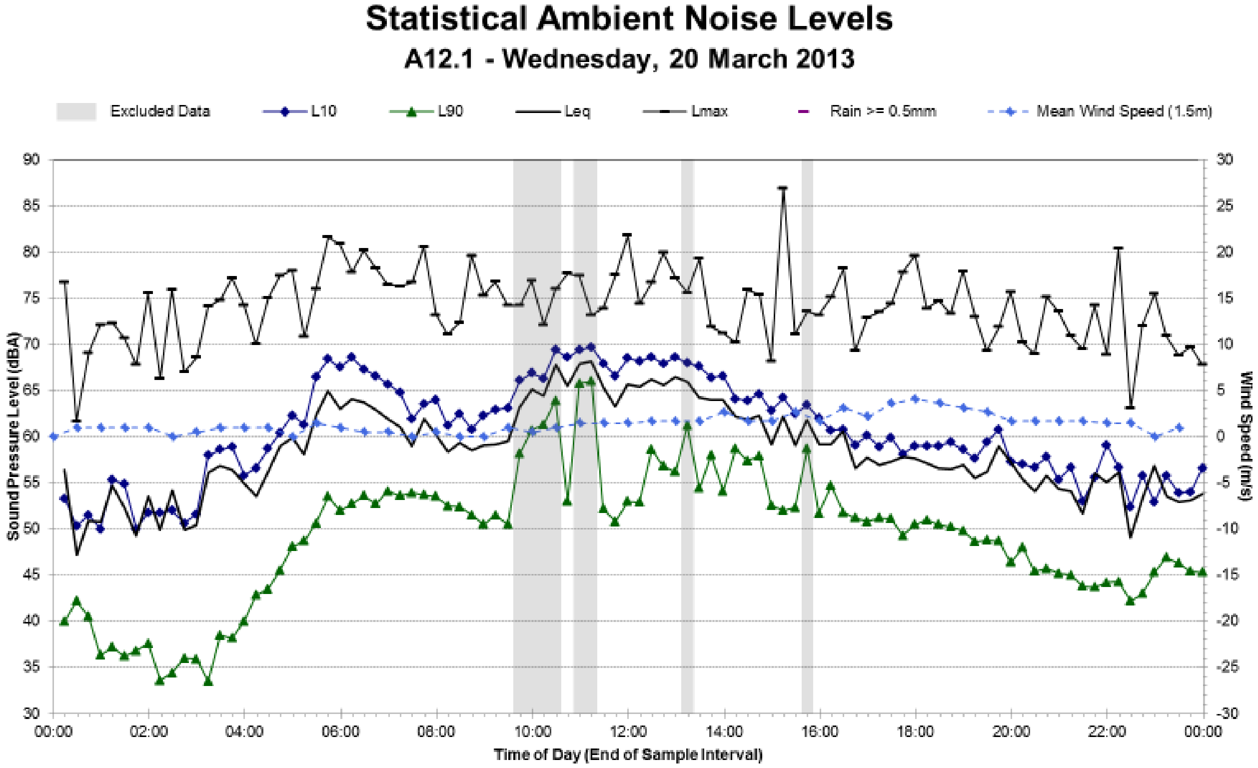


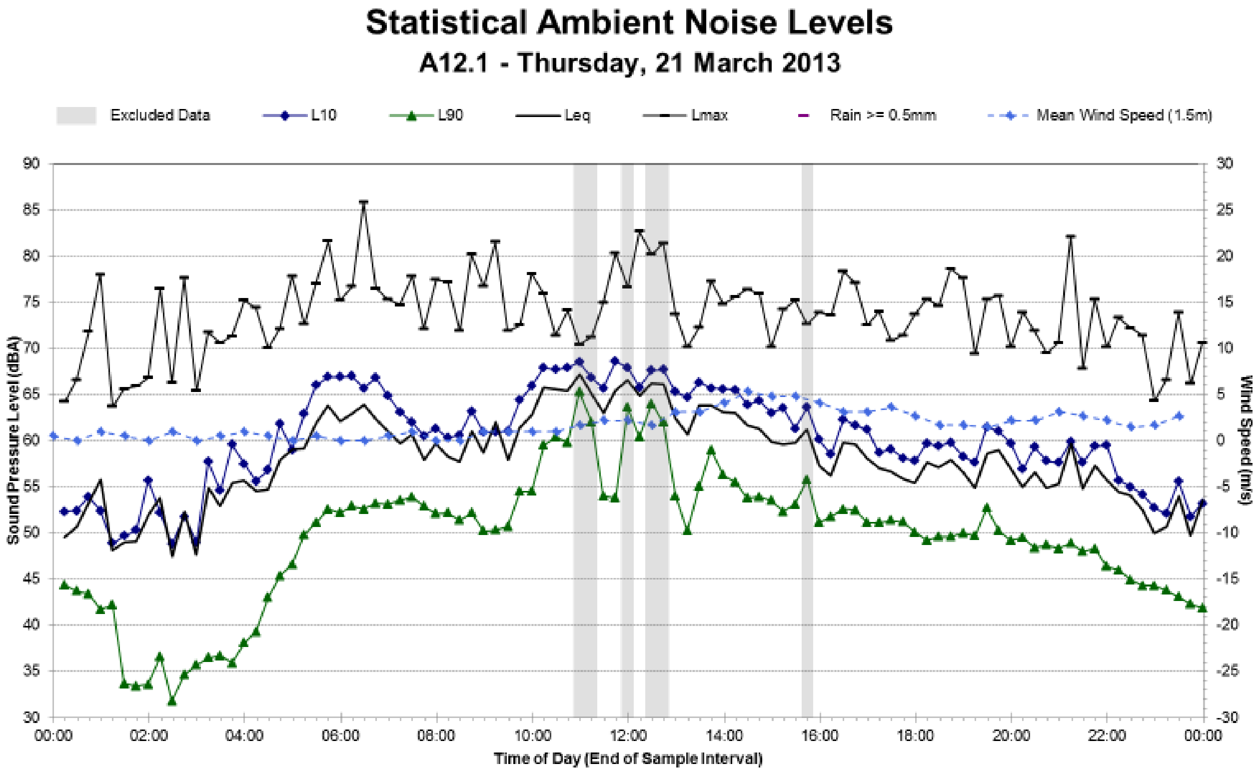
A12 Ambient Noise Monitoring Results

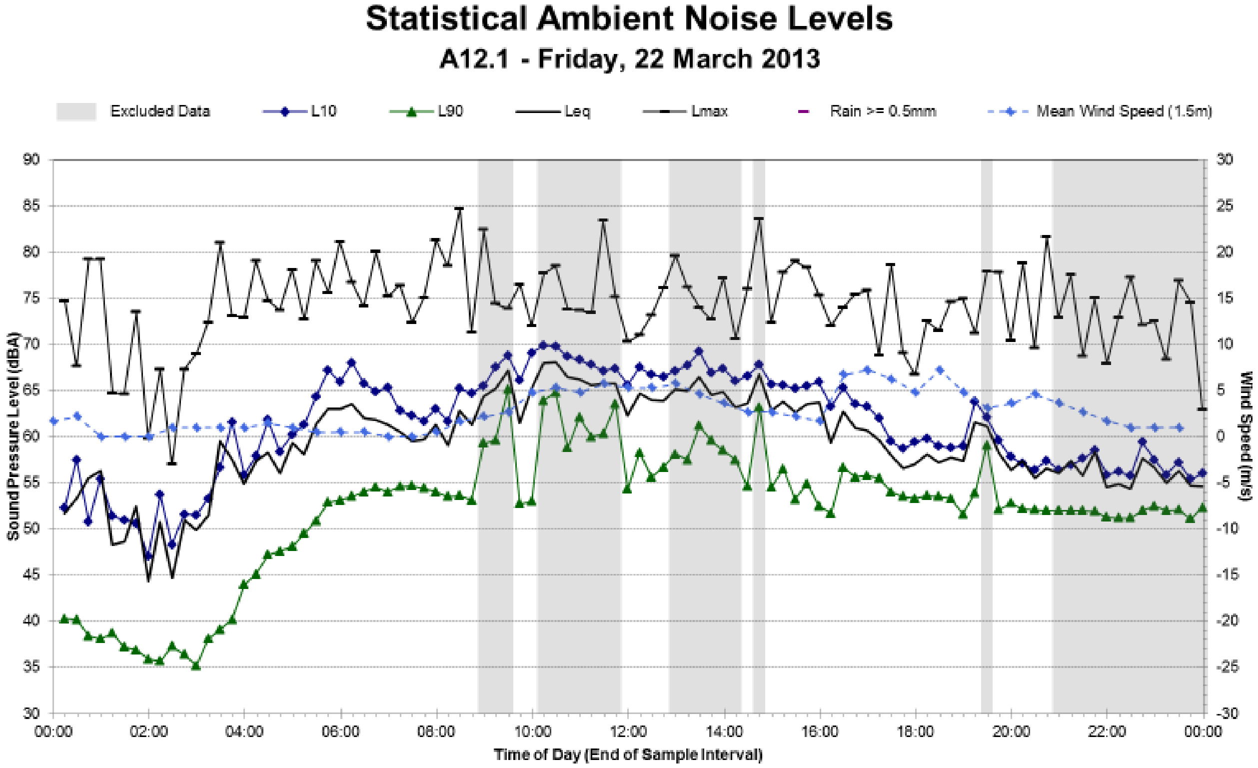


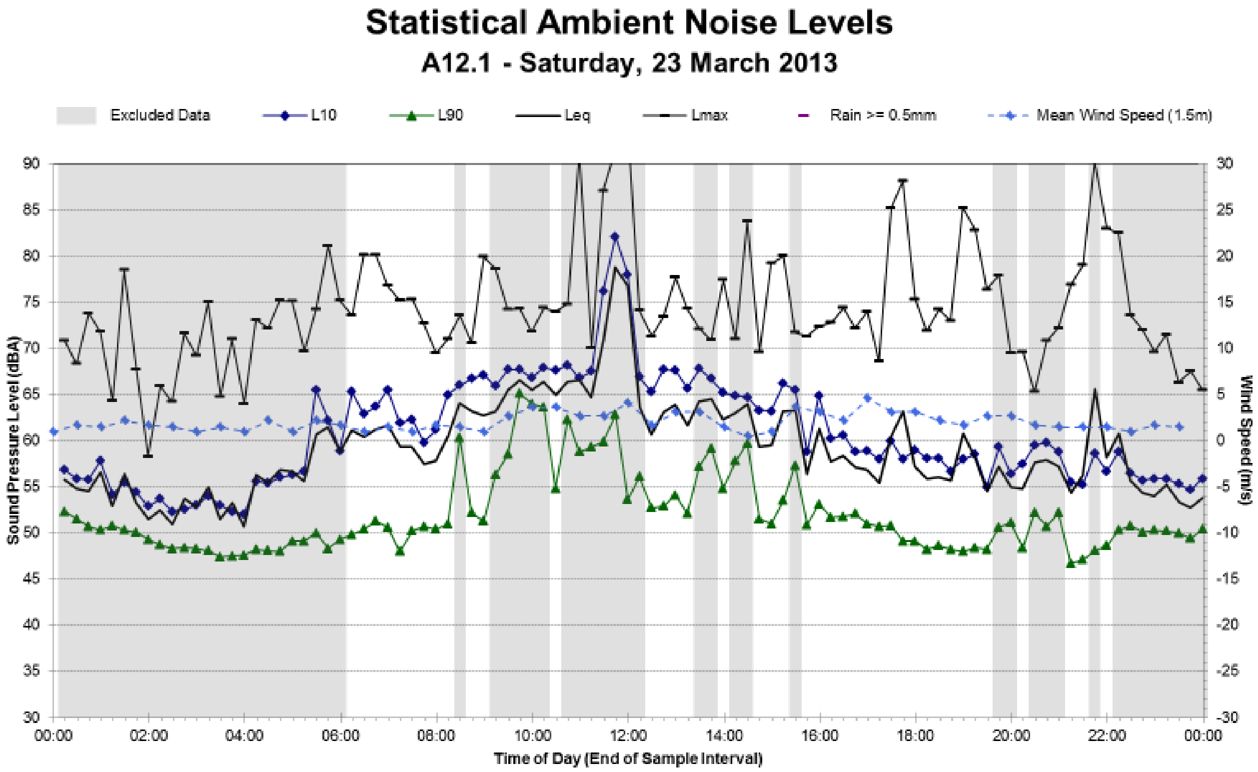


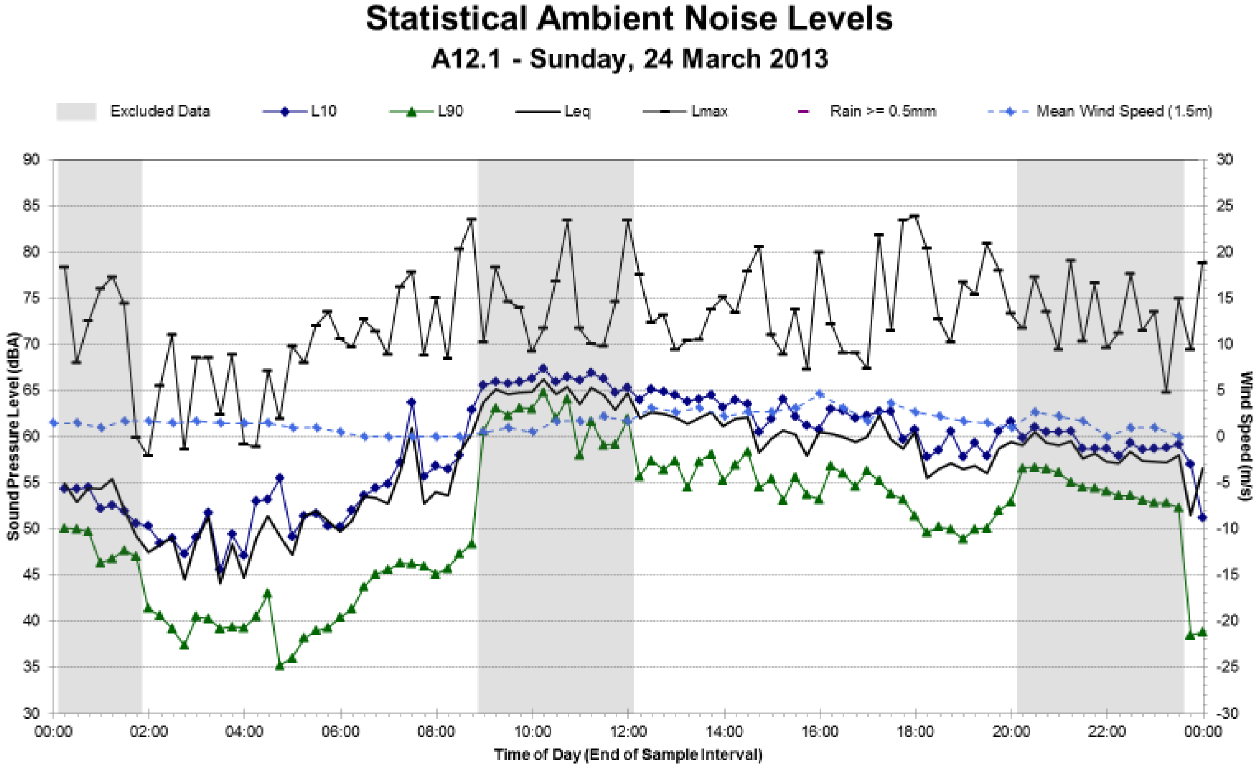
A12 Ambient Noise Monitoring Results

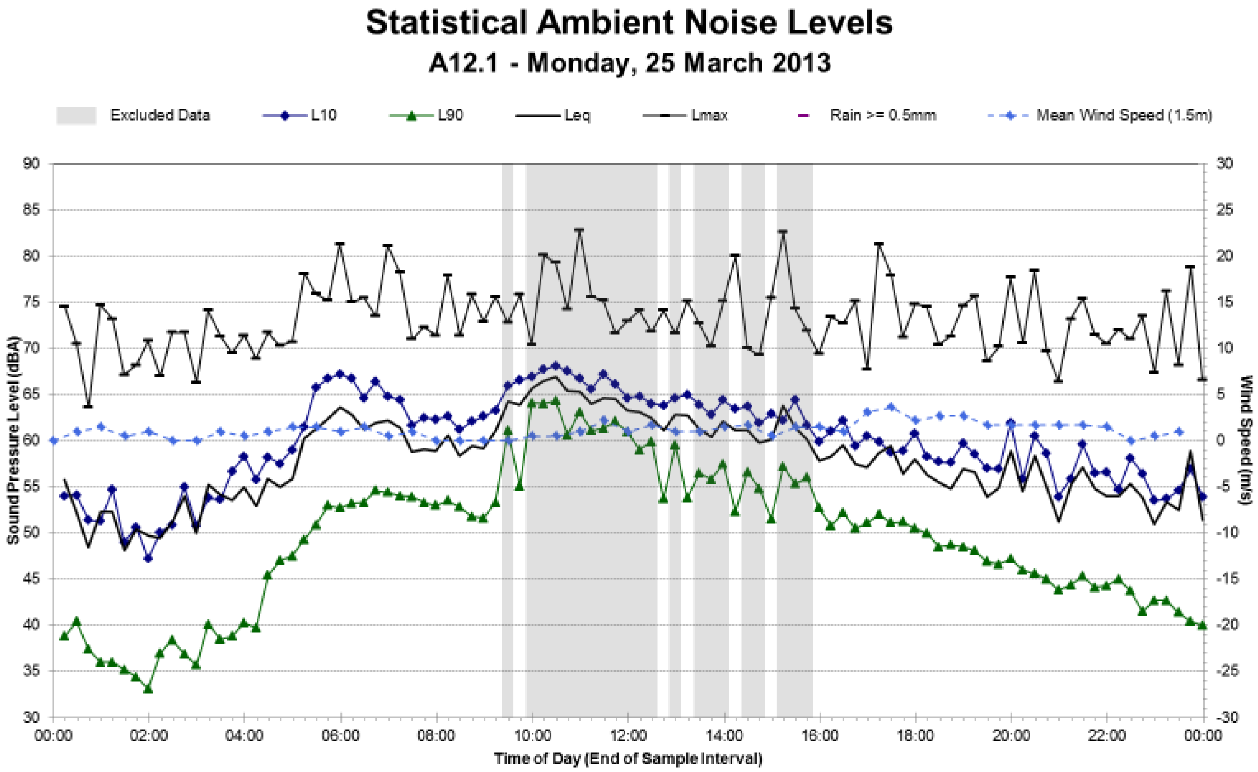




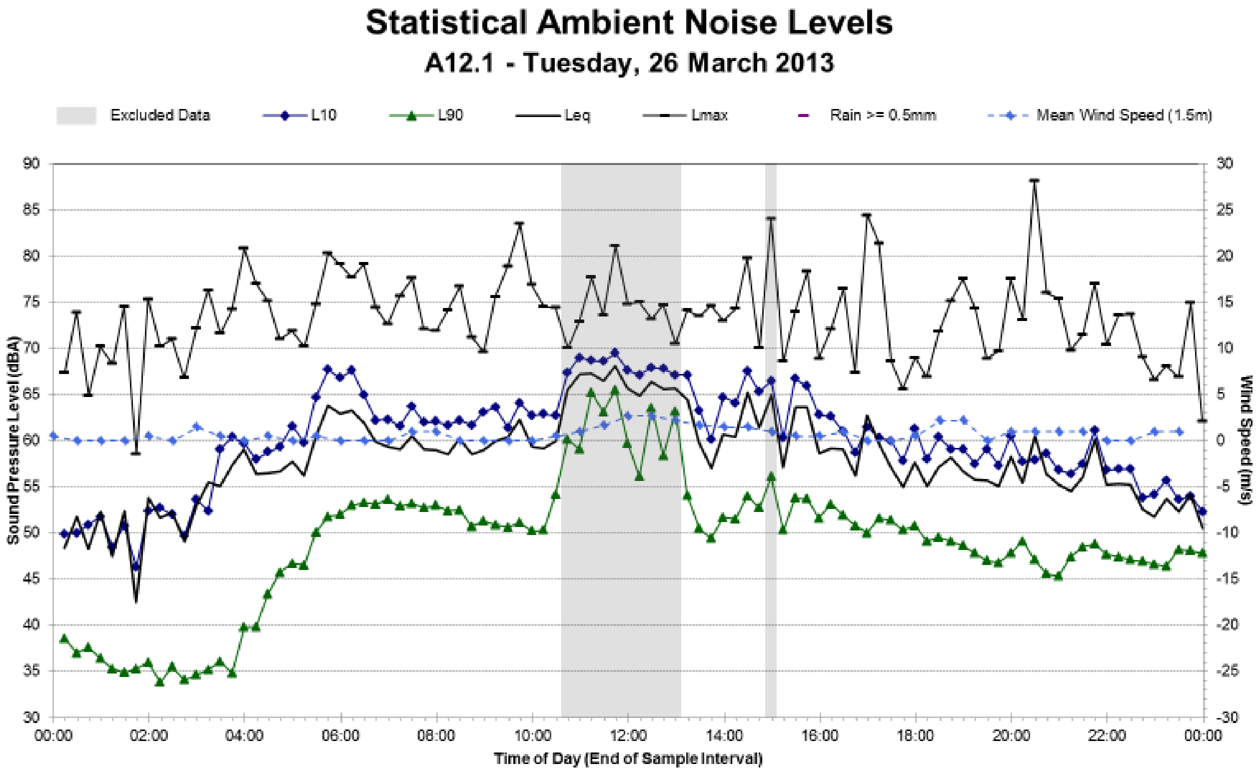

Statistical Ambient Noise Levels
A12.1 - Friday, 22 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

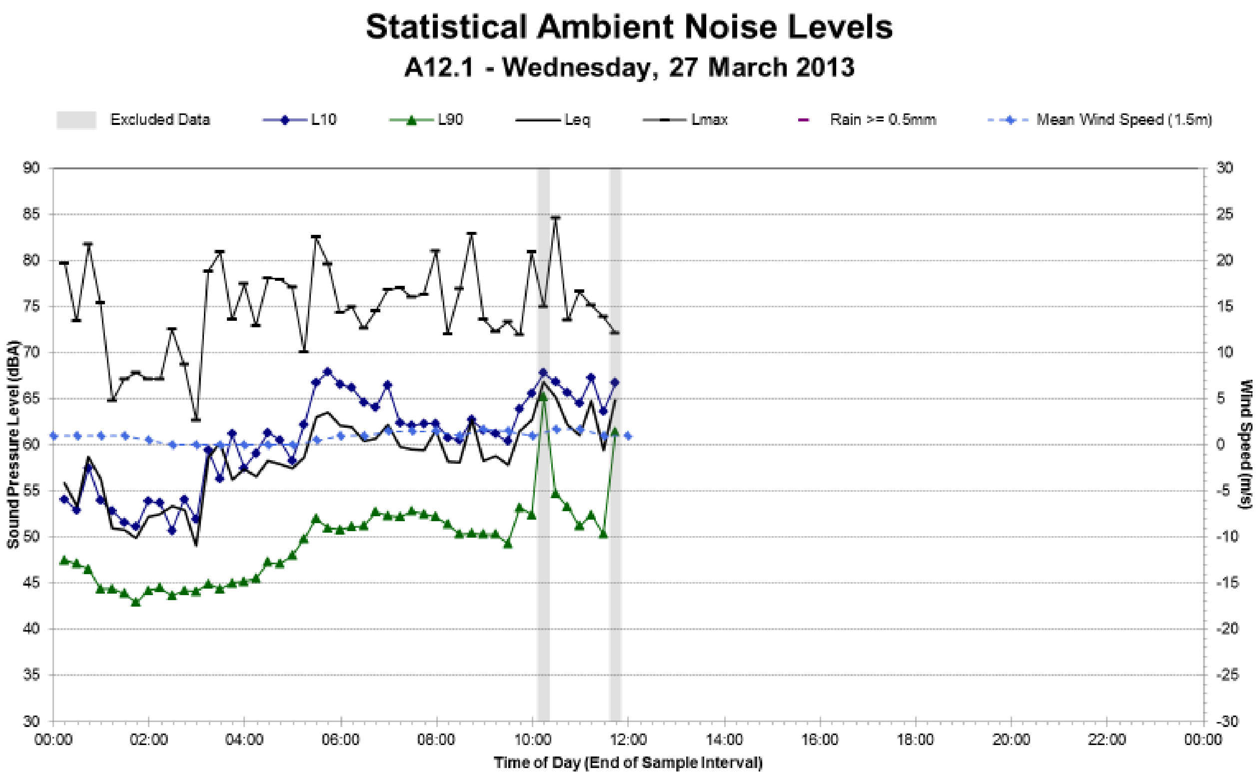

Statistical Ambient Noise Levels
A12.1 - Saturday, 23 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A12.1 - Sunday, 24 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A12.1 - Monday, 25 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A12 Ambient Noise Monitoring Results





A12 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A12.2**
Noise Monitoring Address:	**41-61 Factory Rd, Regentville**

Logger Device Type: Svantek 957
Logger Serial No: 20675

Ambient noise logger deployed at rear of residential address 41-61 Factory Rd, Regentville approximately 65 m from the nearest M4 carriageway.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Frequent tyre-pavement noise from light-vehicle traffic on M4 can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 55-78 dBA, Light-vehicle road traffic: 50-59 dBA, Motorcycles: 57-59 dBA, Birds: 50-58 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	50	57	59	63
Evening	46	56	56	62
Night-time	36	51	53	60

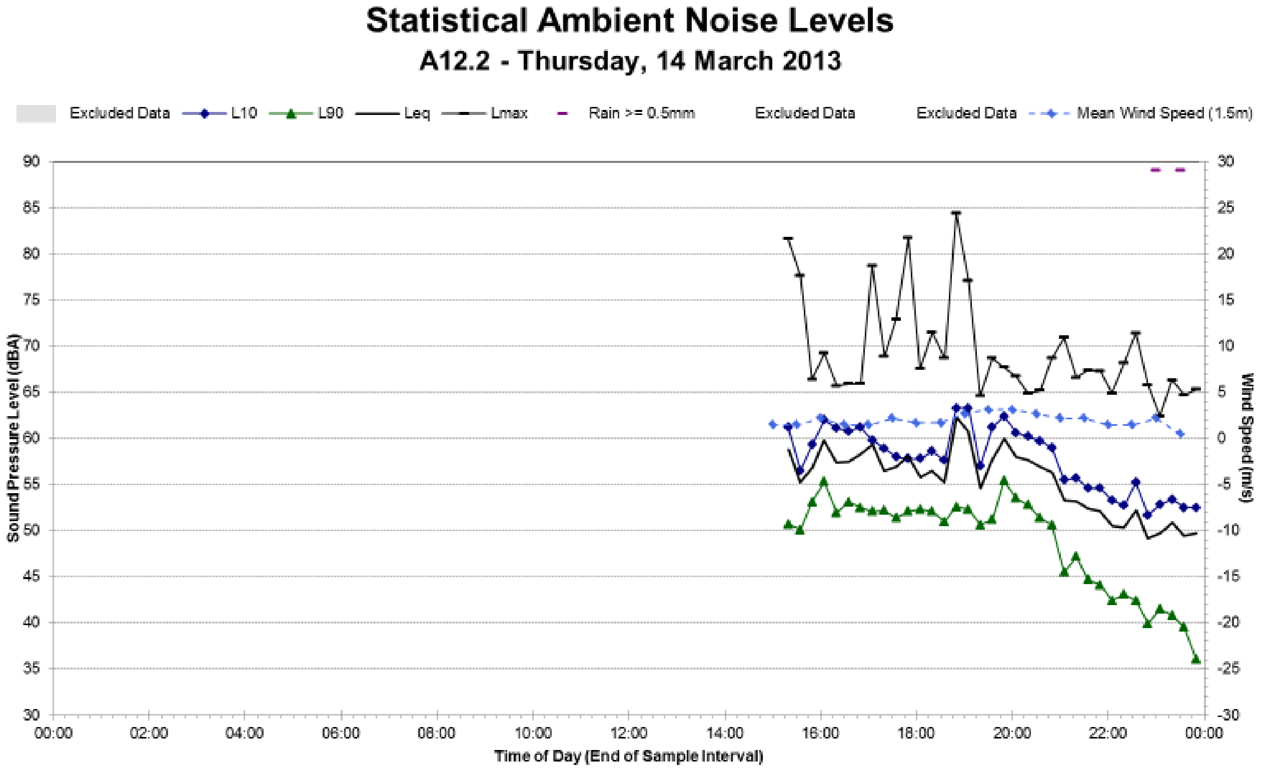
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	8	3	N/A (7 Day Average)
Daytime (7am-10pm)	57	56	56
Night-time (10pm-7am)	52	51	51

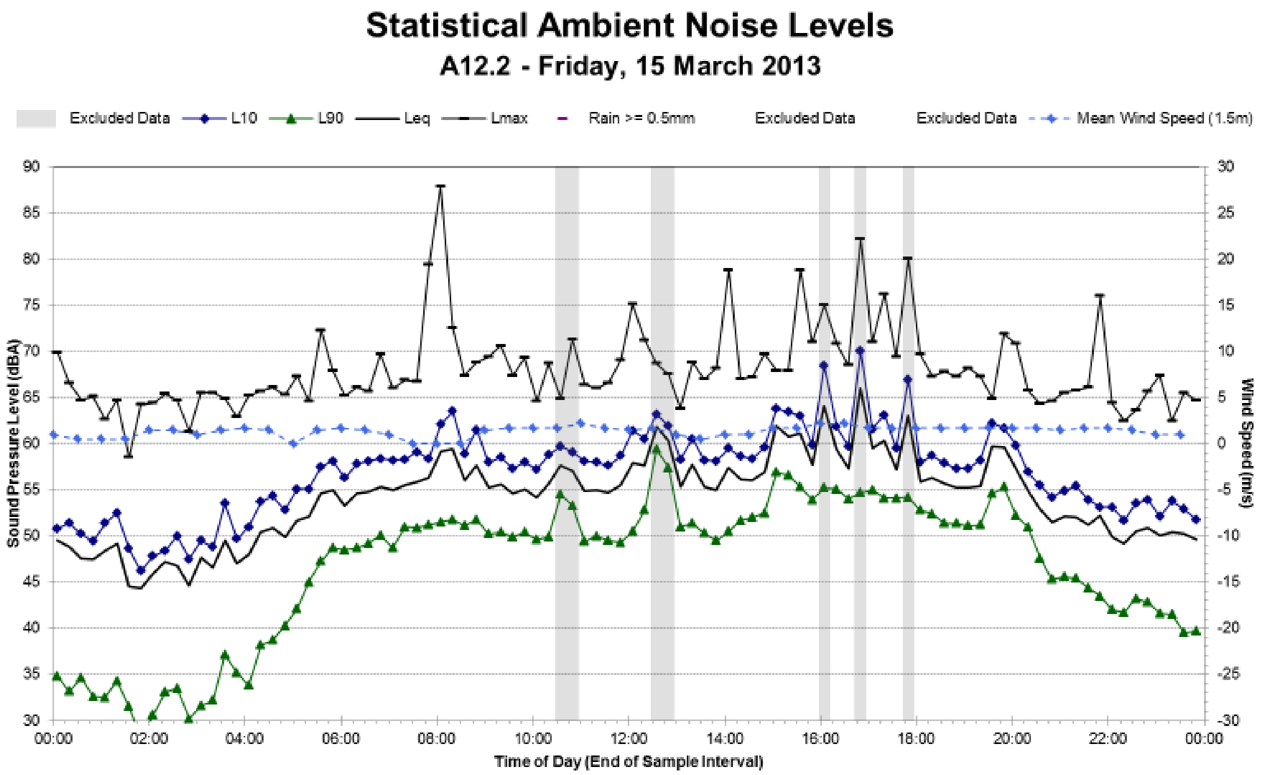
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
14/03/2013	15:15	50	56	78

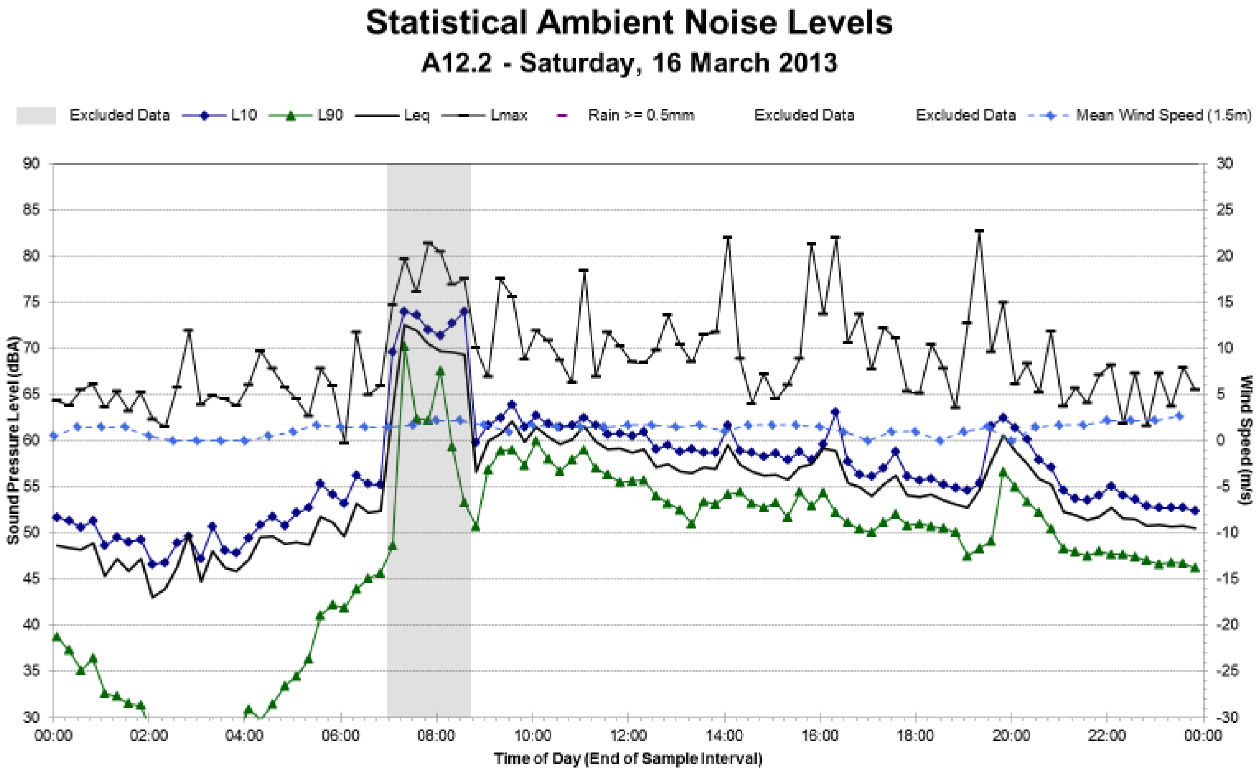
Photo of Noise Monitoring Location

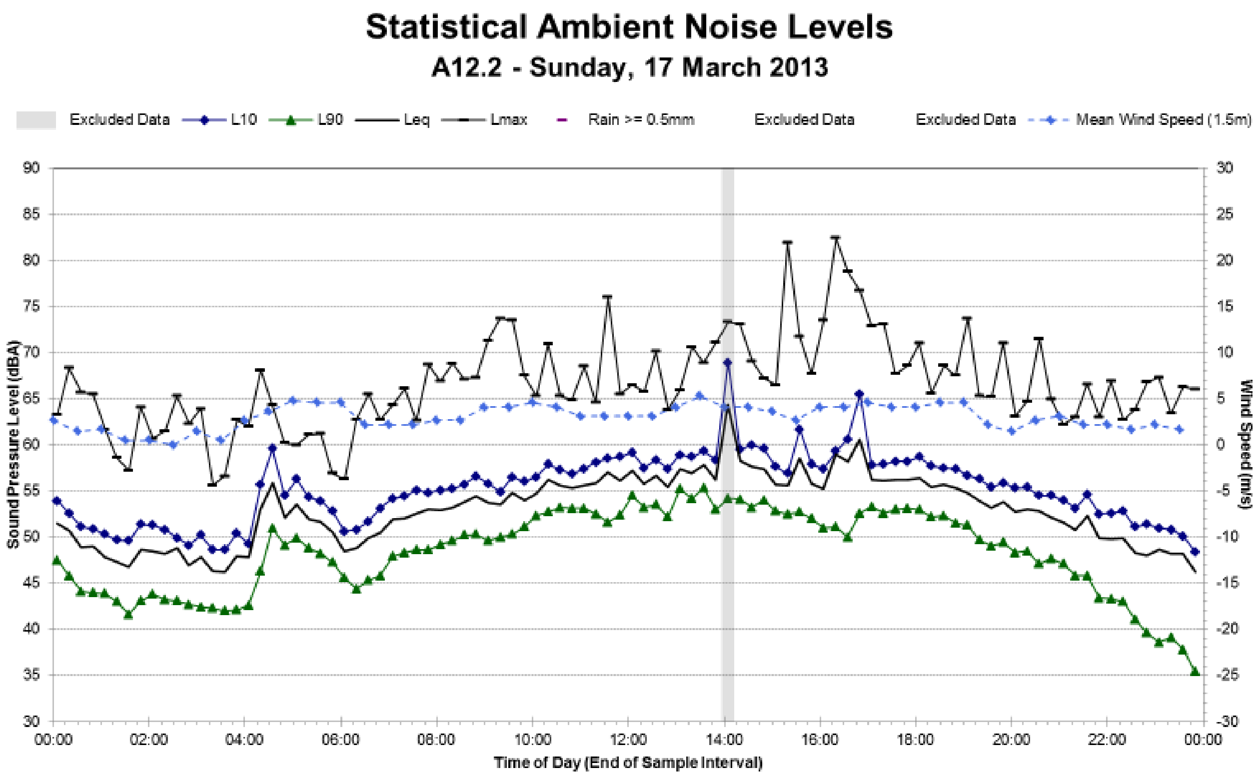


Statistical Ambient Noise Levels
A12.2 - Thursday, 14 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

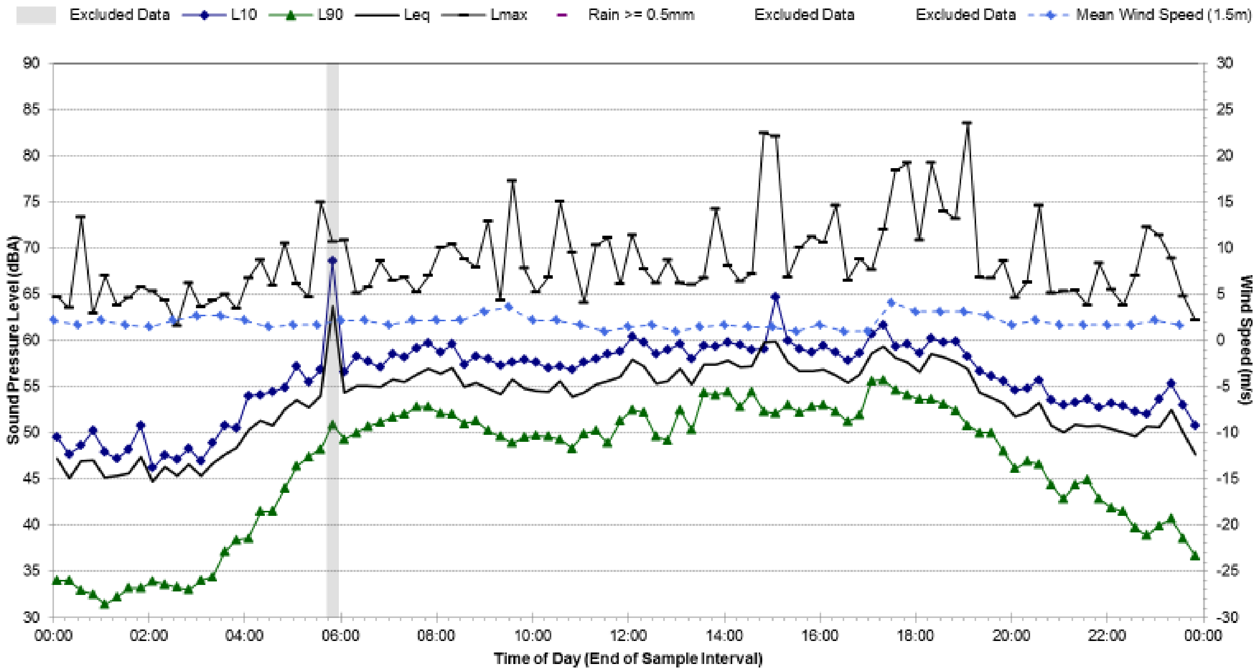


Statistical Ambient Noise Levels
A12.2 - Friday, 15 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

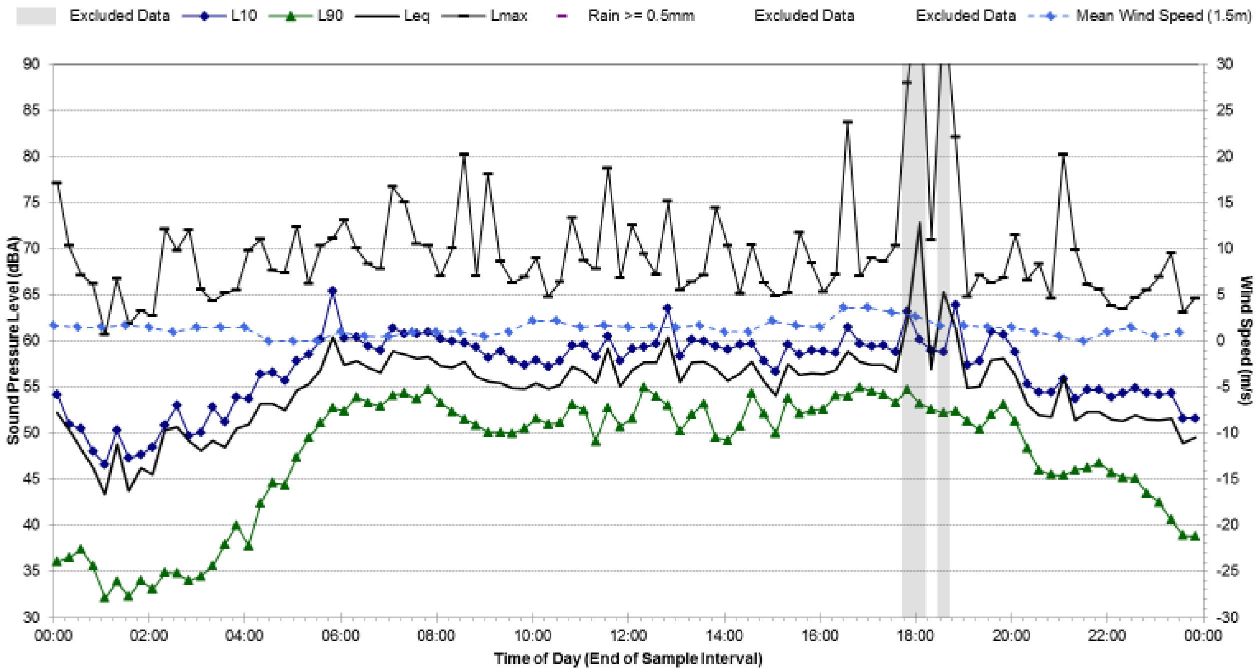

Statistical Ambient Noise Levels
A12.2 - Saturday, 16 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

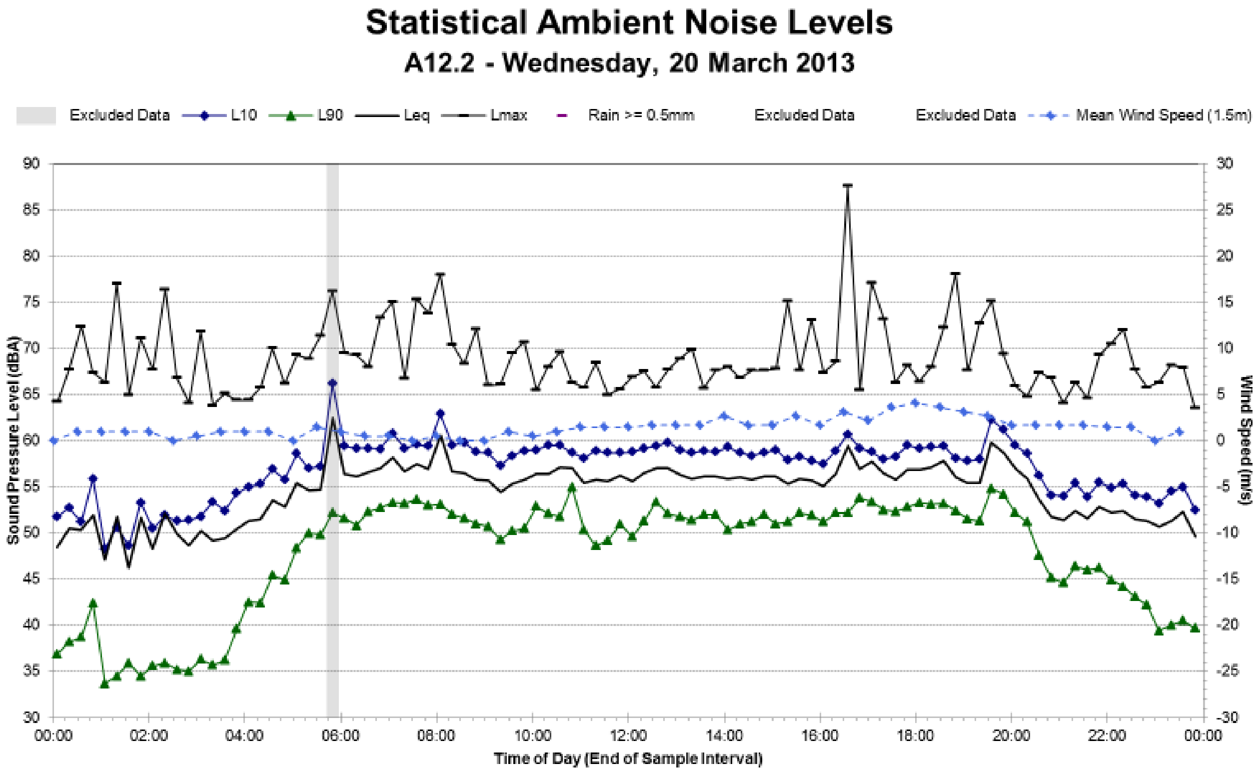

Statistical Ambient Noise Levels
A12.2 - Sunday, 17 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

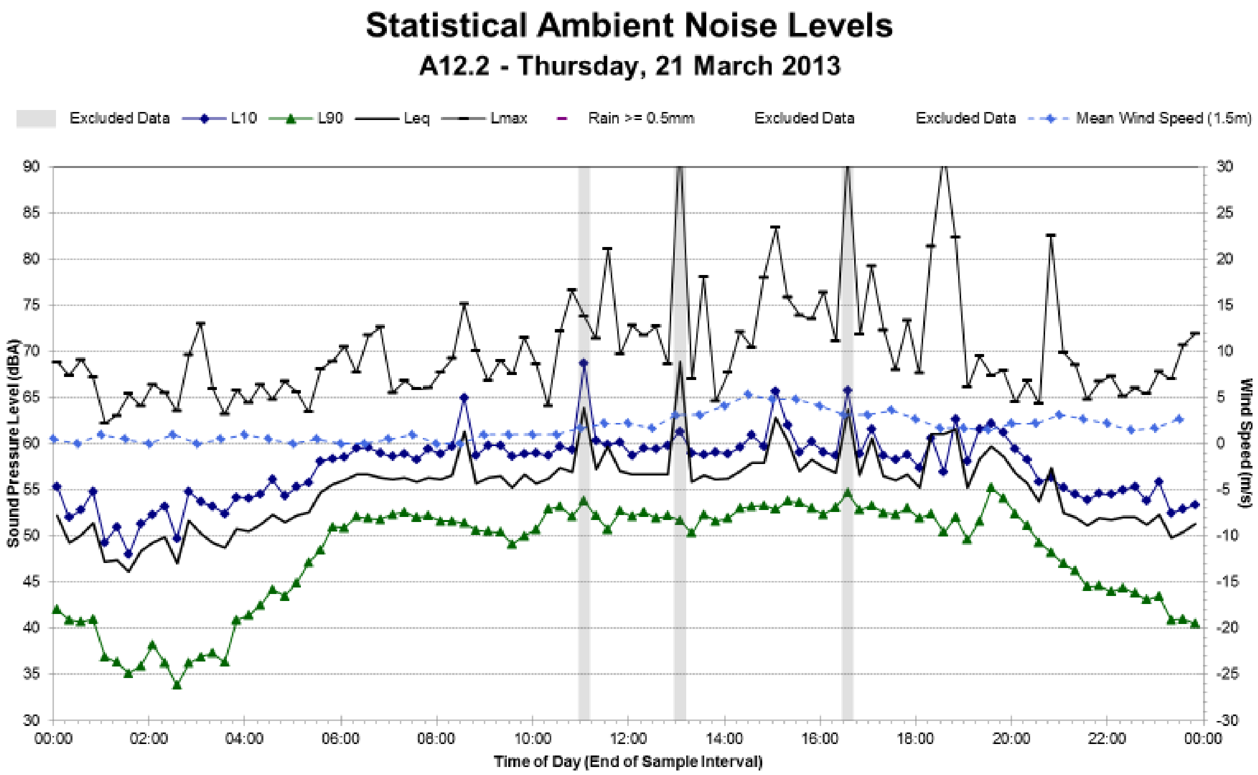
Statistical Ambient Noise Levels
A12.2 - Monday, 18 March 2013

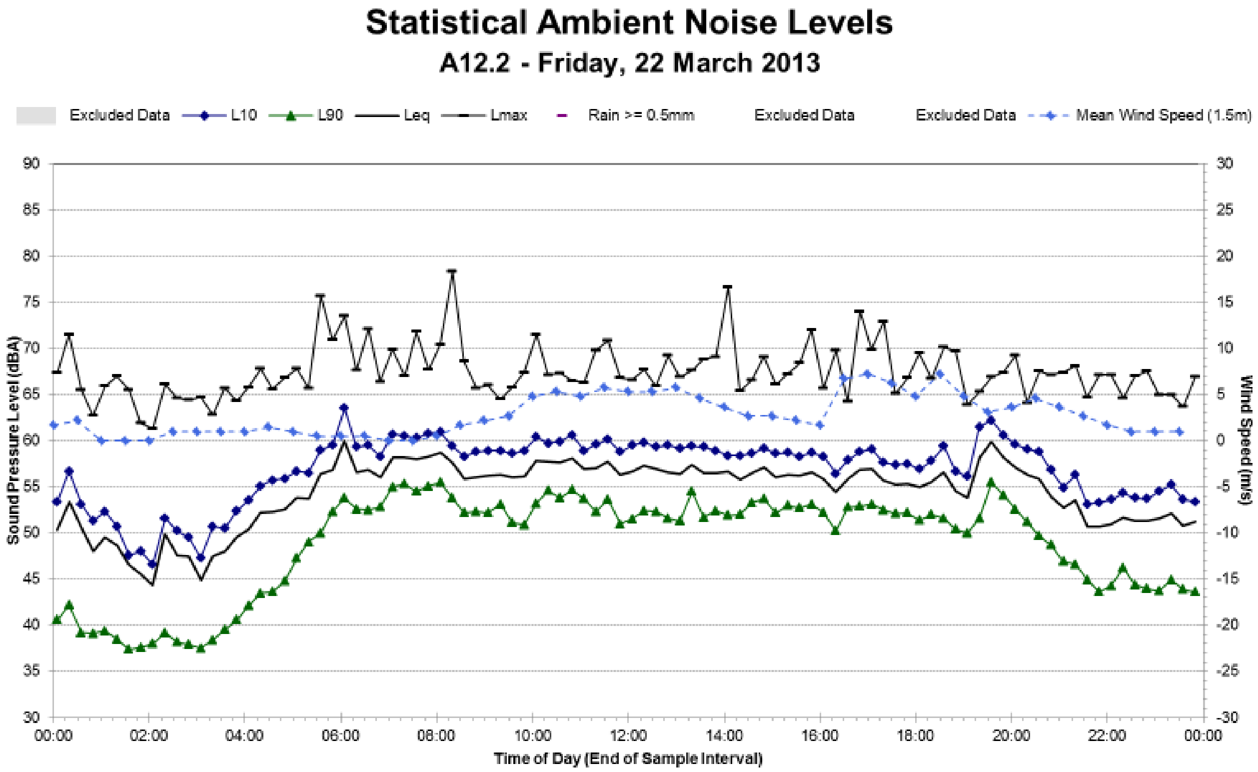


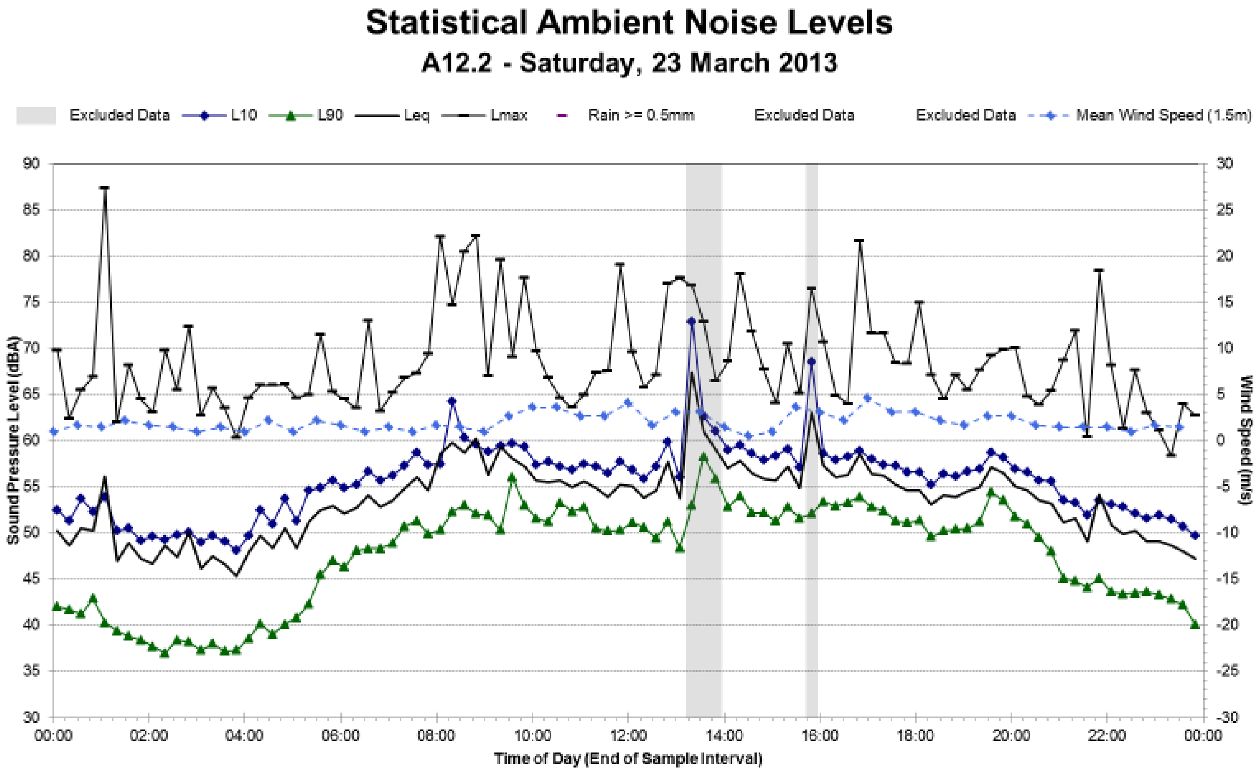
Statistical Ambient Noise Levels
A12.2 - Tuesday, 19 March 2013




Statistical Ambient Noise Levels
A12.2 - Wednesday, 20 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

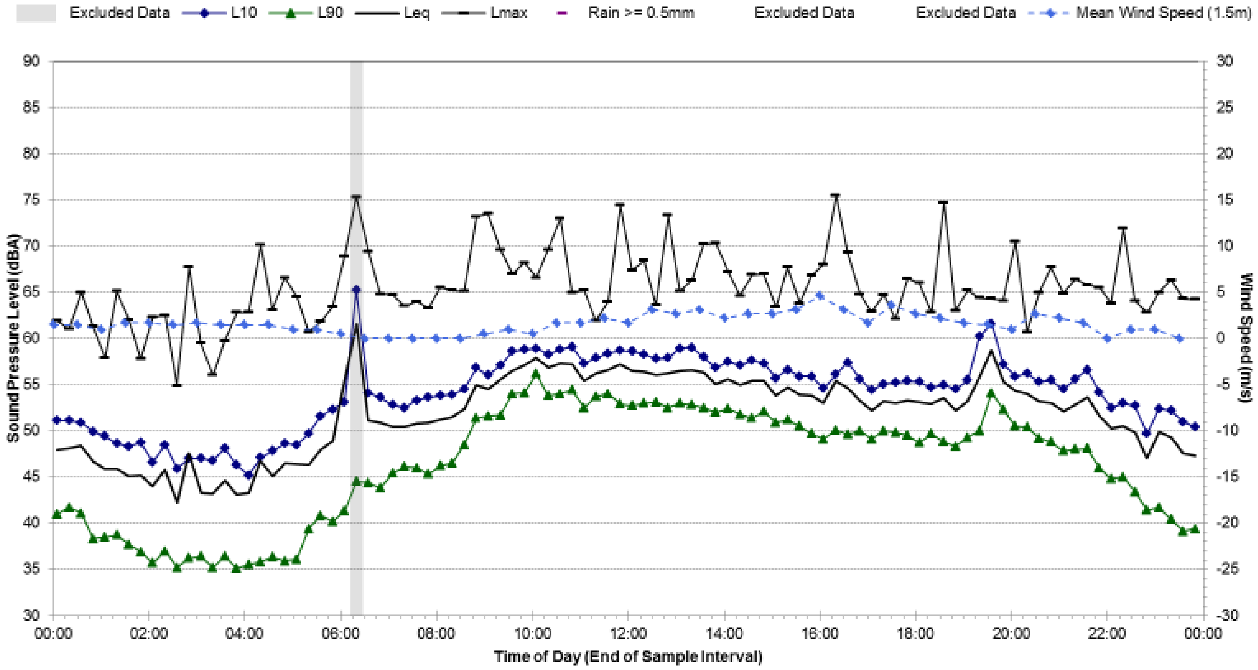

Statistical Ambient Noise Levels
A12.2 - Thursday, 21 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A12.2 - Friday, 22 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

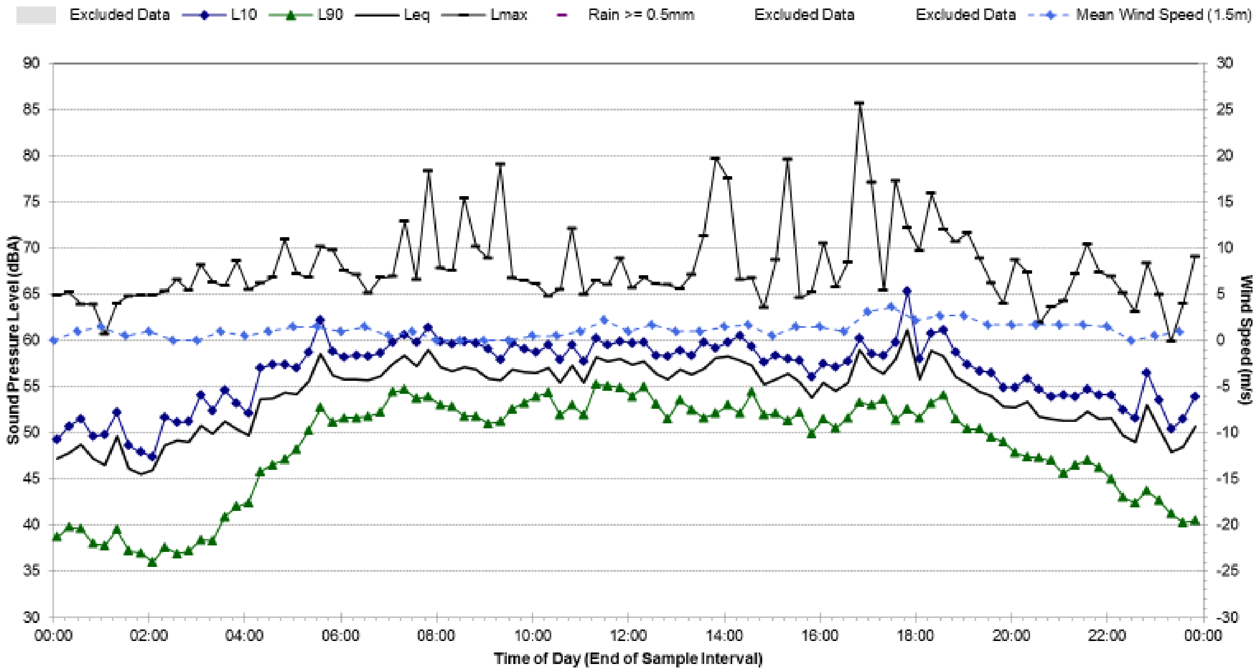

Statistical Ambient Noise Levels
A12.2 - Saturday, 23 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A12 Ambient Noise Monitoring Results

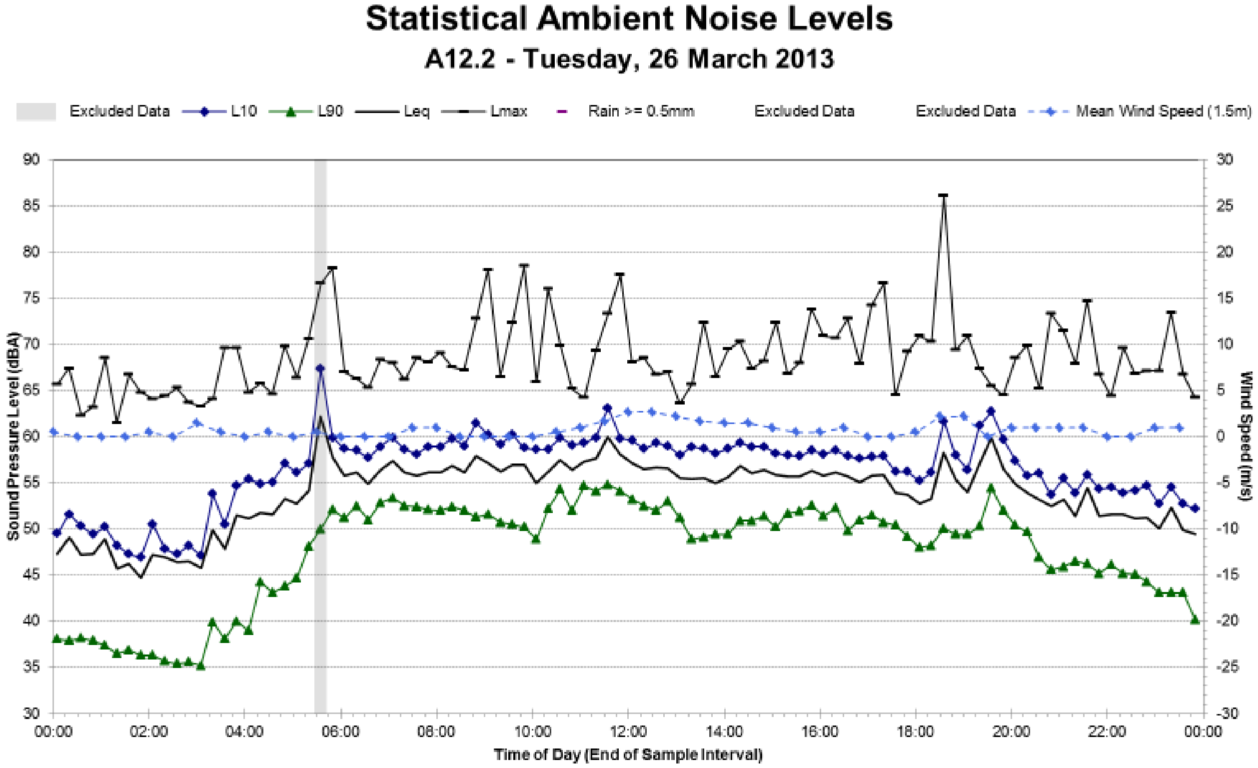
Statistical Ambient Noise Levels
A12.2 - Sunday, 24 March 2013

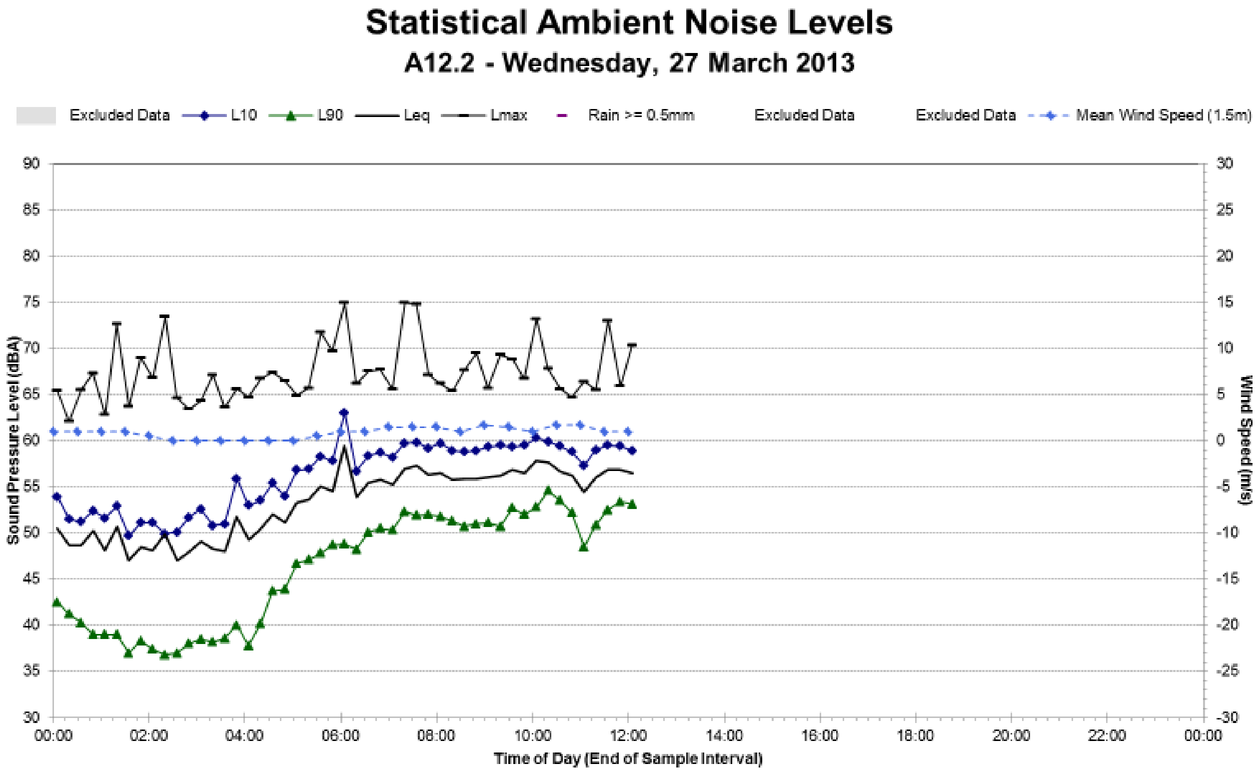


Statistical Ambient Noise Levels
A12.2 - Monday, 25 March 2013



A12 Ambient Noise Monitoring Results





A13 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A13.1**
Noise Monitoring Address:	**6 Tattersall Pl, Emu Plains**

Logger Device Type: Svantek 957
Logger Serial No: 21884

Ambient noise logger deployed in front garden of residential address 6 Tattersall Pl, Emu Plains approximately 1 m from the north-west facing building facade.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4 and insects. Frequent tyre-pavement noise from light-vehicle traffic on M4 can be heard at this location. Discrete traffic noise level peaks from heavy vehicle movements are generally engine/exhaust generated.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 61-70 dBA, Light-vehicle road traffic: 60-65 dBA, Insects: ~65 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	51	60	62	67
Evening	47	55	57	63
Night-time	34	54	55	63

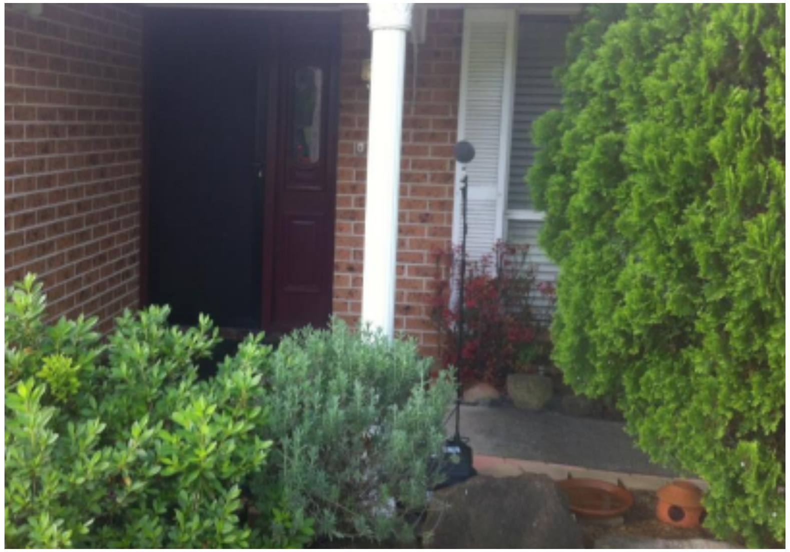
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	8	3	N/A (7 Day Average)
Daytime (7am-10pm)	59	59	59
Night-time (10pm-7am)	54	53	54

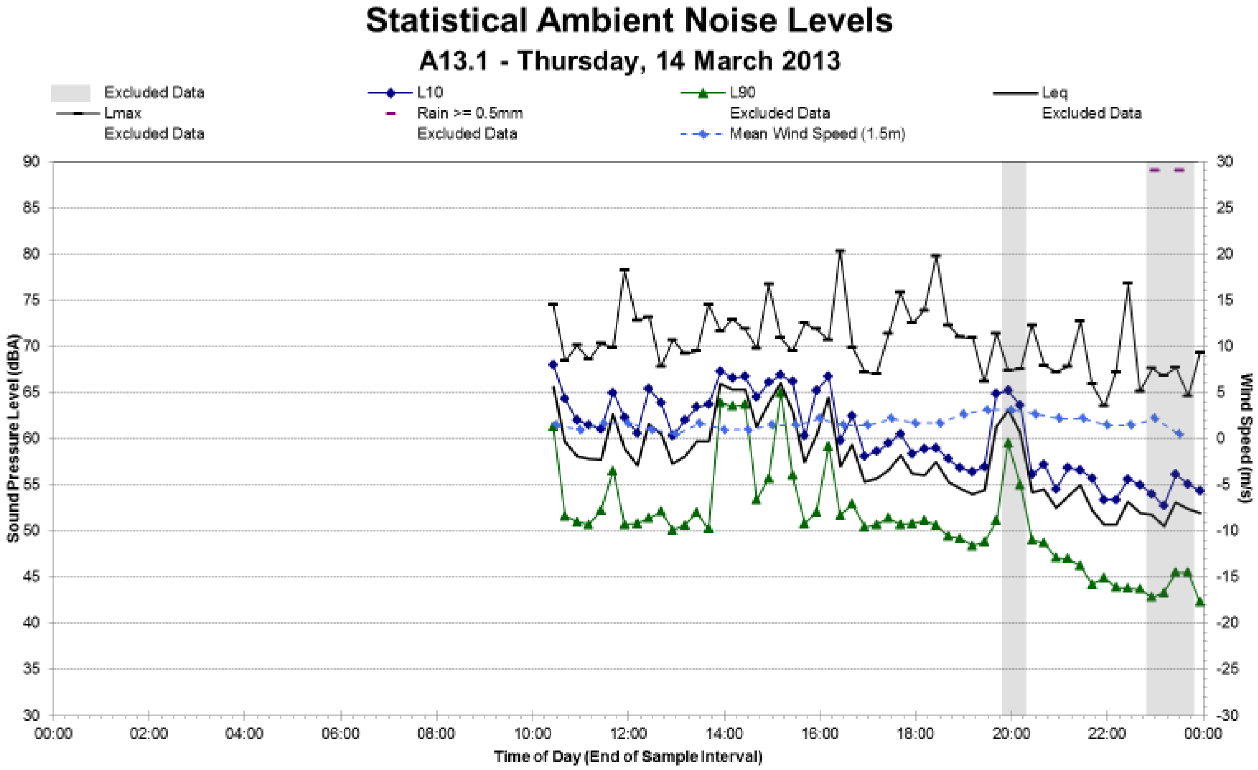
Attended Noise Measurement Results

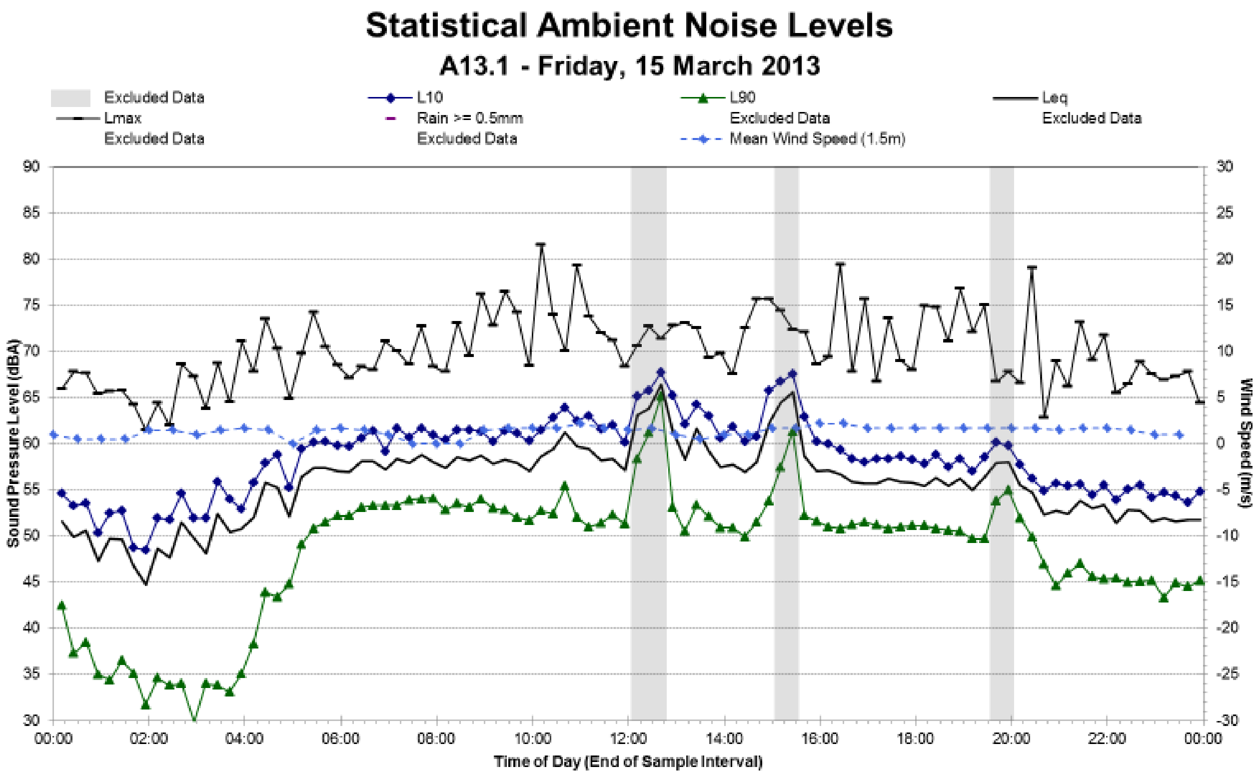
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
14/03/2013	09:35	57	65	70

Photo of Noise Monitoring Location

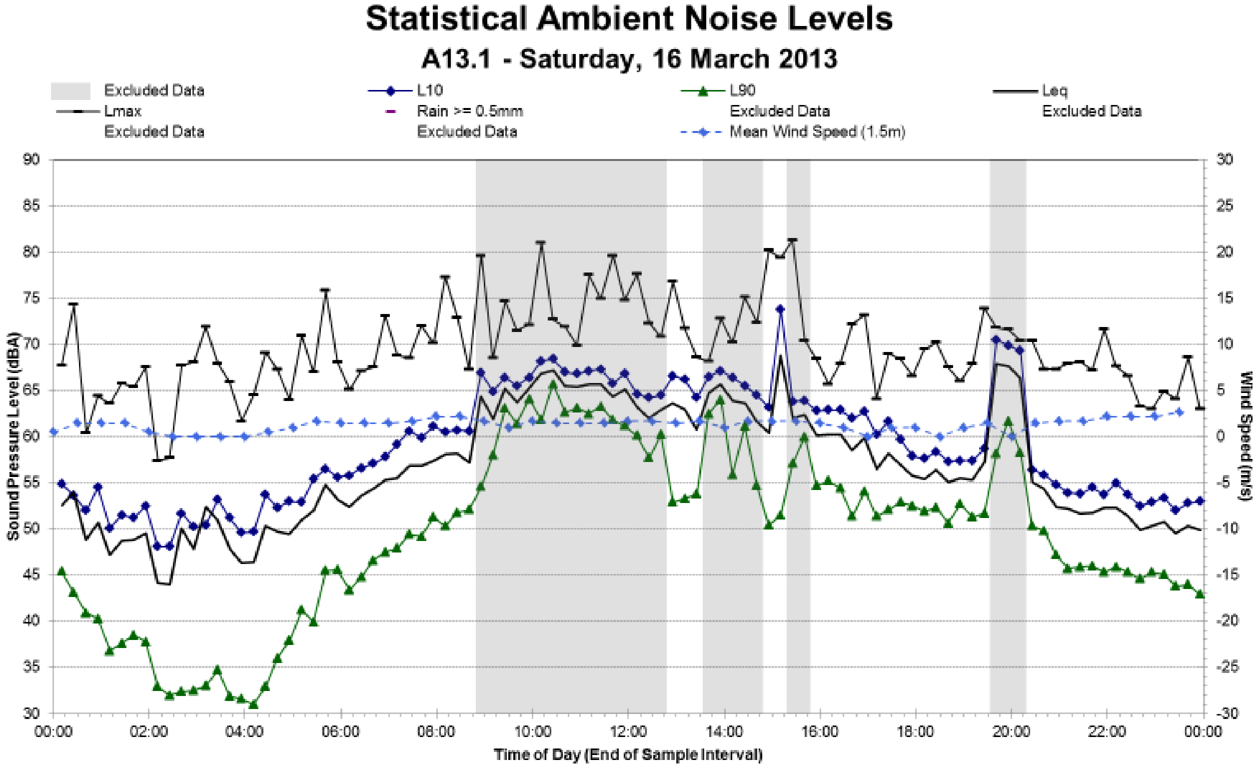


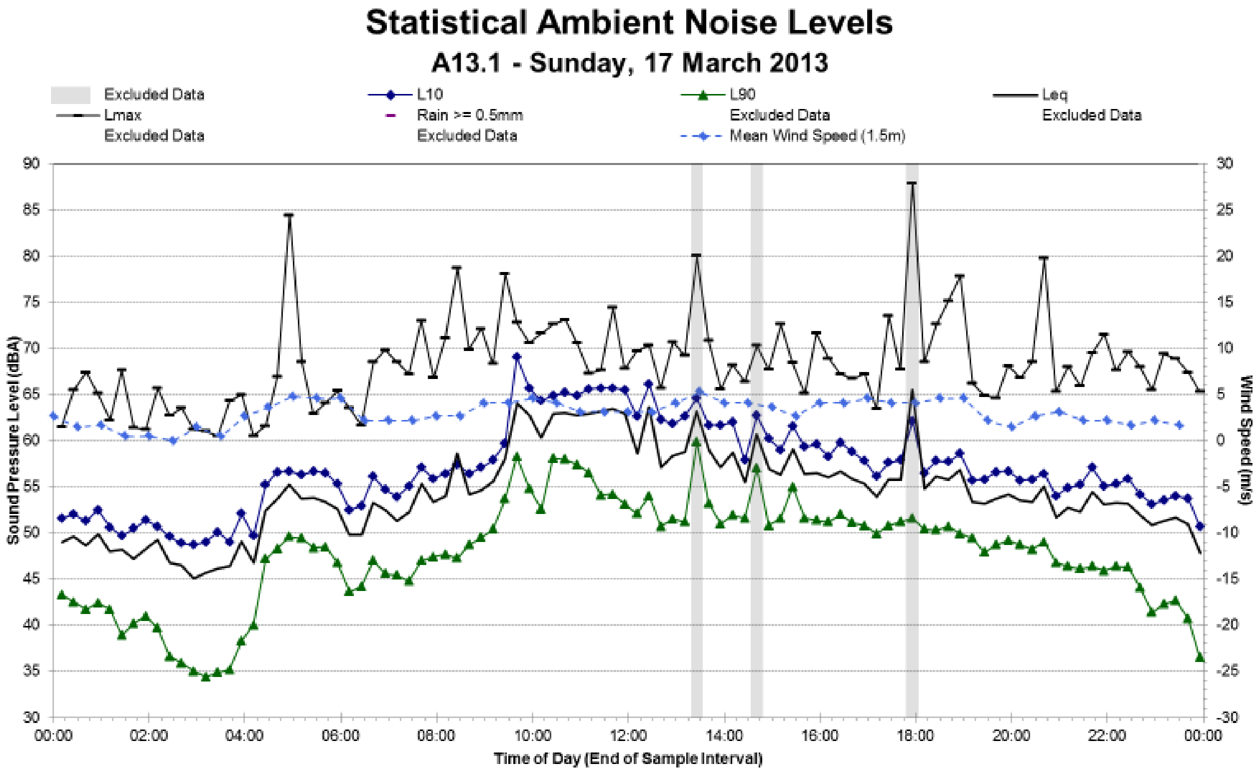
A13 Ambient Noise Monitoring Results

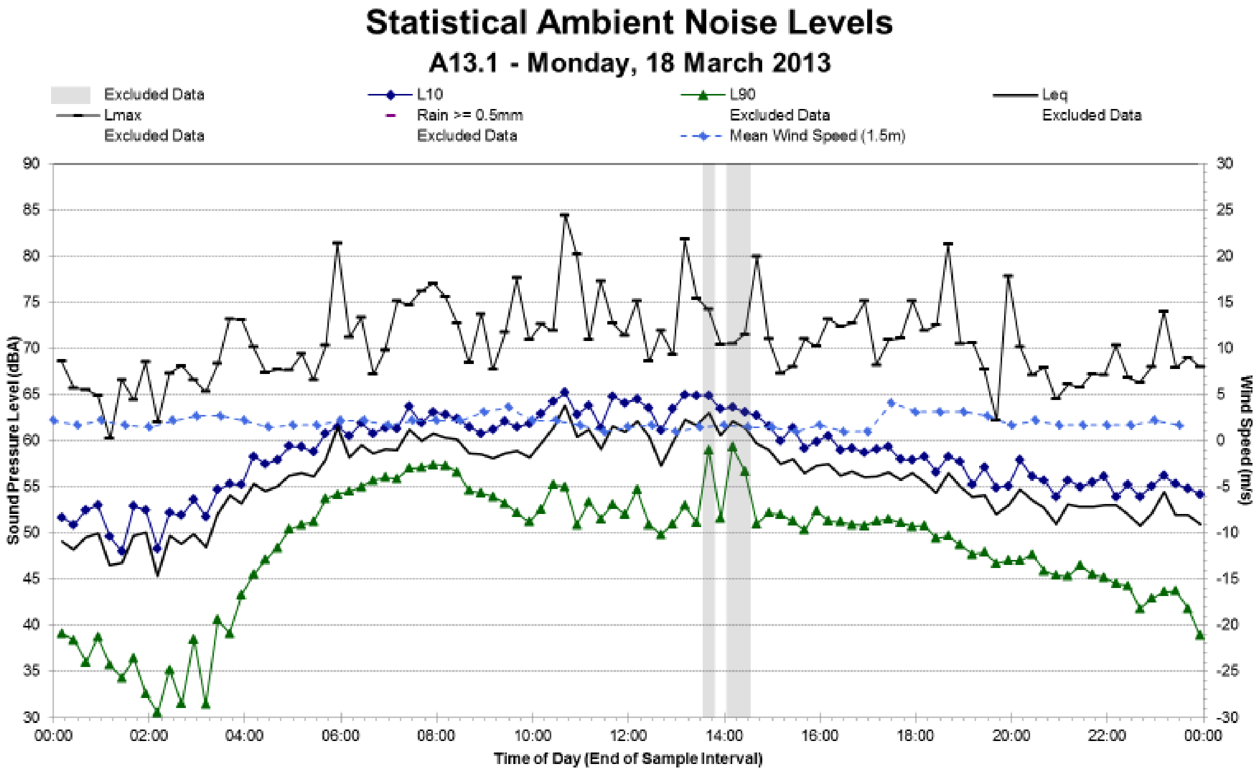


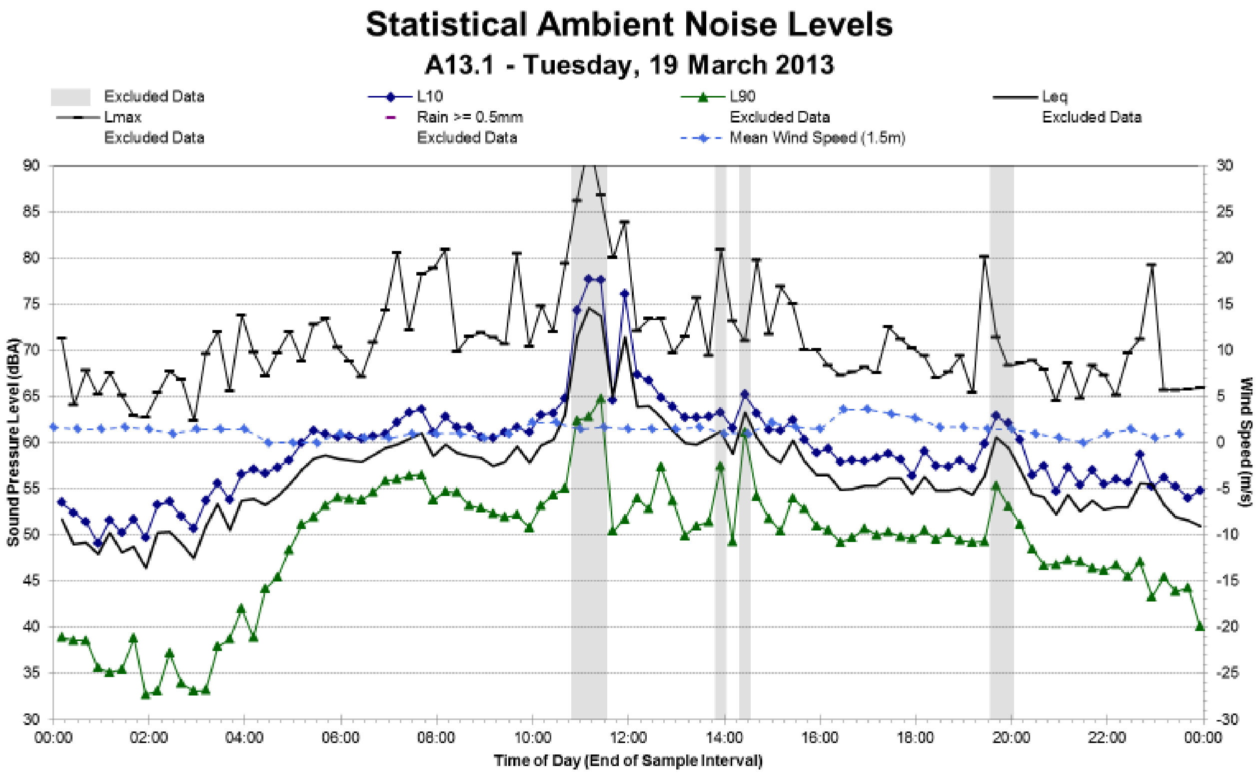


A13 Ambient Noise Monitoring Results

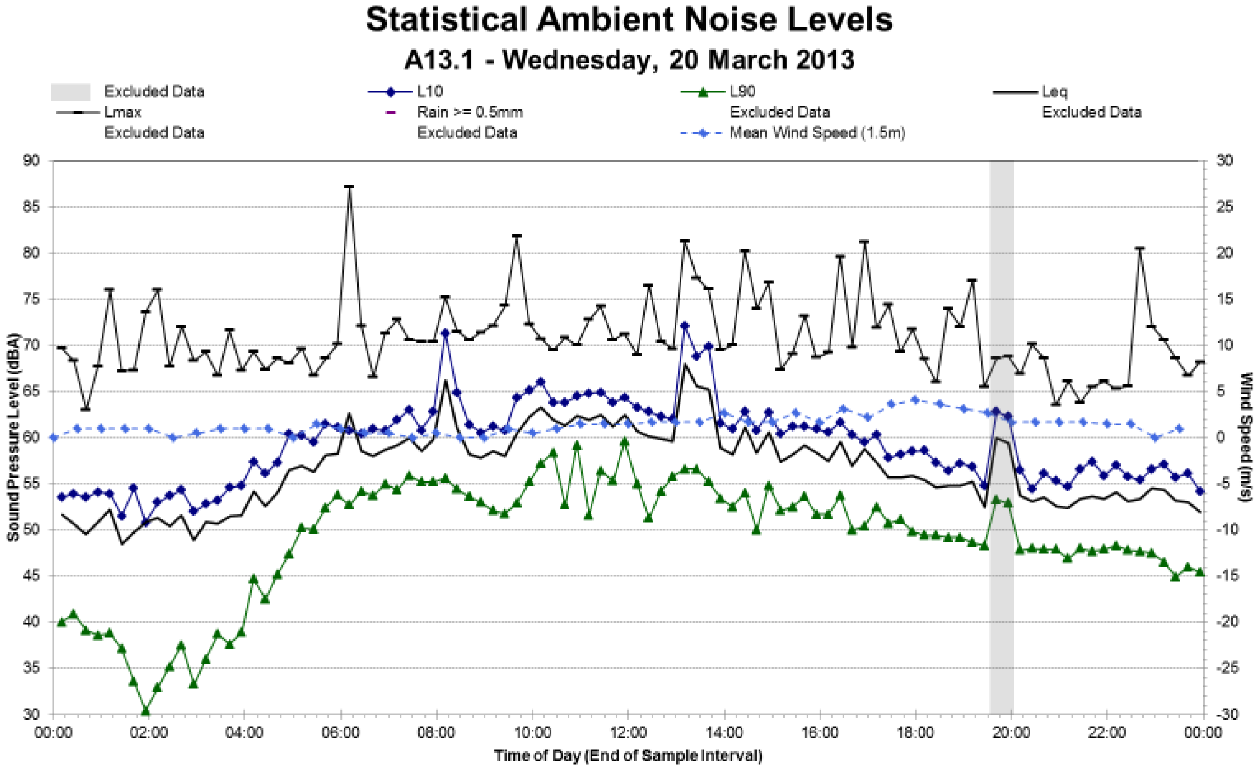


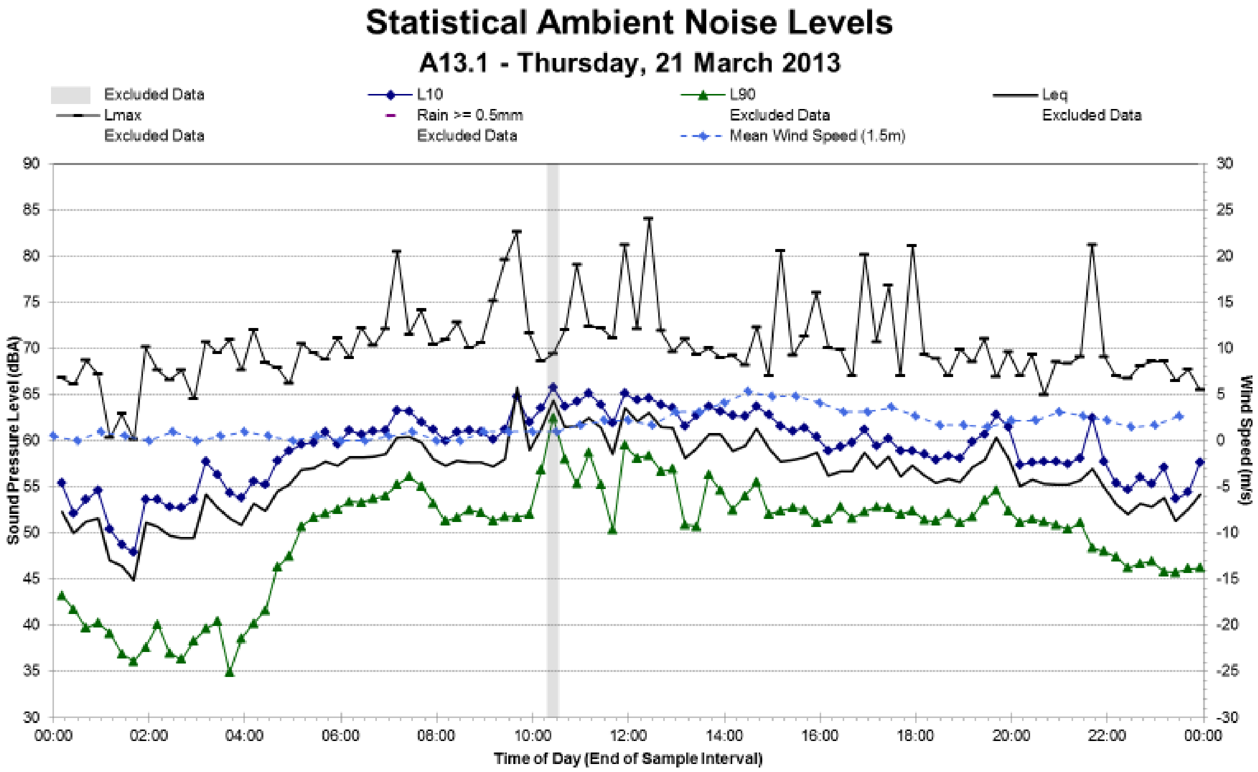



Statistical Ambient Noise Levels
A13.1 - Monday, 18 March 2013
Excluded Data
Lmax
Excluded Data
L10
Rain >= 0.5mm
Excluded Data
L90
Excluded Data
Mean Wind Speed (1.5m)
Leq
Excluded Data
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

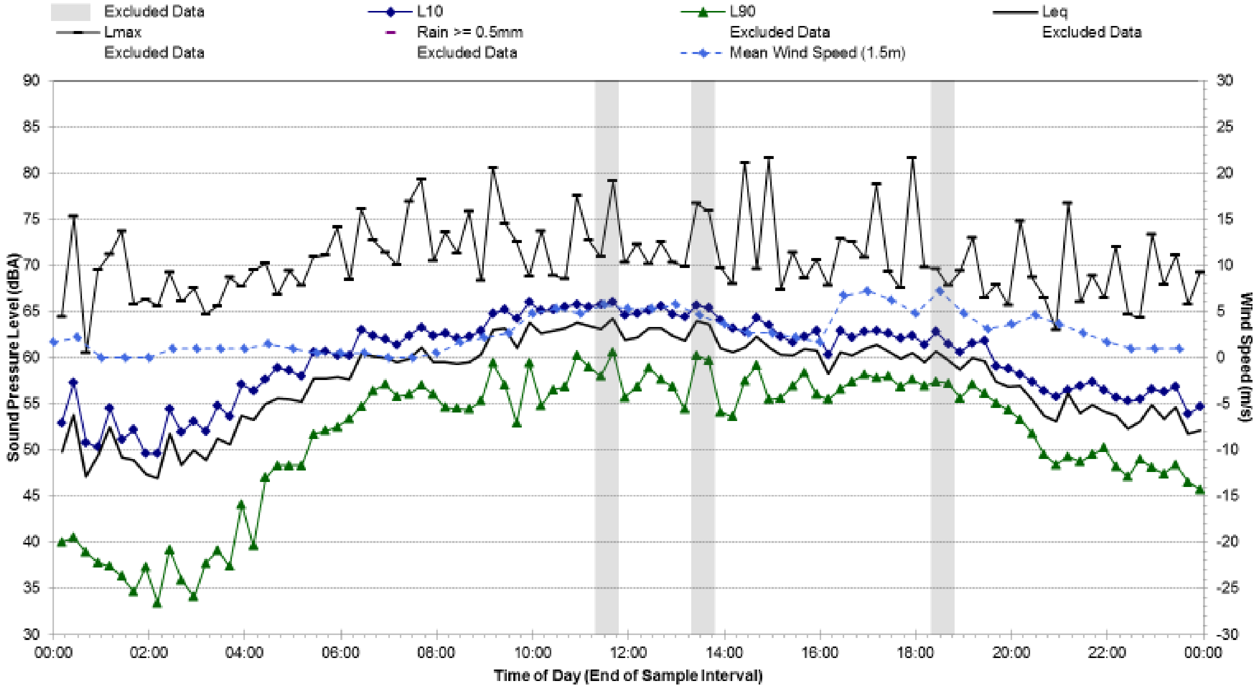

Statistical Ambient Noise Levels
A13.1 - Tuesday, 19 March 2013
Excluded Data
Lmax
Excluded Data
L10
Rain >= 0.5mm
Excluded Data
L90
Excluded Data
Mean Wind Speed (1.5m)
Leq
Excluded Data
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A13 Ambient Noise Monitoring Results

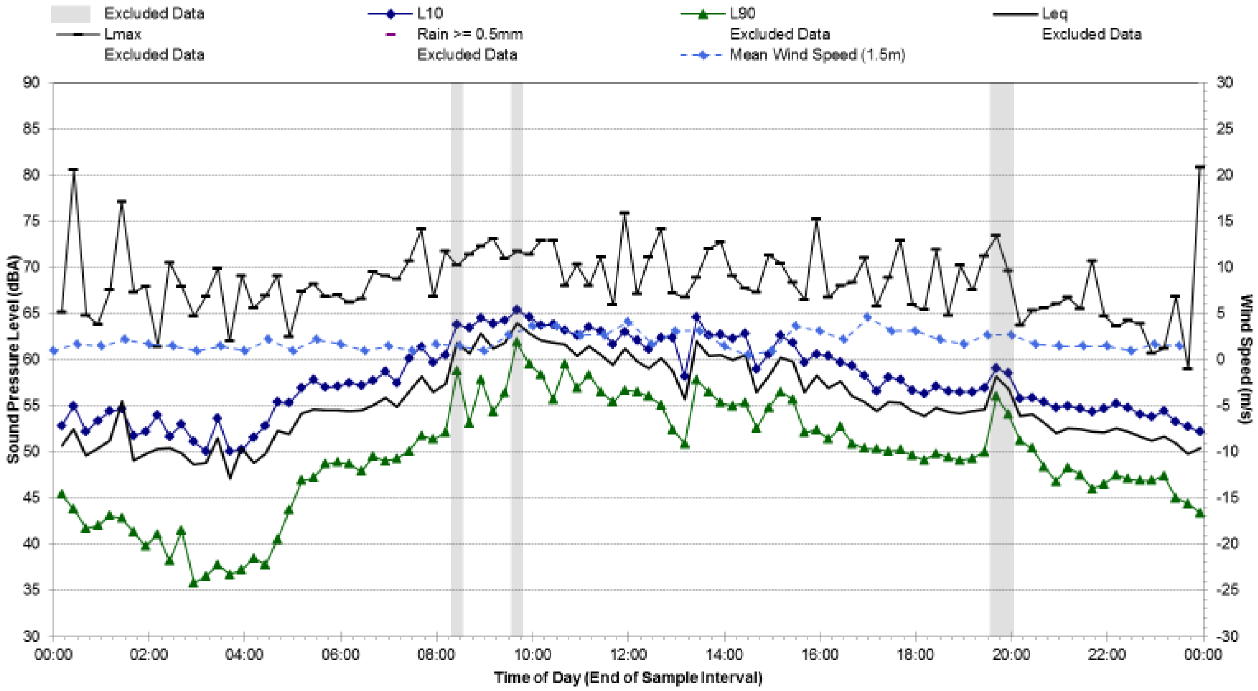




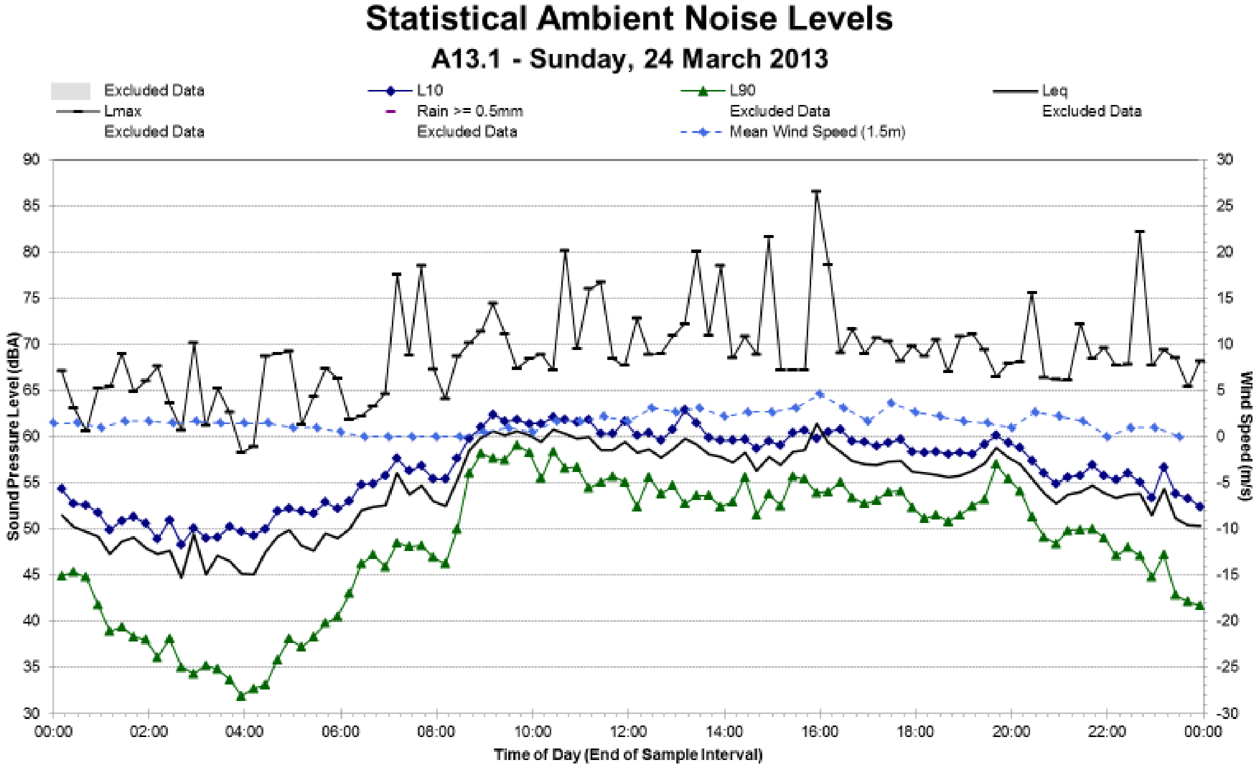
Statistical Ambient Noise Levels
A13.1 - Friday, 22 March 2013

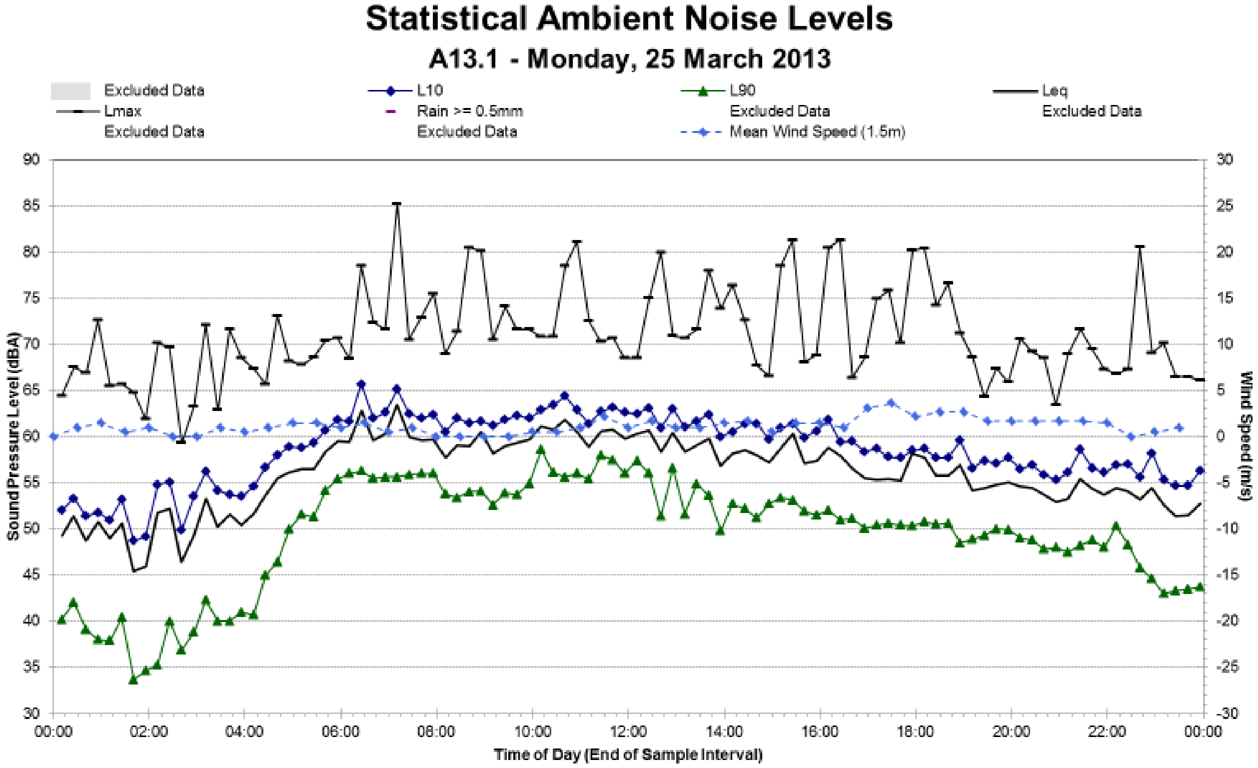


Statistical Ambient Noise Levels
A13.1 - Saturday, 23 March 2013

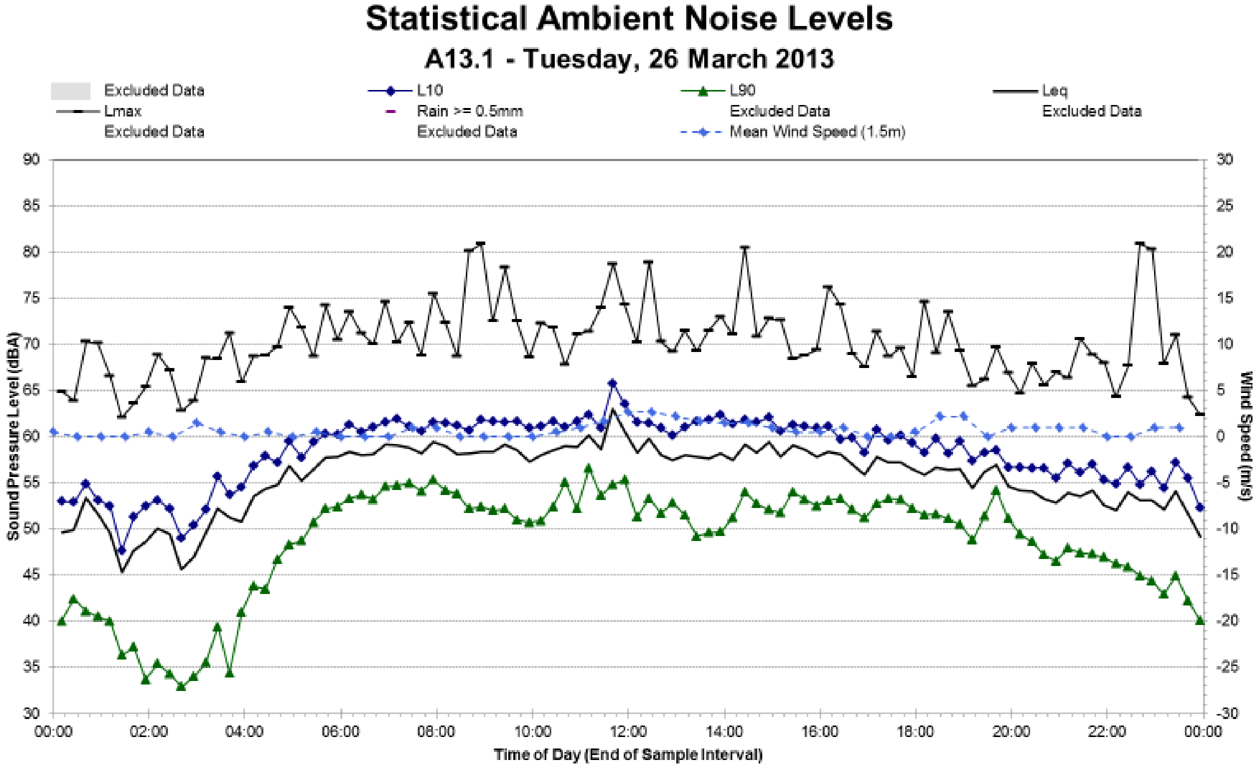


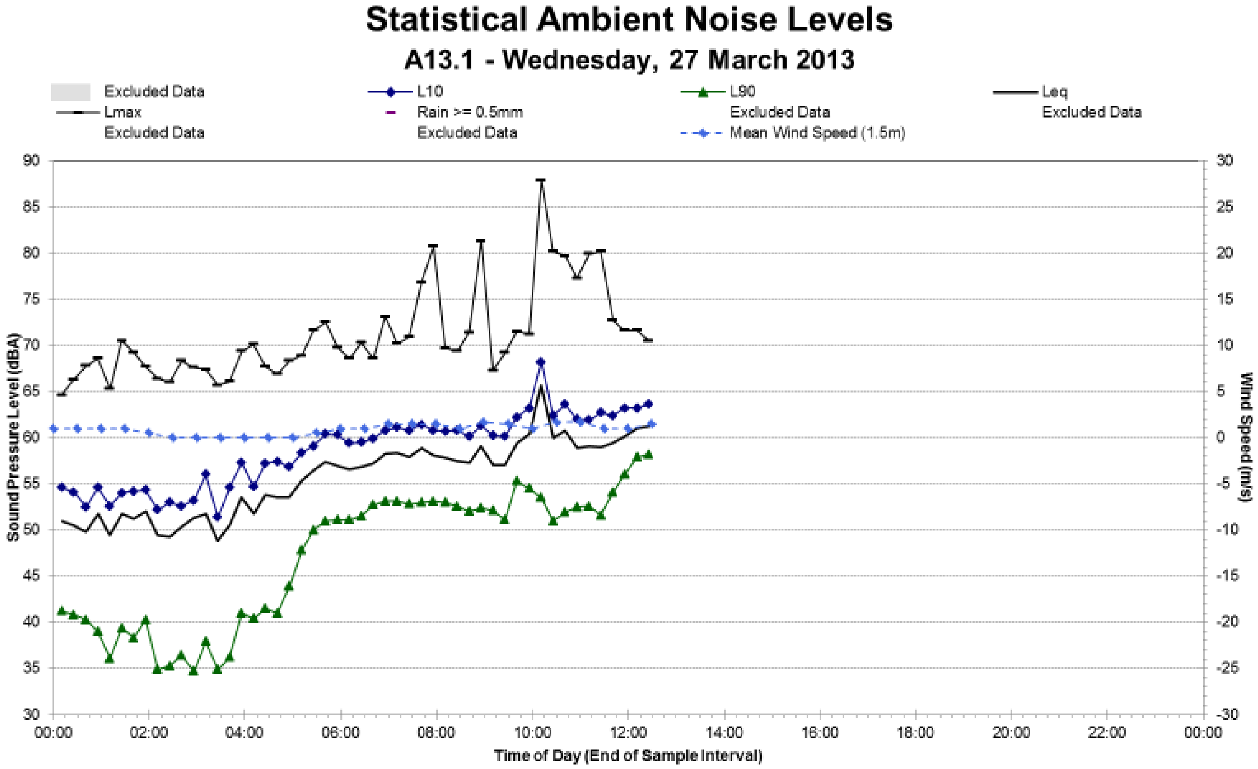
A13 Ambient Noise Monitoring Results





A13 Ambient Noise Monitoring Results





A13 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A13.2**
Noise Monitoring Address:	**70 Pamela Ln, Leonay**

Map of Noise Monitoring Location

Logger Device Type: Svantek 957
Logger Serial No: 20674

Ambient noise logger deployed in backyard of residential address 70 Pamela Ln, Leonay. Logger located on western side of property approximately 7 m from nearest facade.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4 westbound off-ramp during the daytime with several occurrences of insect noise. Noise level peaks from heavy vehicle movements were observed to occur frequently and included truck compression braking noise and truck engine noise when accelerating.

Analysis of the daytime ambient noise levels indicated that extraneous noise (expected to be Fauna) influences daytime L90 and Leq noise levels. Periods affected by extraneous noise have been filtered from the dataset.

Recorded Noise Levels (LAmax):
M4 Heavy-vehicle road traffic: 54-69dBA, Light road traffic: 48 - 54 dBA, Insects: 60 – 67 dBA

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	50	60	59	64
Evening	45	54	54	58
Night-time	35	49	51	57

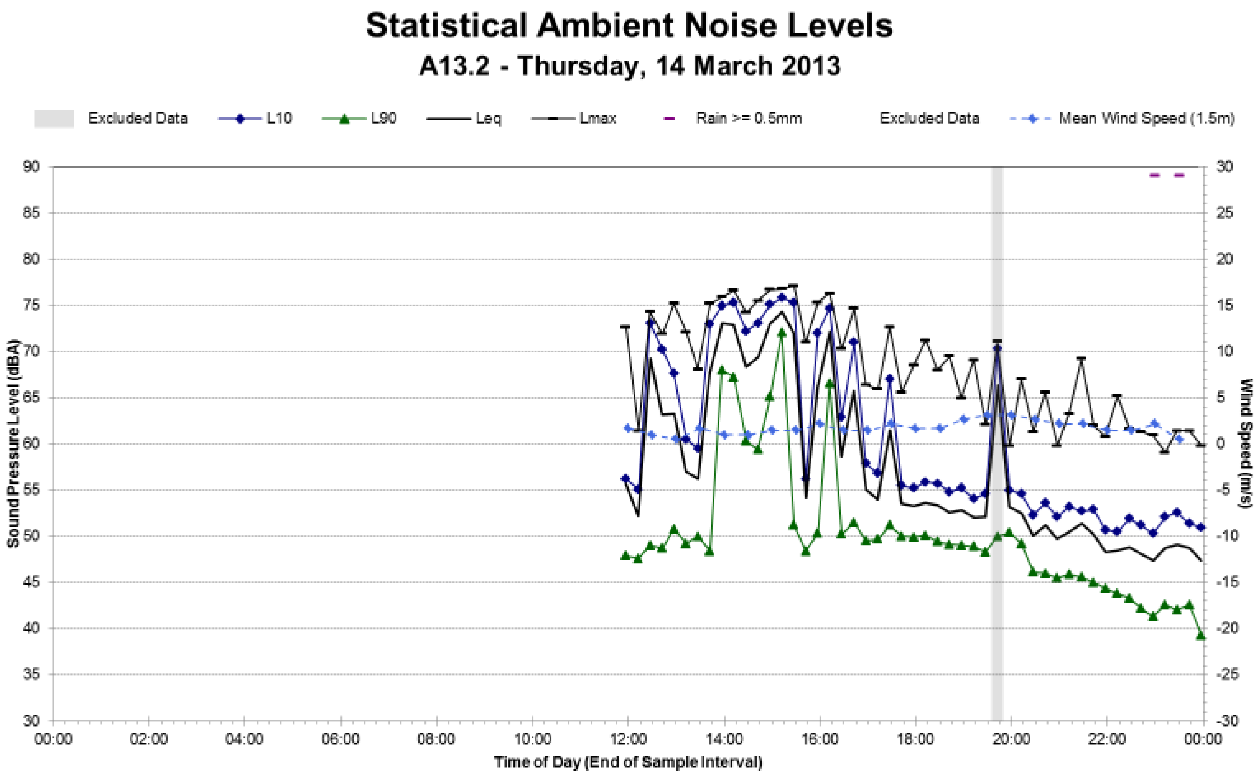
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	3	2	N/A (7 Day Average)
Daytime (7am-10pm)	57	61	59
Night-time (10pm-7am)	50	49	49

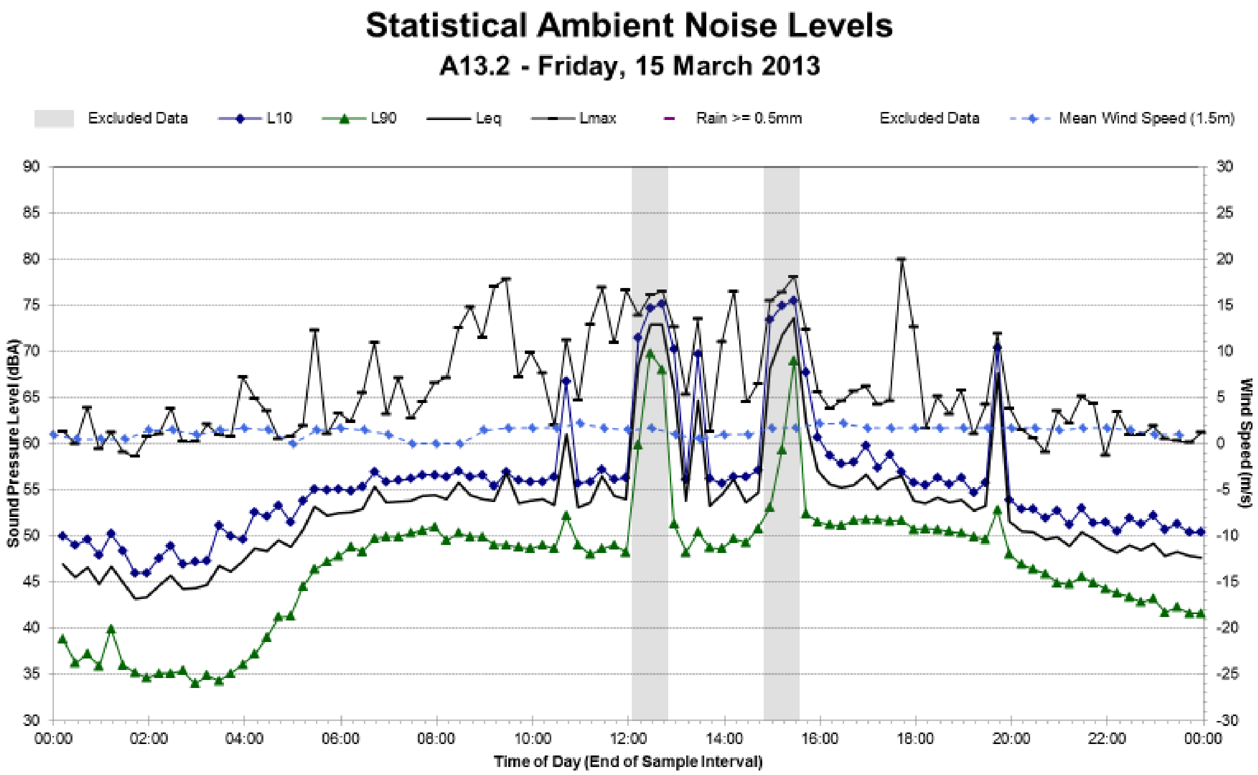
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
4/03/2013	11:35	48	63	69

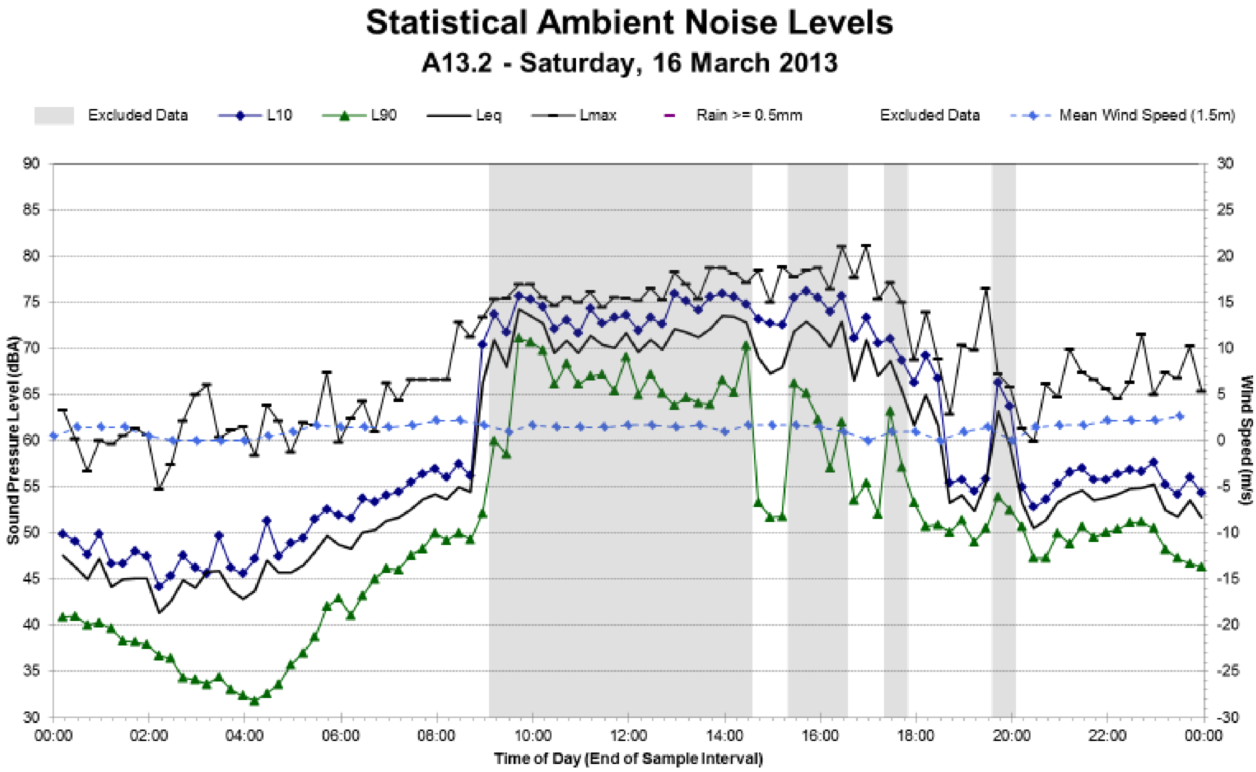
Photo of Noise Monitoring Location



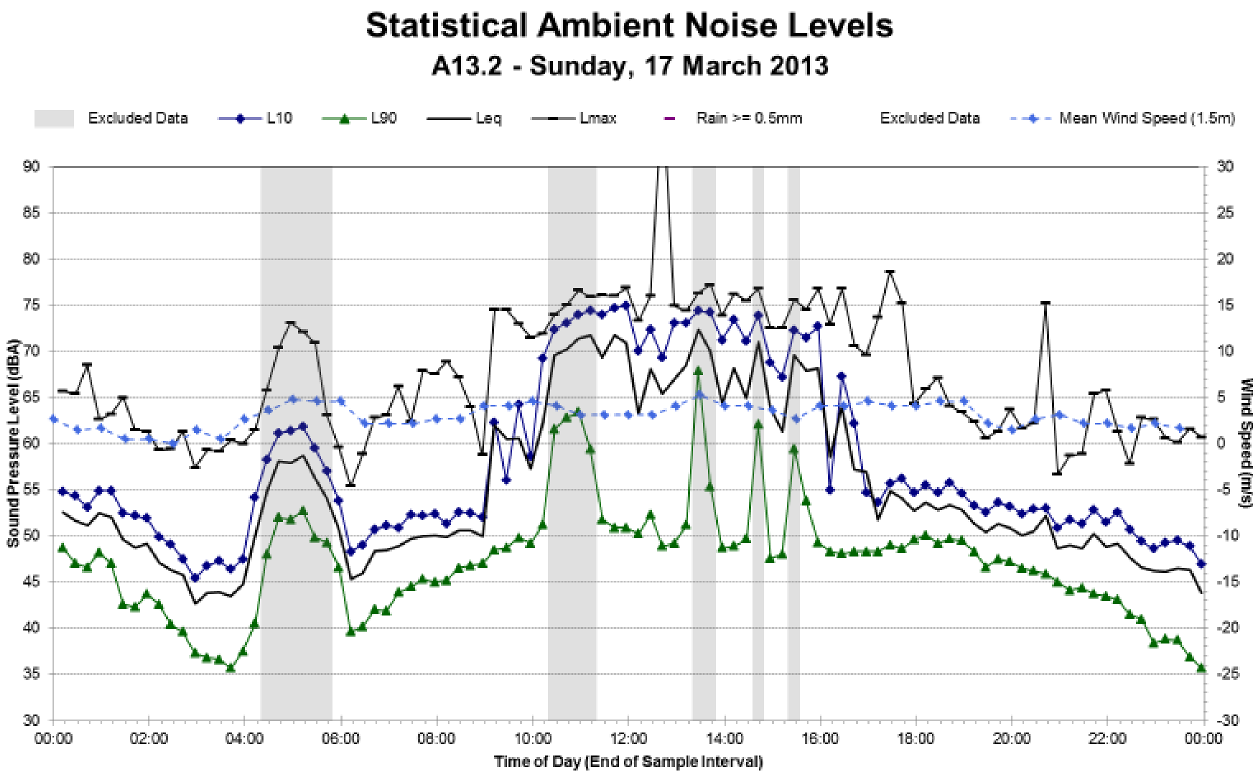
Statistical Ambient Noise Levels
A13.2 - Thursday, 14 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
A13.2 - Friday, 15 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

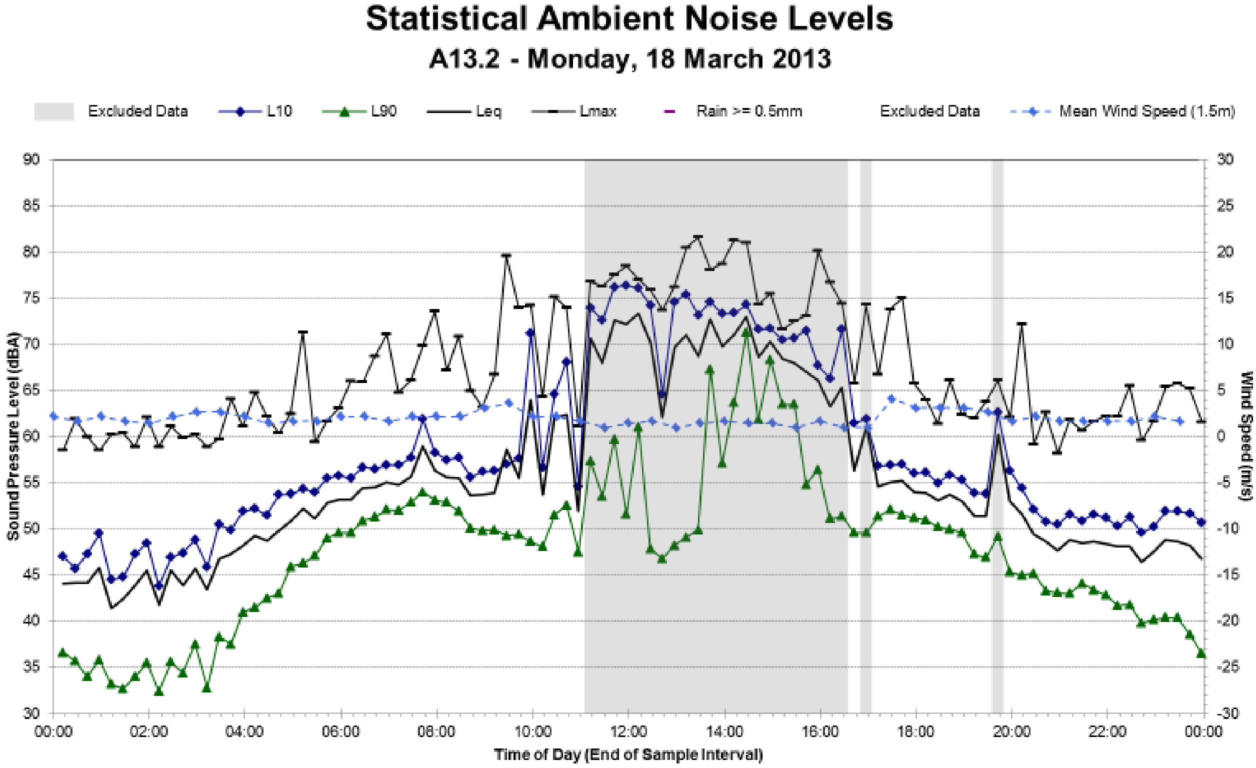


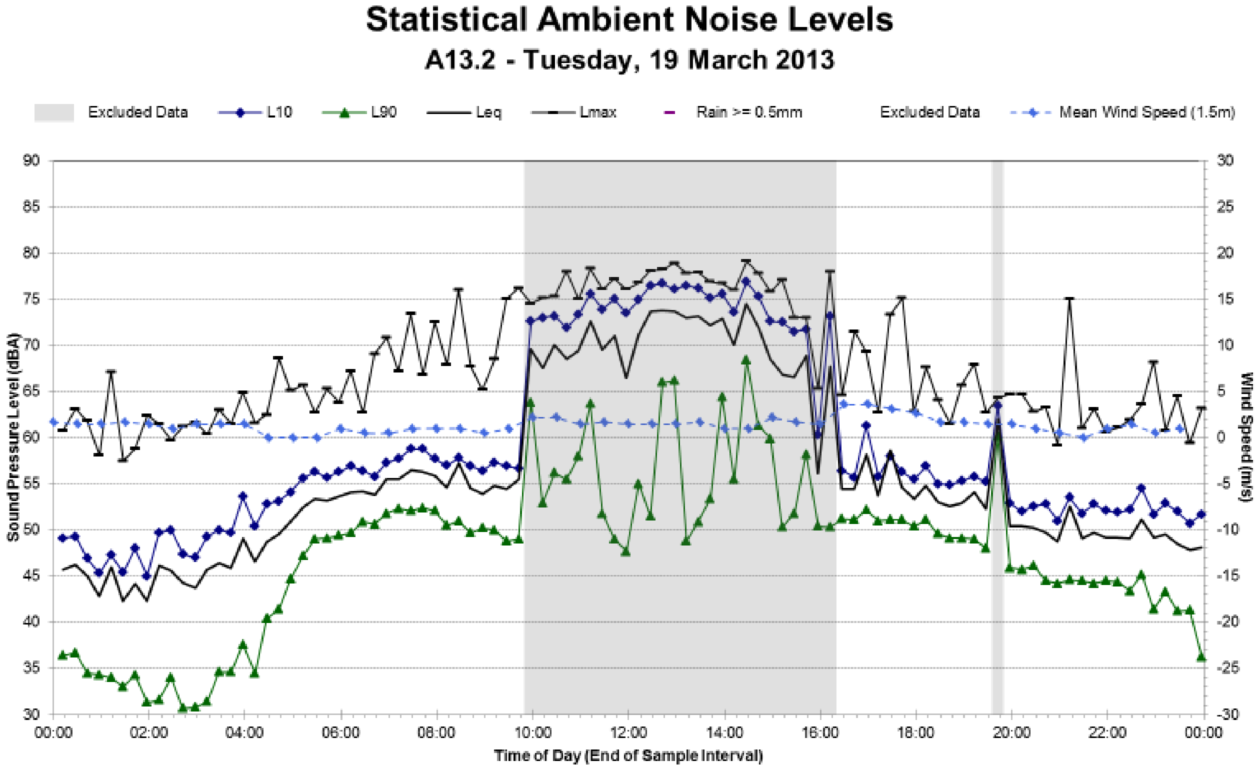
Statistical Ambient Noise Levels
A13.2 - Saturday, 16 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

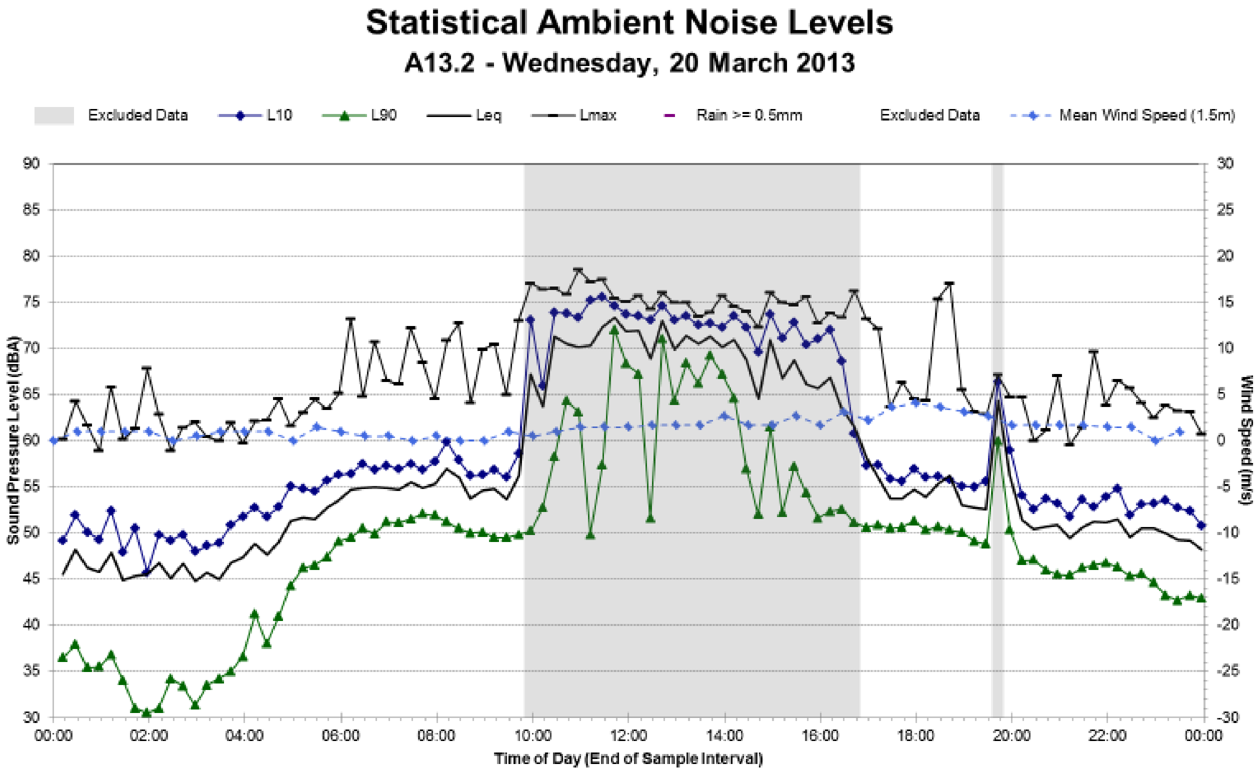


Statistical Ambient Noise Levels
A13.2 - Sunday, 17 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

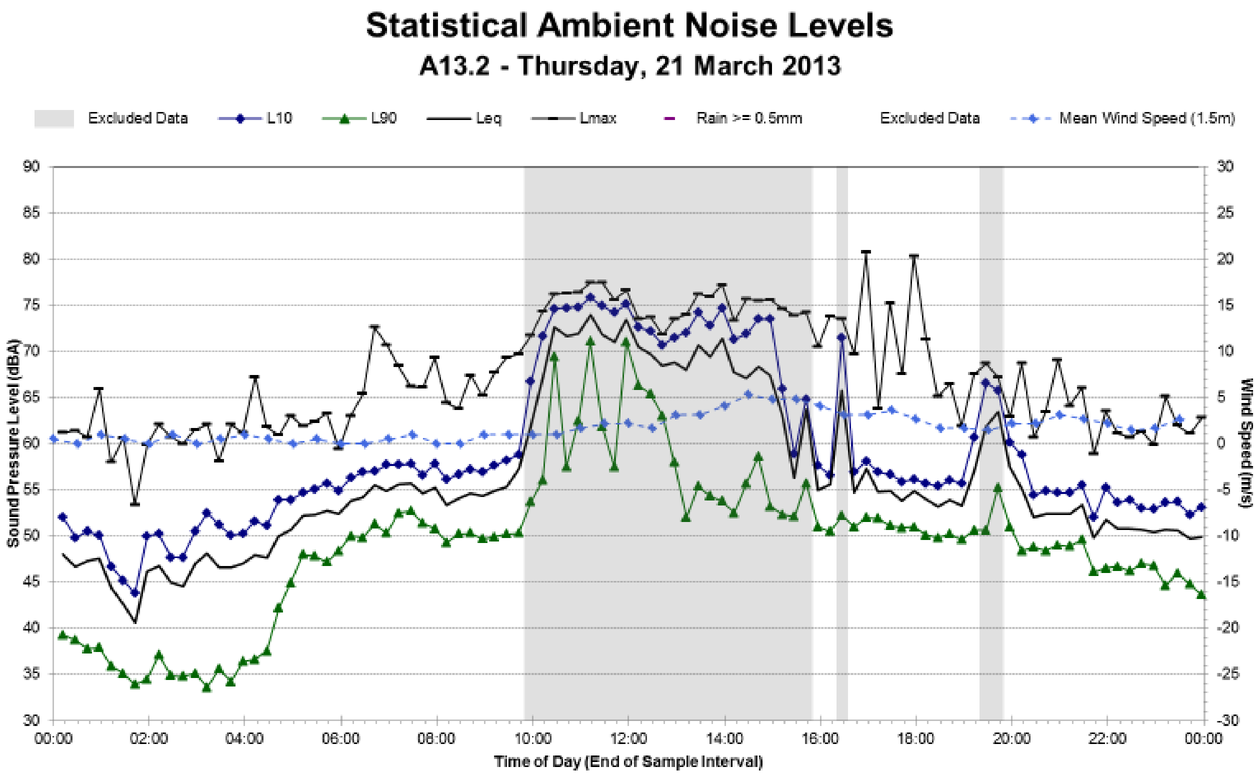
A13 Ambient Noise Monitoring Results





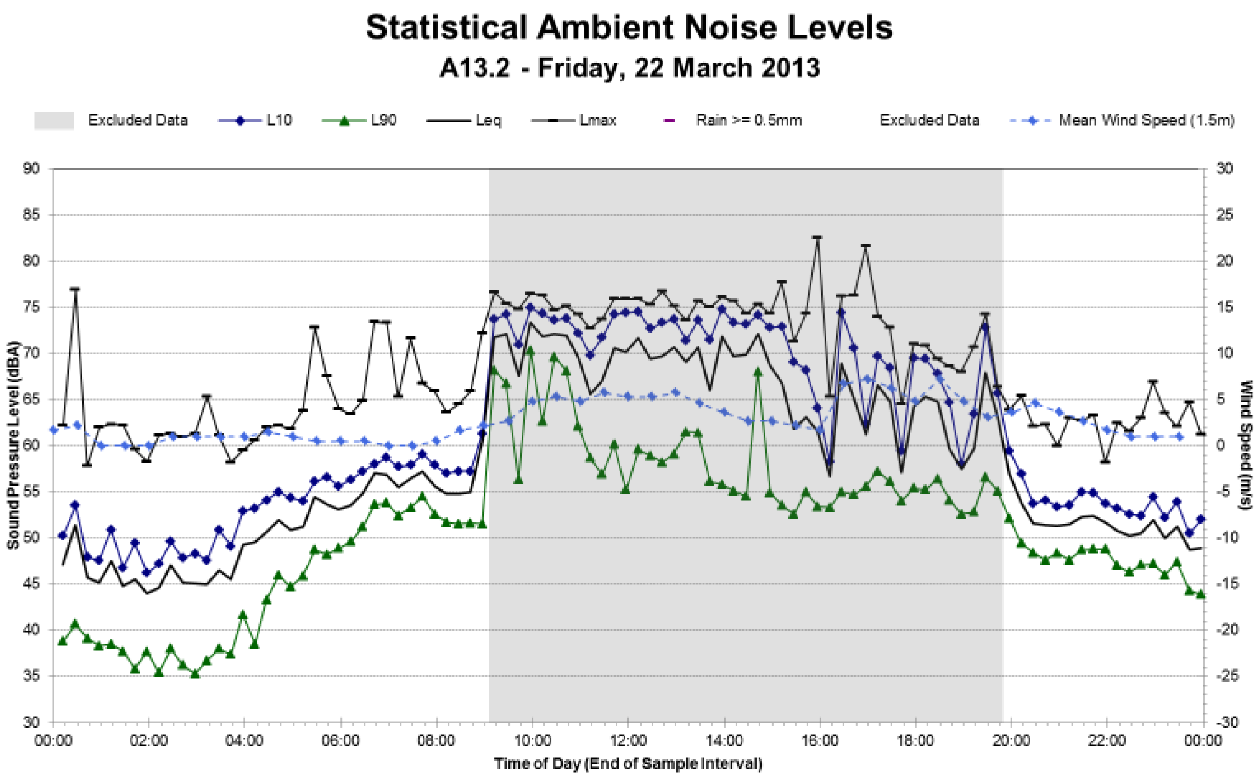


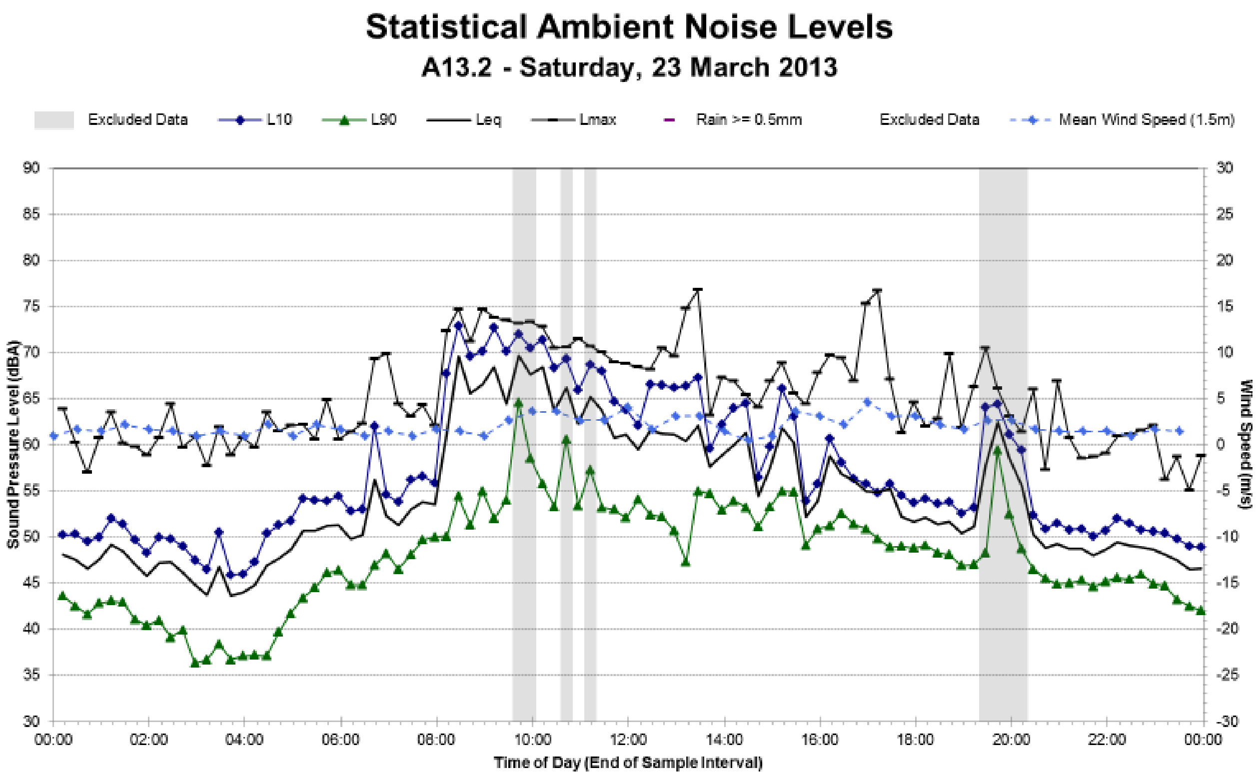
Statistical Ambient Noise Levels
A13.2 - Wednesday, 20 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
A13.2 - Thursday, 21 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

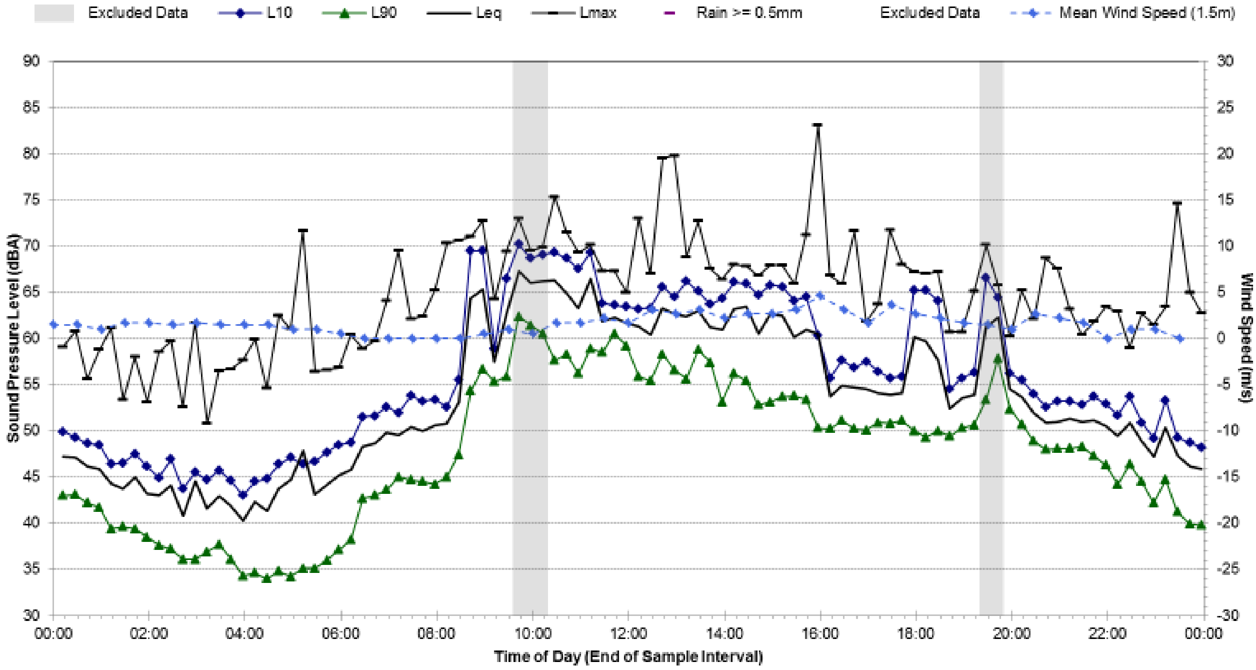
A13 Ambient Noise Monitoring Results



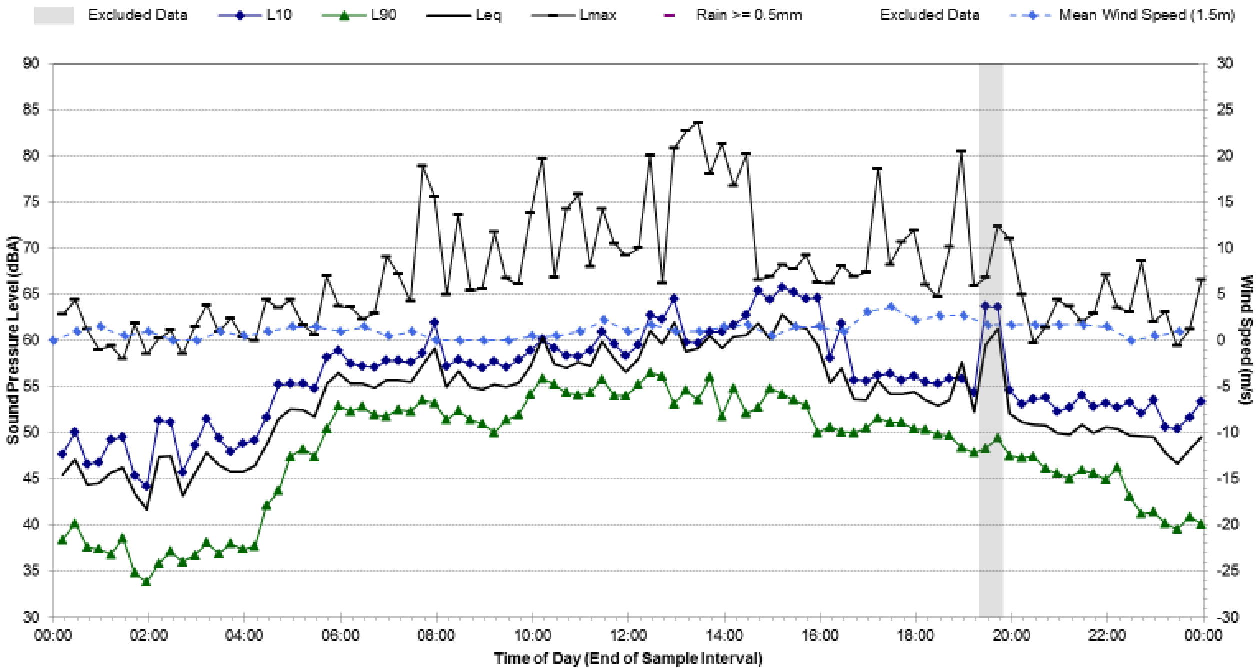


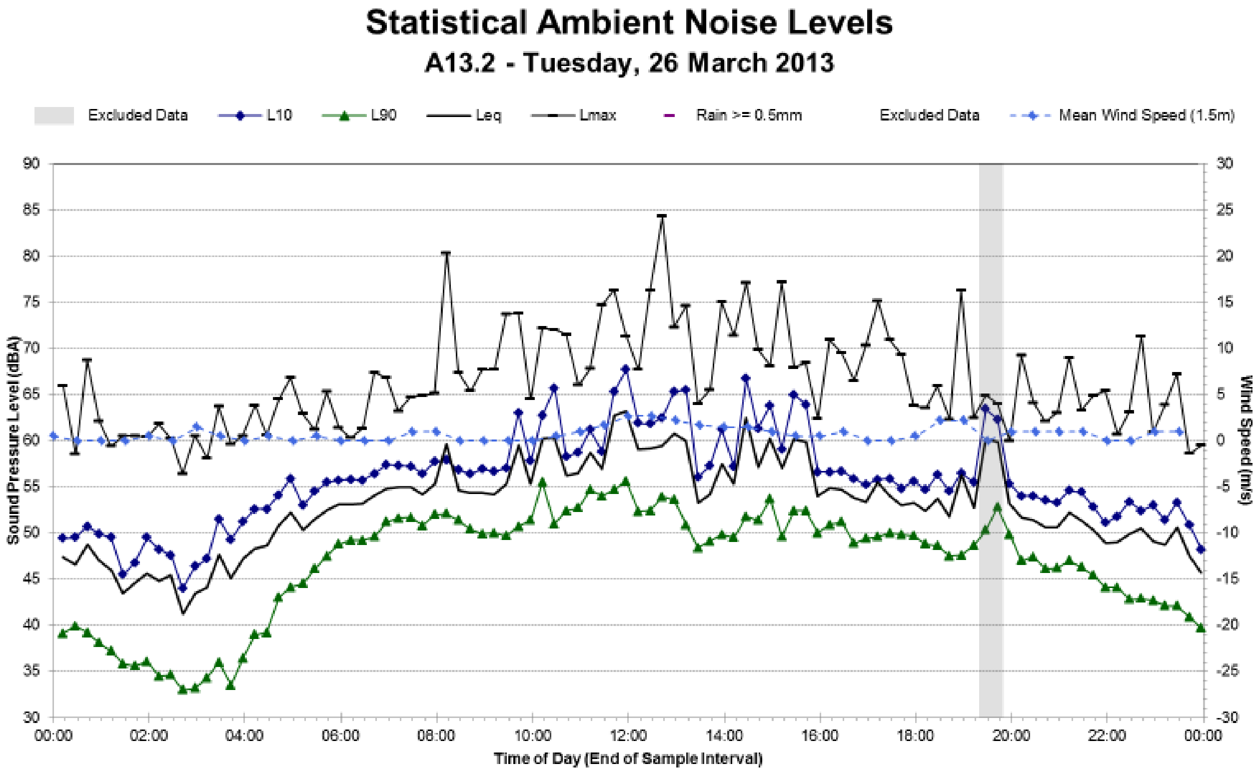
A13 Ambient Noise Monitoring Results

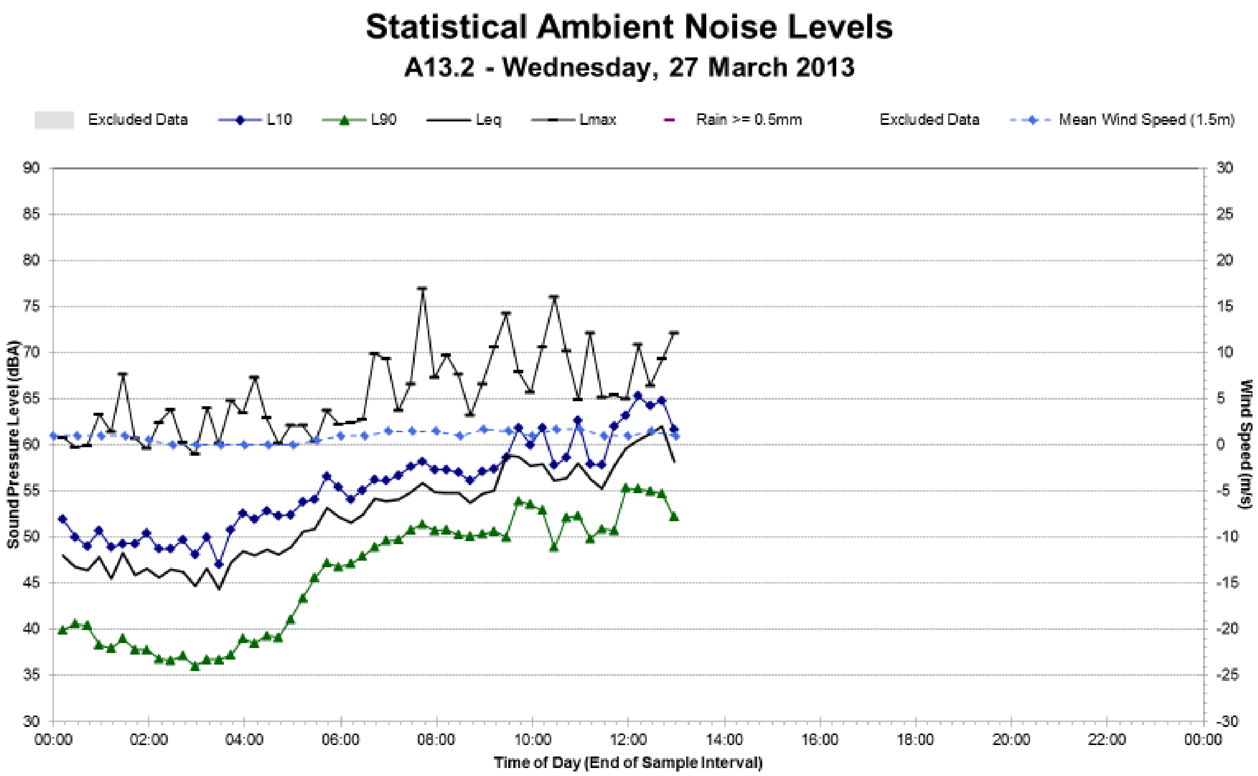
Statistical Ambient Noise Levels
A13.2 - Sunday, 24 March 2013



Statistical Ambient Noise Levels
A13.2 - Monday, 25 March 2013




Statistical Ambient Noise Levels
A13.2 - Tuesday, 26 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A13.2 - Wednesday, 27 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A13 Ambient Noise Monitoring Results

Noise Monitoring Location:	**A13.3**
Noise Monitoring Address:	**13 Palmer Pl, Emu Plains**

Logger Device Type: Svantek 957
Logger Serial No: 23241

Ambient noise logger deployed at rear of residential address 13 Palmer Pl, Emu Plains.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from M4. Frequent tyre-pavement noise from light-vehicle traffic on M4 can be heard at this location however, heavy vehicle movements are notably higher in level. Discretely audible heavy vehicle passby events occur frequently.

This ambient noise monitoring location appears to be exposed to significant levels of insect noise which are prevalent during the middle of the day. These extraneous noise sources have been removed from the dataset.

Recorded Noise Levels (LAmax):
Heavy-vehicle road traffic: 53-63 dBA, Light-vehicle road traffic: ~52 dBA, Birds: 68 dBA, Distant construction: 57 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – INP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	48	59	59	64
Evening	48	54	54	59
Night-time	44	53	53	56

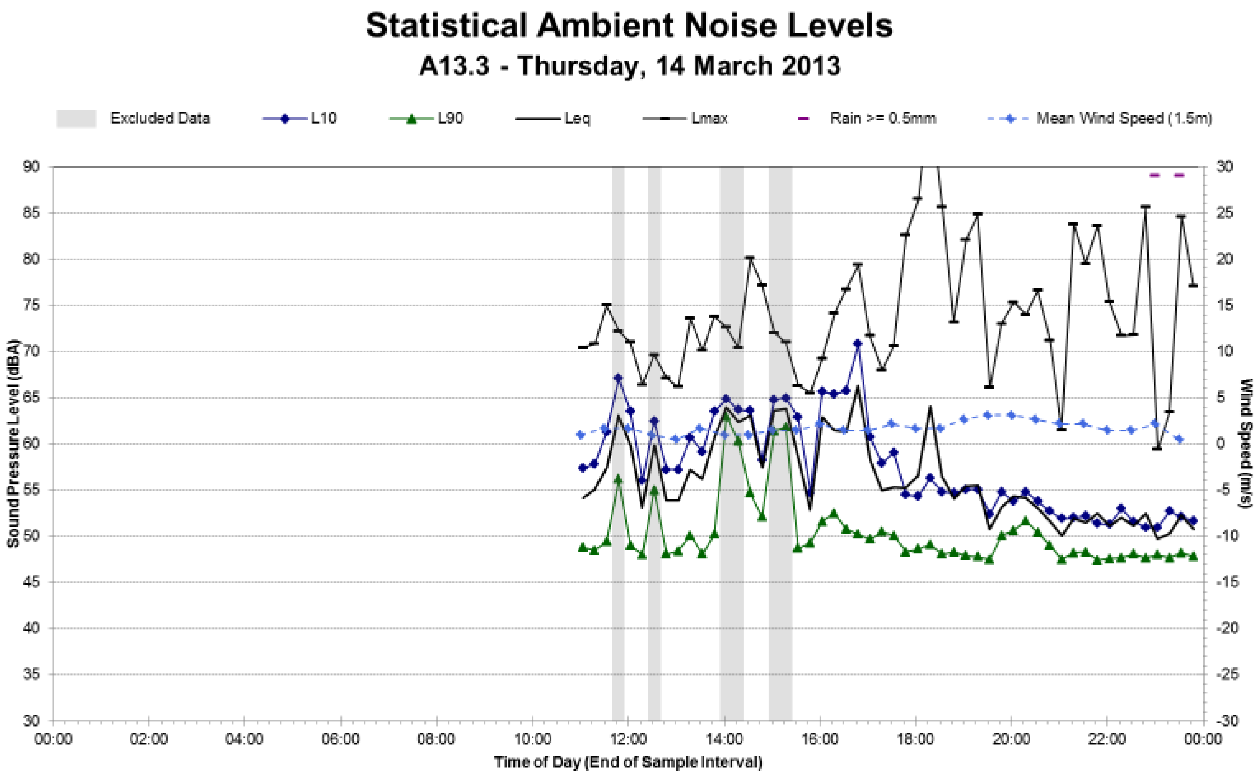
Ambient Noise Logging Results – RNP Defined Time Periods

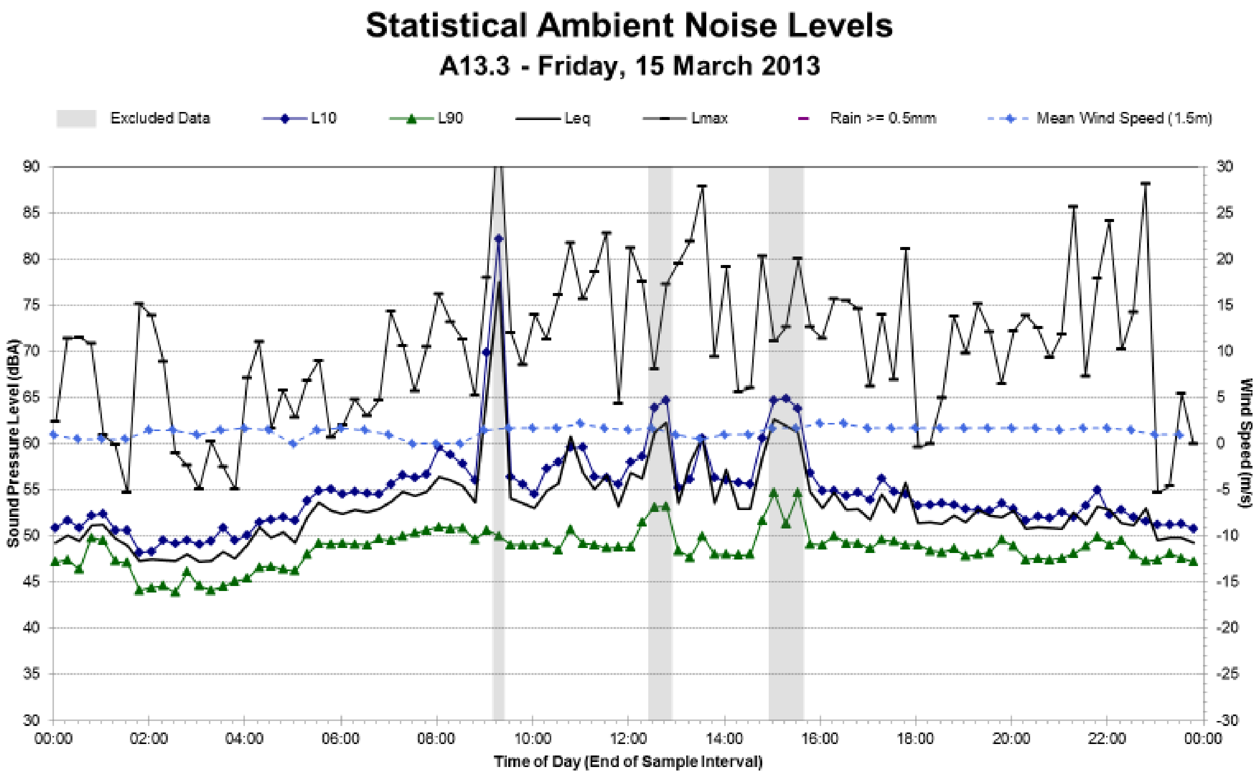
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	4	2	N/A (7 Day Average)
Daytime (7am-10pm)	58	60	58
Night-time (10pm-7am)	53	53	53

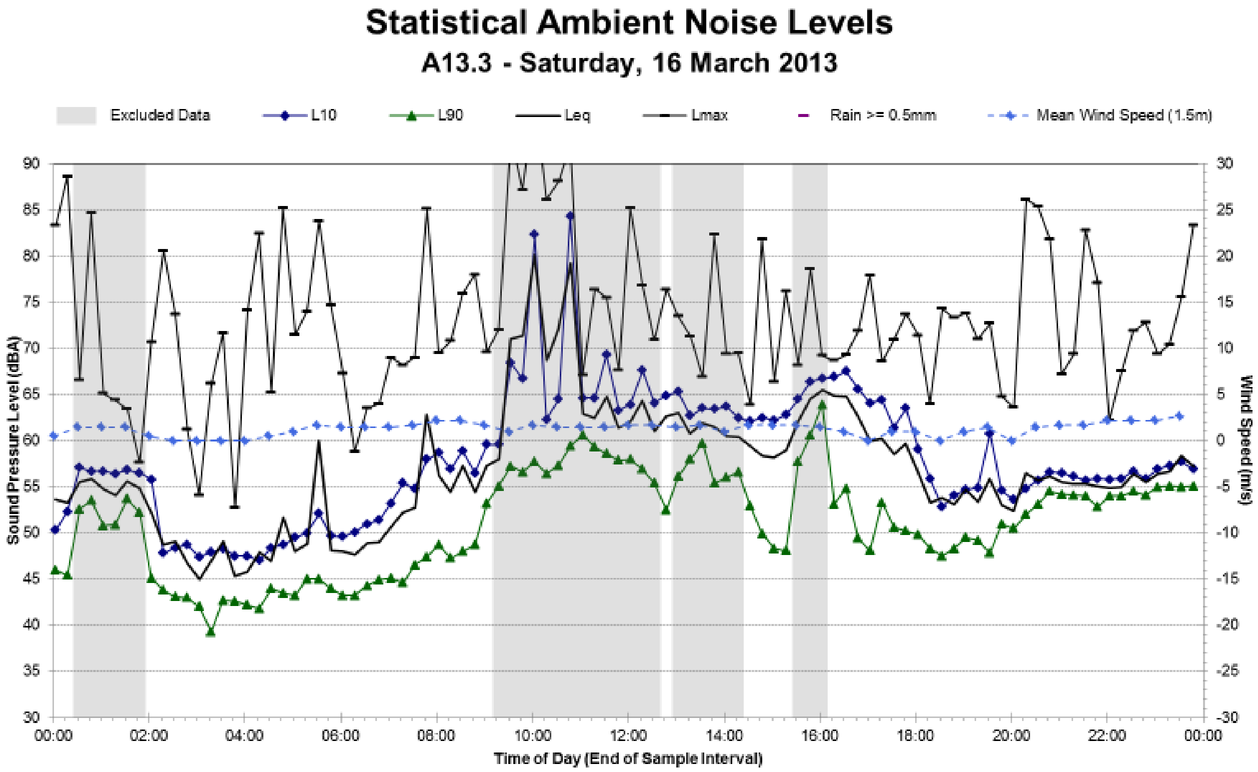
Attended Noise Measurement Results

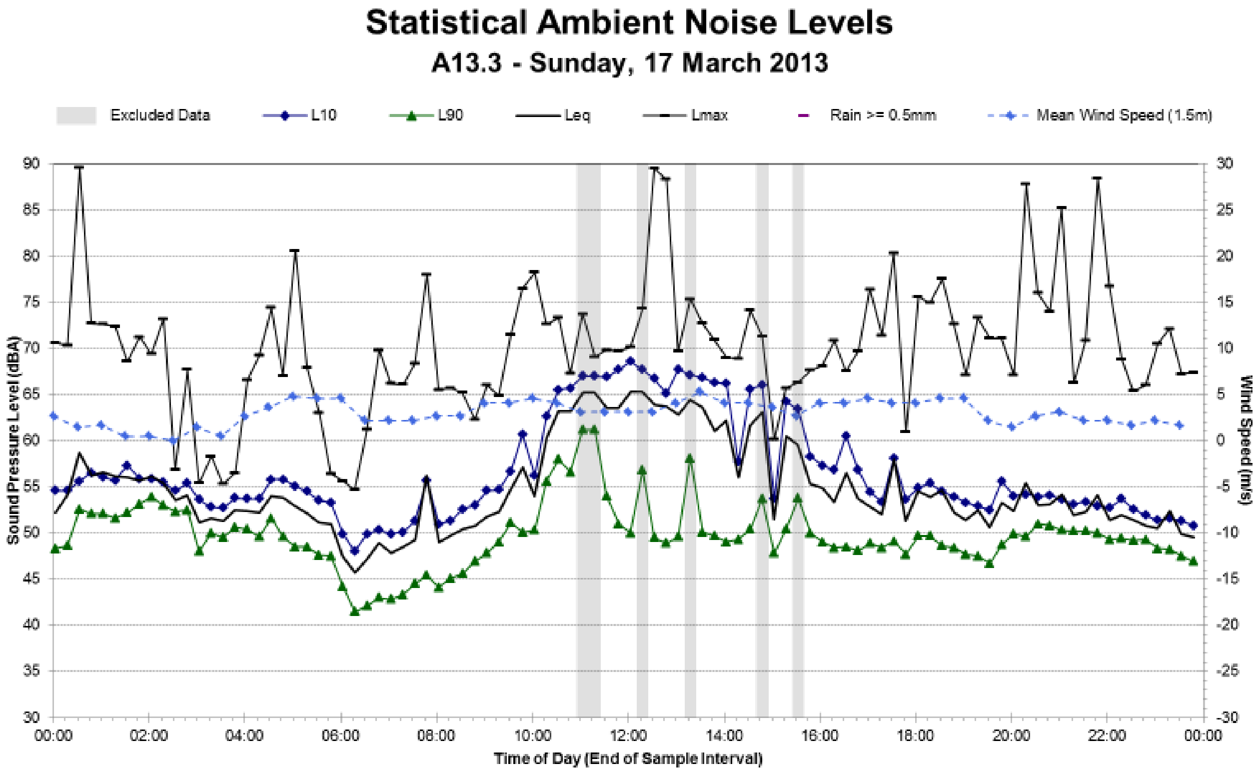
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
14/03/2013	10:50	47	55	75

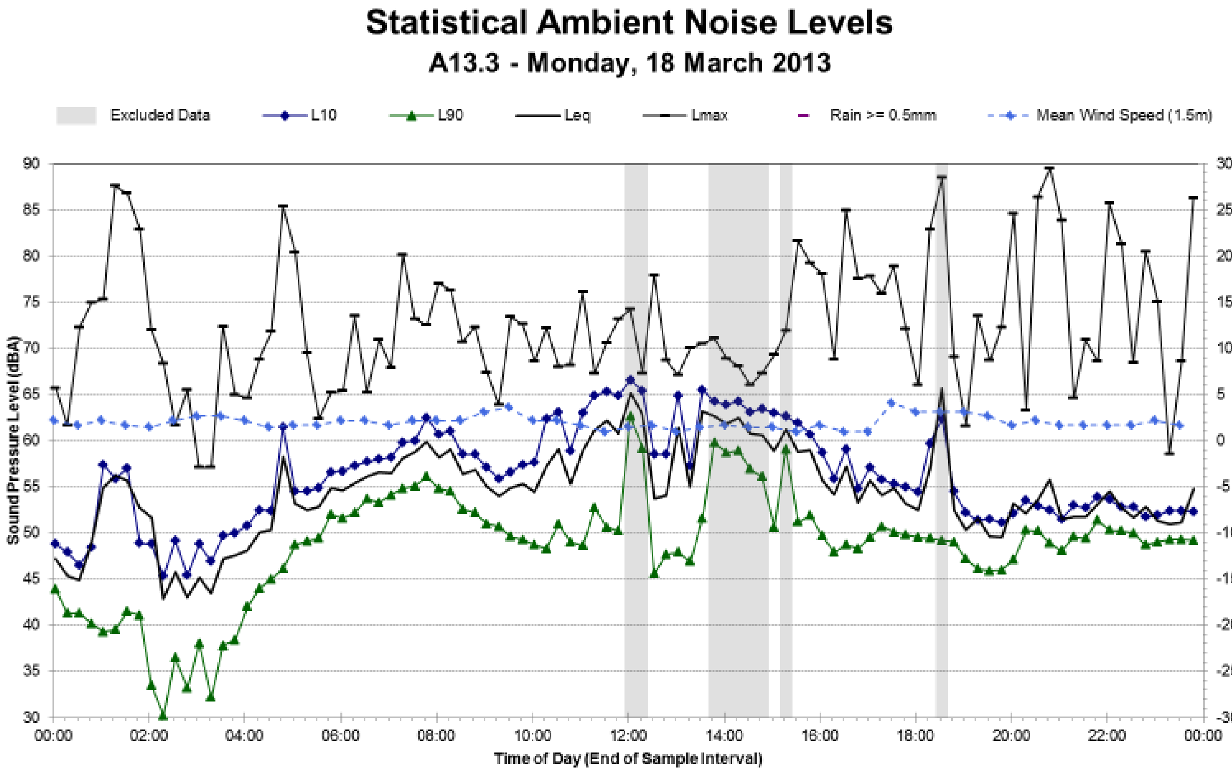
Photo of Noise Monitoring Location

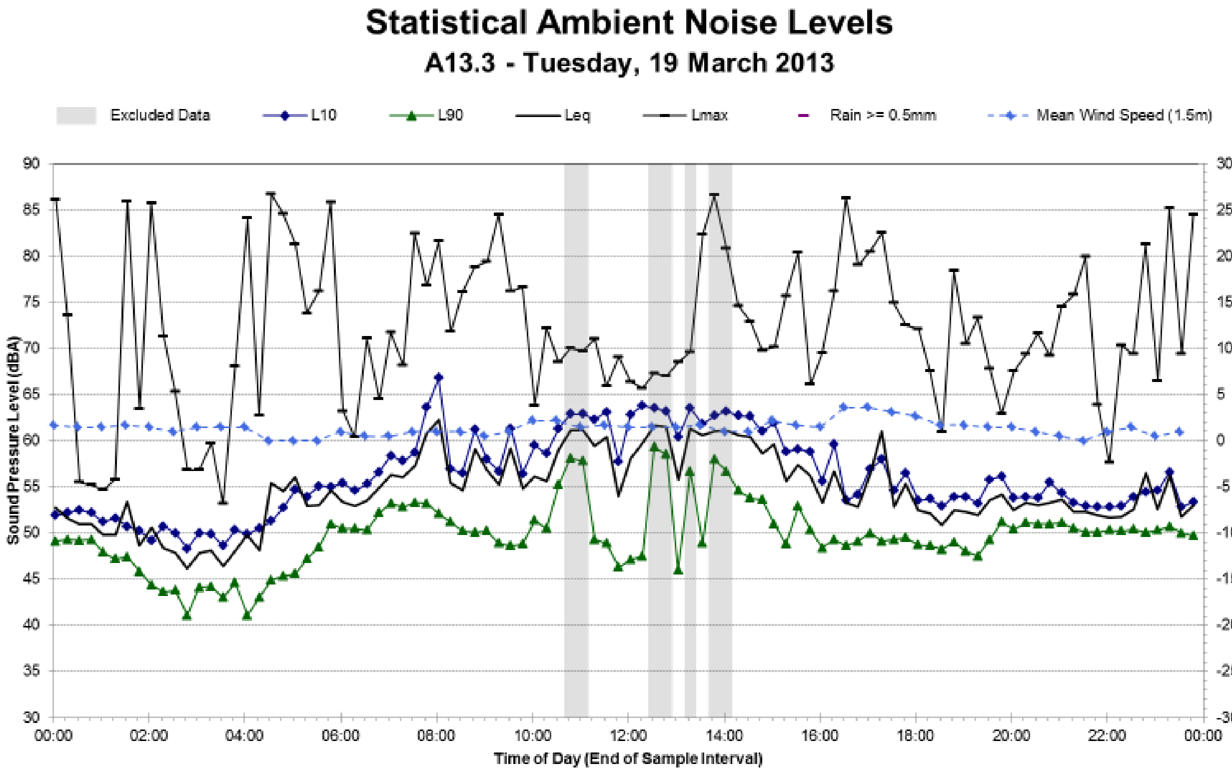

Statistical Ambient Noise Levels
A13.3 - Thursday, 14 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

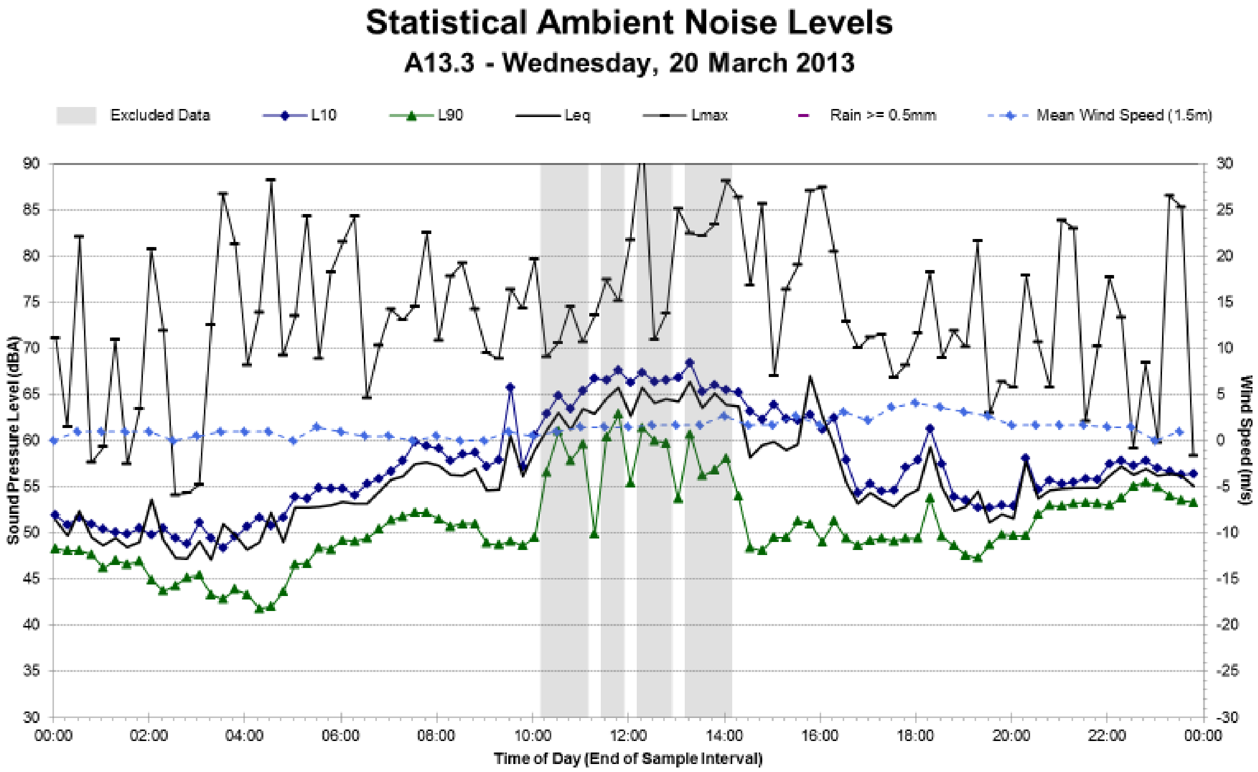

Statistical Ambient Noise Levels
A13.3 - Friday, 15 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

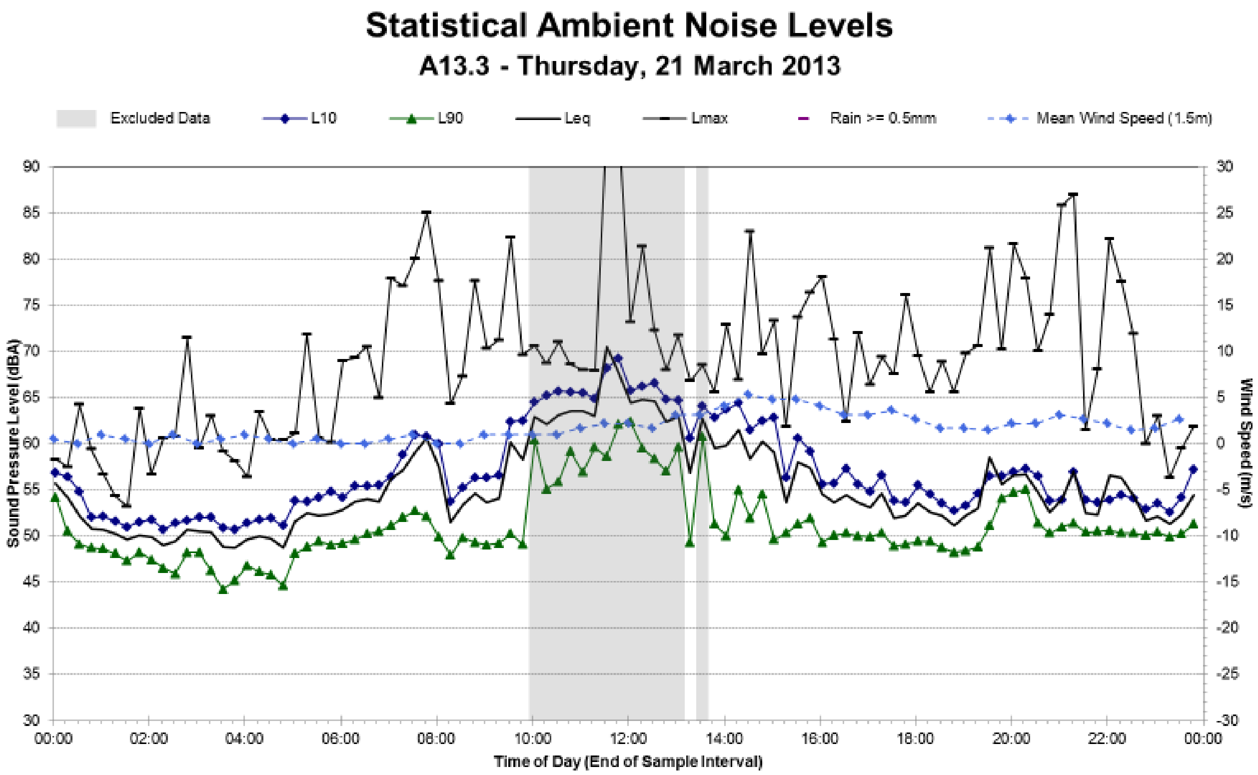

Statistical Ambient Noise Levels
A13.3 - Saturday, 16 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

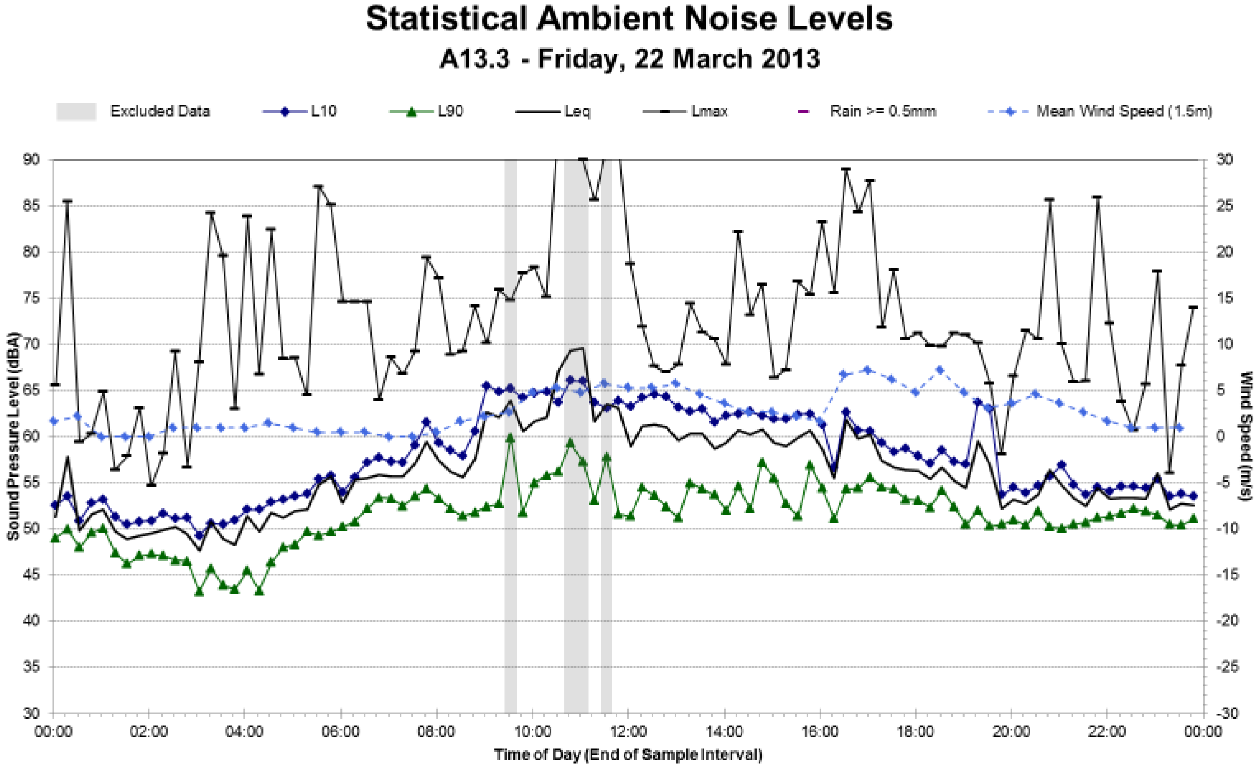

Statistical Ambient Noise Levels
A13.3 - Sunday, 17 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

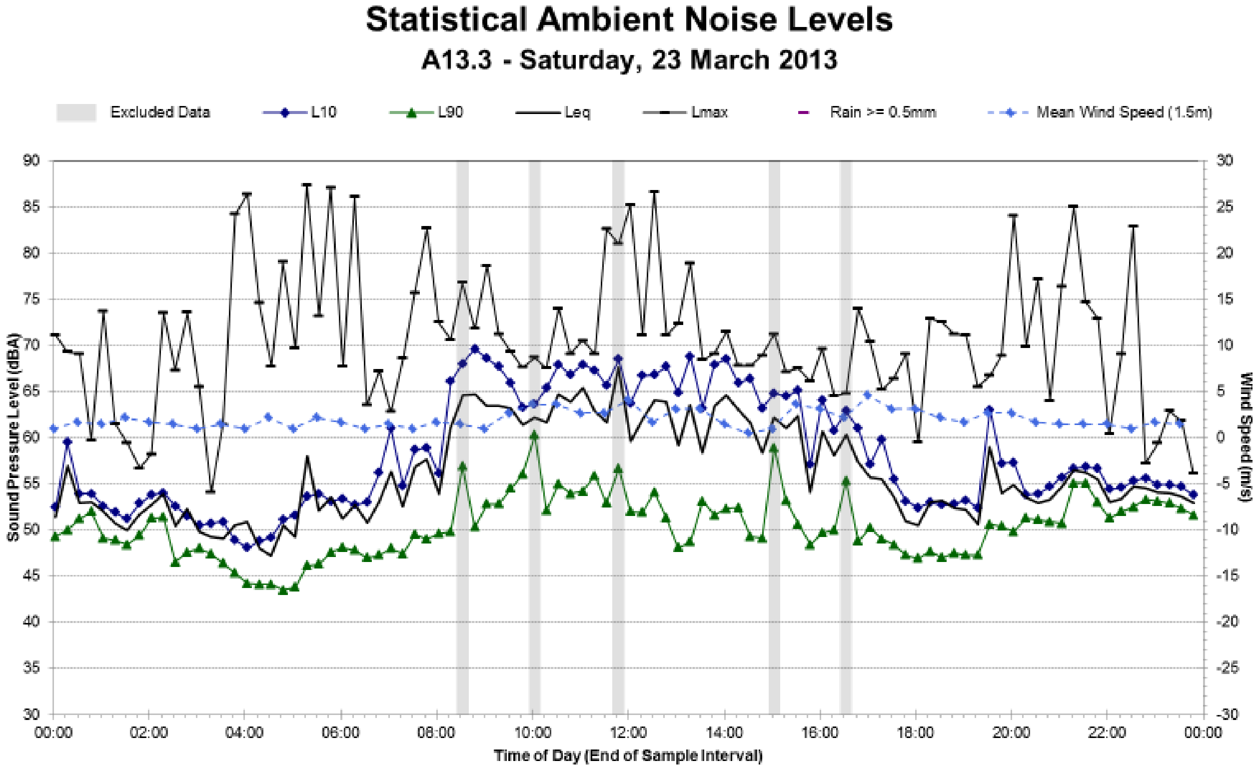

Statistical Ambient Noise Levels
A13.3 - Monday, 18 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

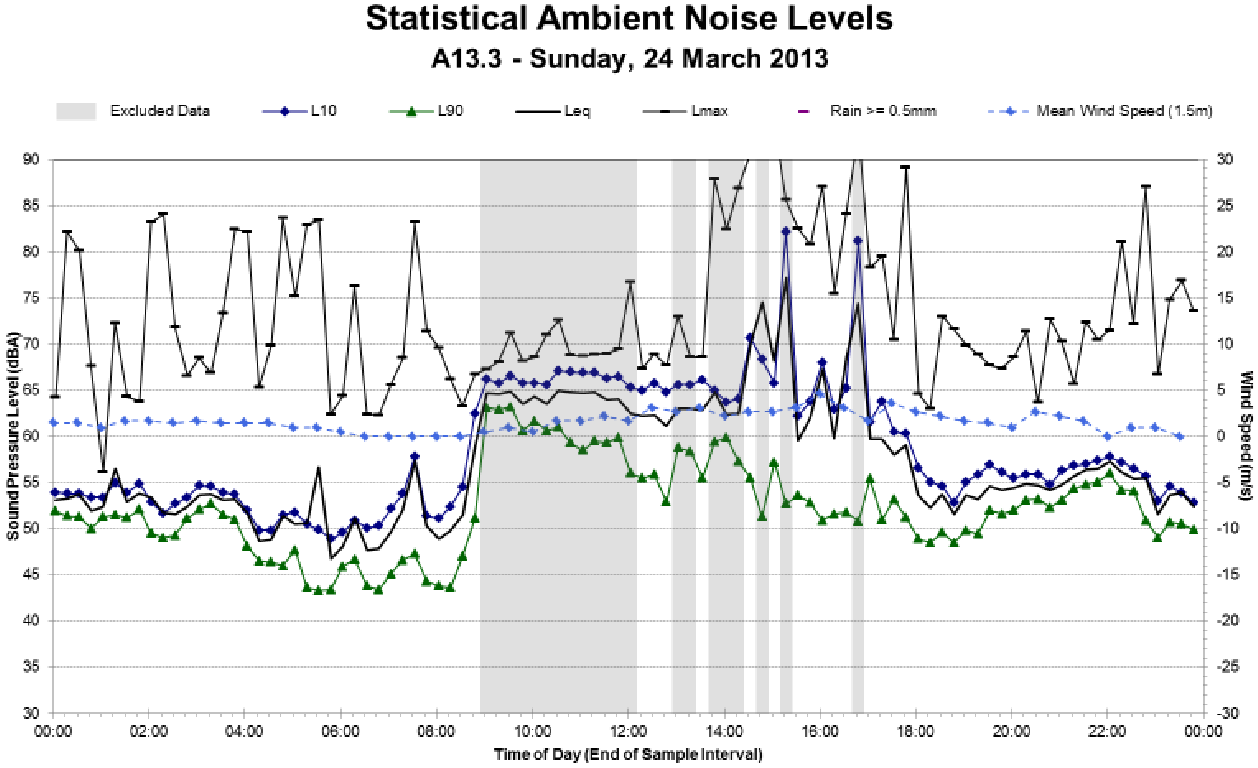

Statistical Ambient Noise Levels
A13.3 - Tuesday, 19 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

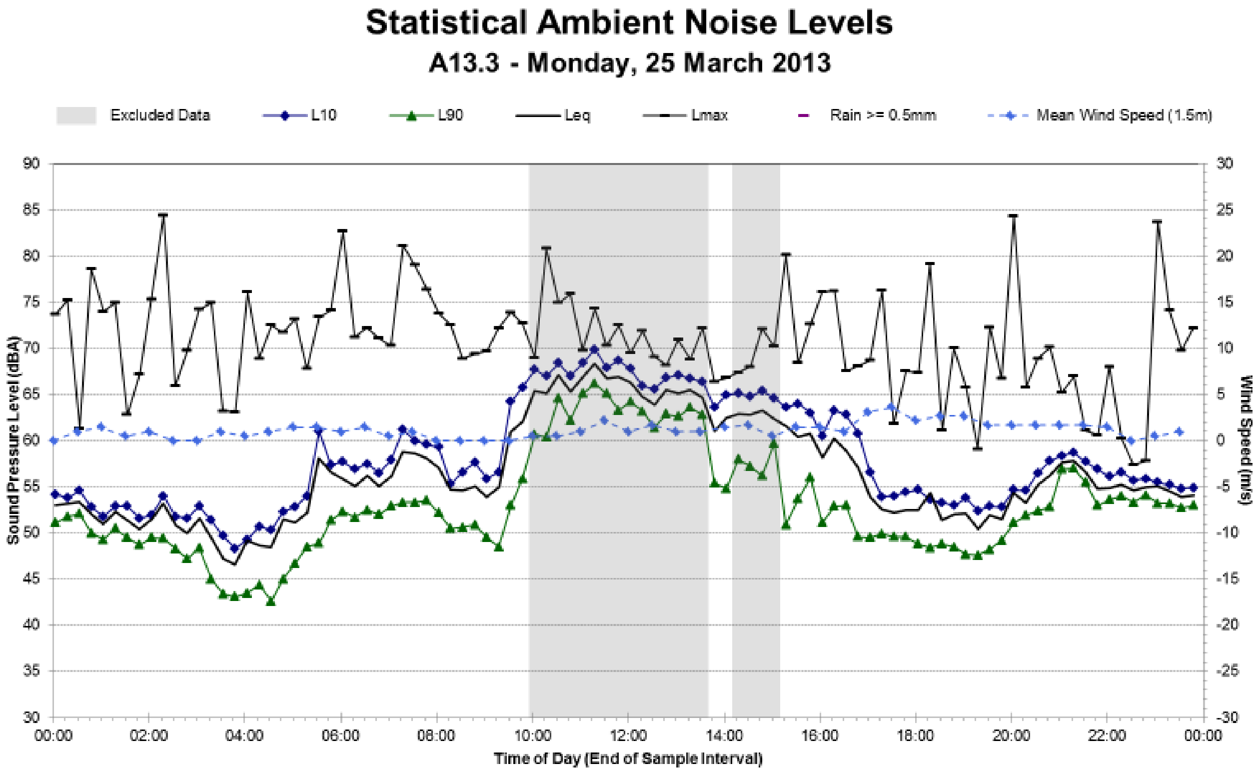

Statistical Ambient Noise Levels
A13.3 - Wednesday, 20 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00


Statistical Ambient Noise Levels
A13.3 - Thursday, 21 March 2013
Excluded Data
L10
L90
Leq
Lmax
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

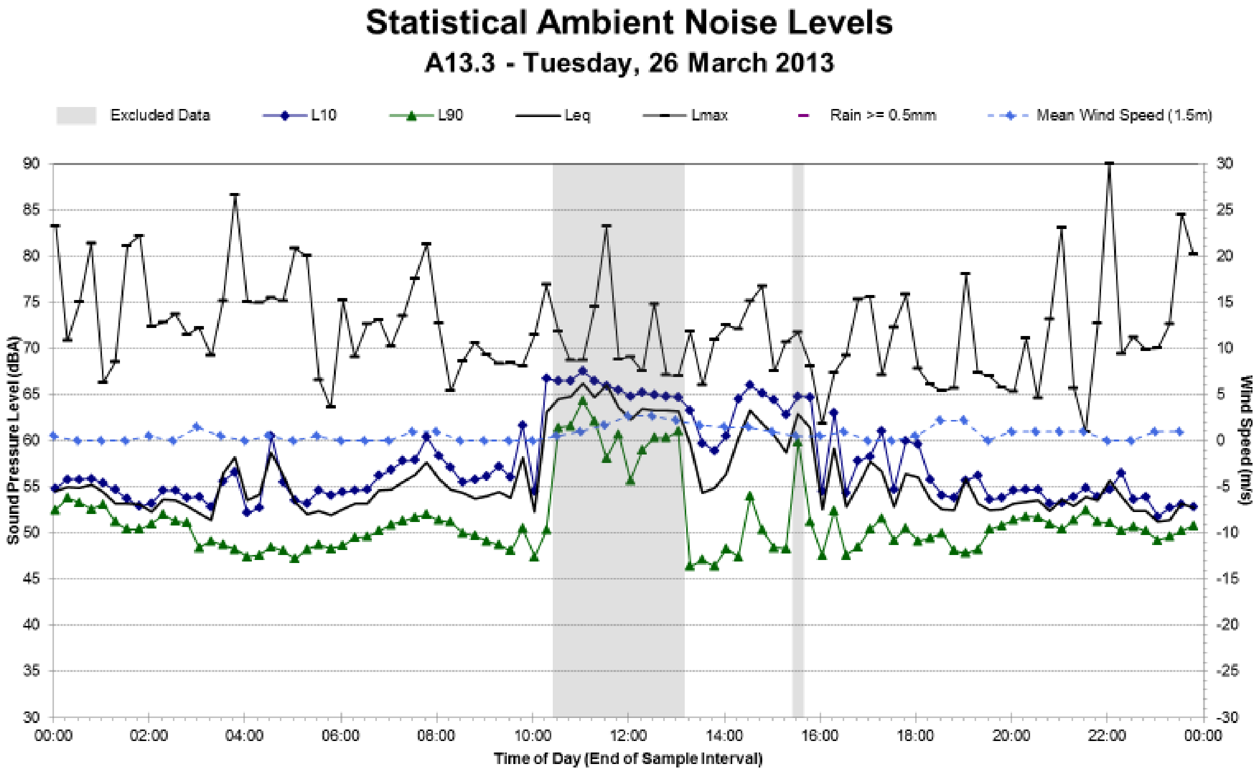

Statistical Ambient Noise Levels
A13.3 - Friday, 22 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

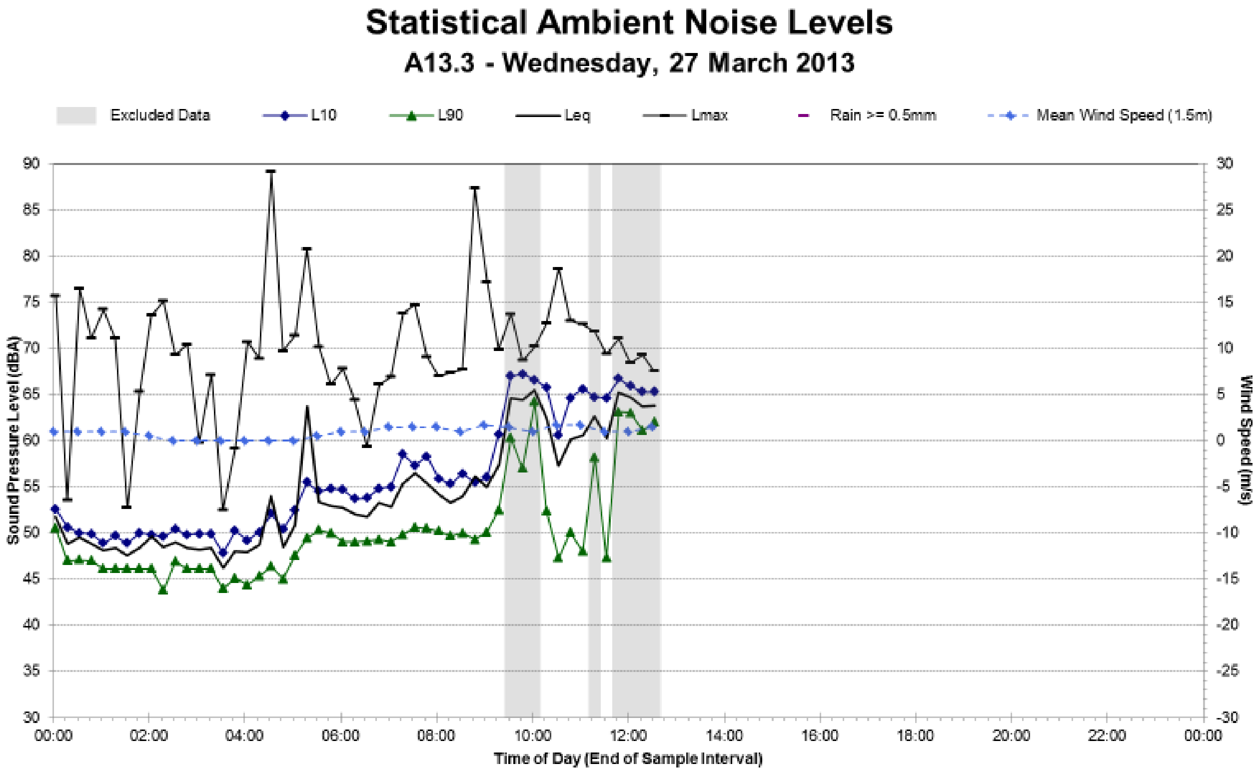

Statistical Ambient Noise Levels
A13.3 - Saturday, 23 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
A13.3 - Sunday, 24 March 2013
Excluded Data
L10
L90
Leq
Lmax
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
A13.3 - Monday, 25 March 2013
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

A13 Ambient Noise Monitoring Results





Noise Monitoring Location:	ADD.06.x2
Noise Monitoring Address:	**RMS Land – Berith Rd, Greystanes**

Logger Device Type: ARL316
Logger Serial No: 16-207-046

Ambient noise logger deployed on RMS land adjacent to access gate on Berith Road. Logger deployed on the mound with direct line of site to the M4 Corridor.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4. Steady flow of traffic for the measurement.

Recorded Noise Levels (LAmax):
M4 Light-vehicle road traffic: typically ~76-79 dBA; M4 Heavy-vehicle road traffic: 79-94 dBA; Motorcycle: 84 dBA

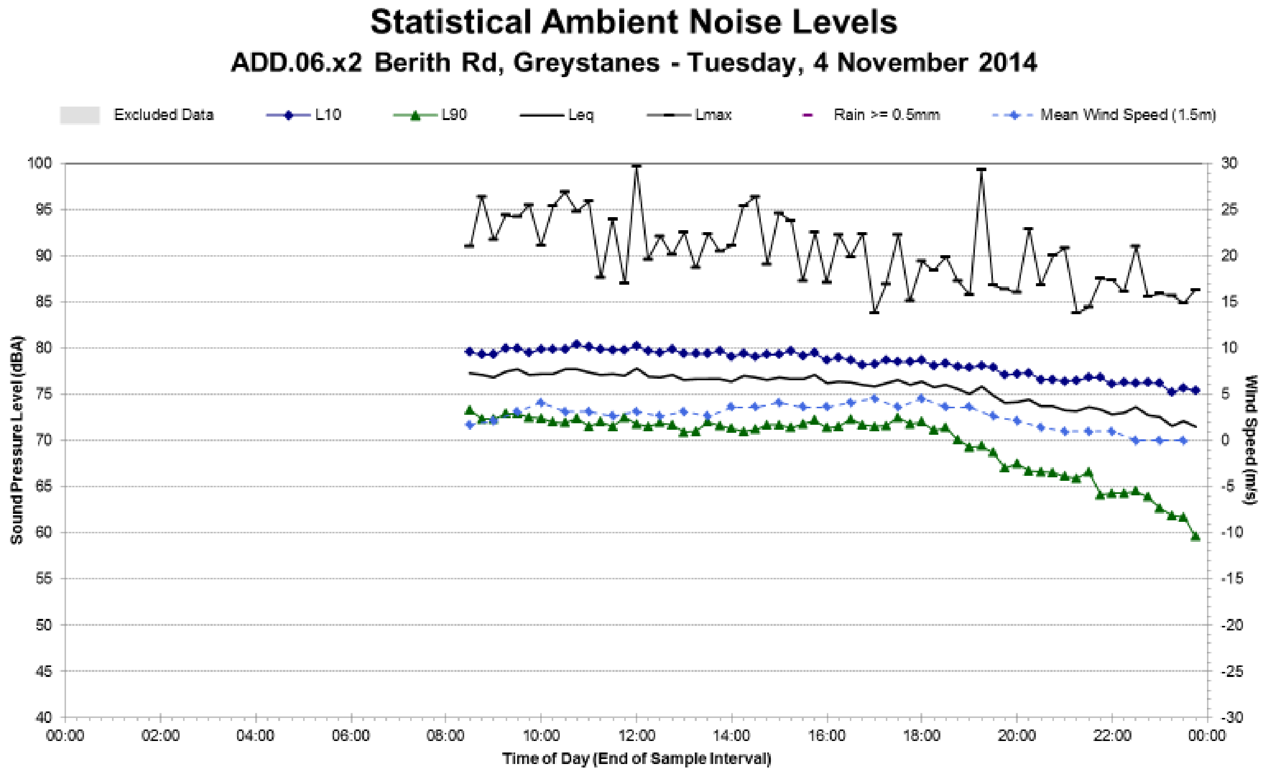
Map of Noise Monitoring Location

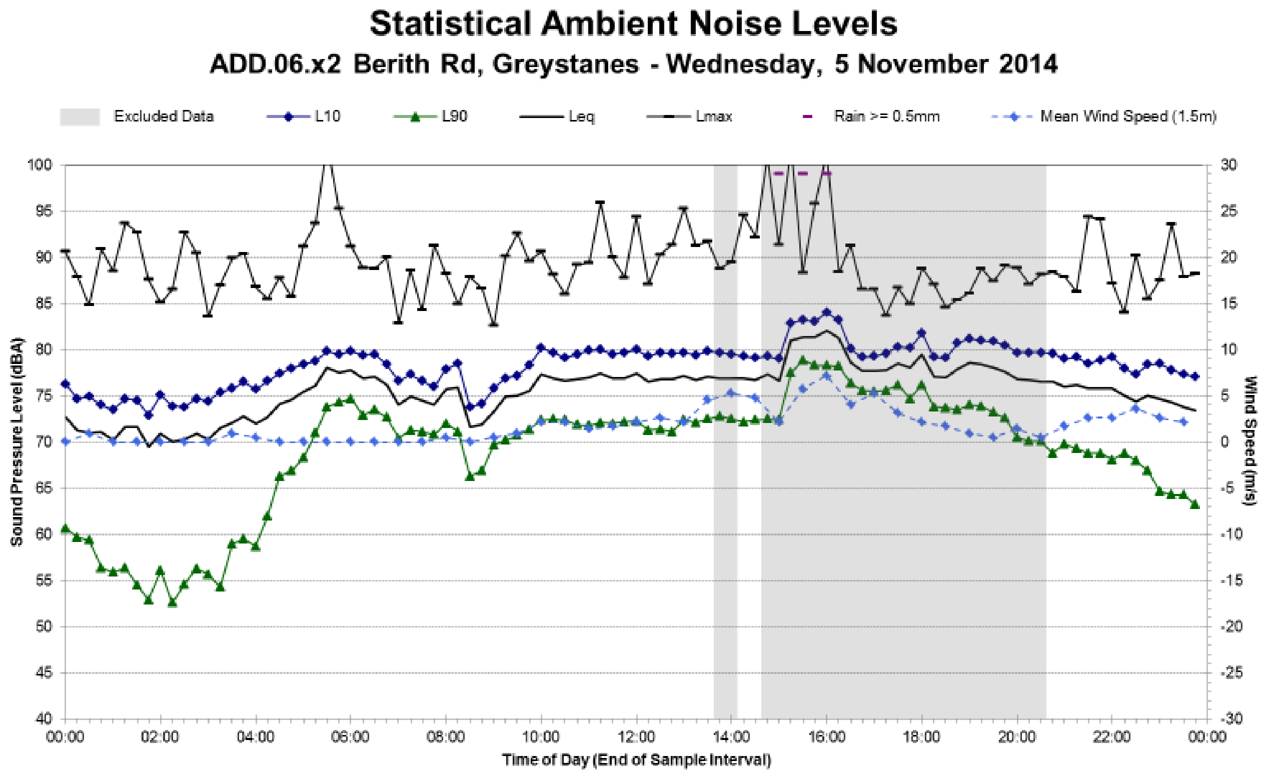
Ambient Noise Logging Results – ICNG Defined Time Periods				
Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	70	76	79	83
Evening	66	75	77	81
Night-time	55	74	76	81

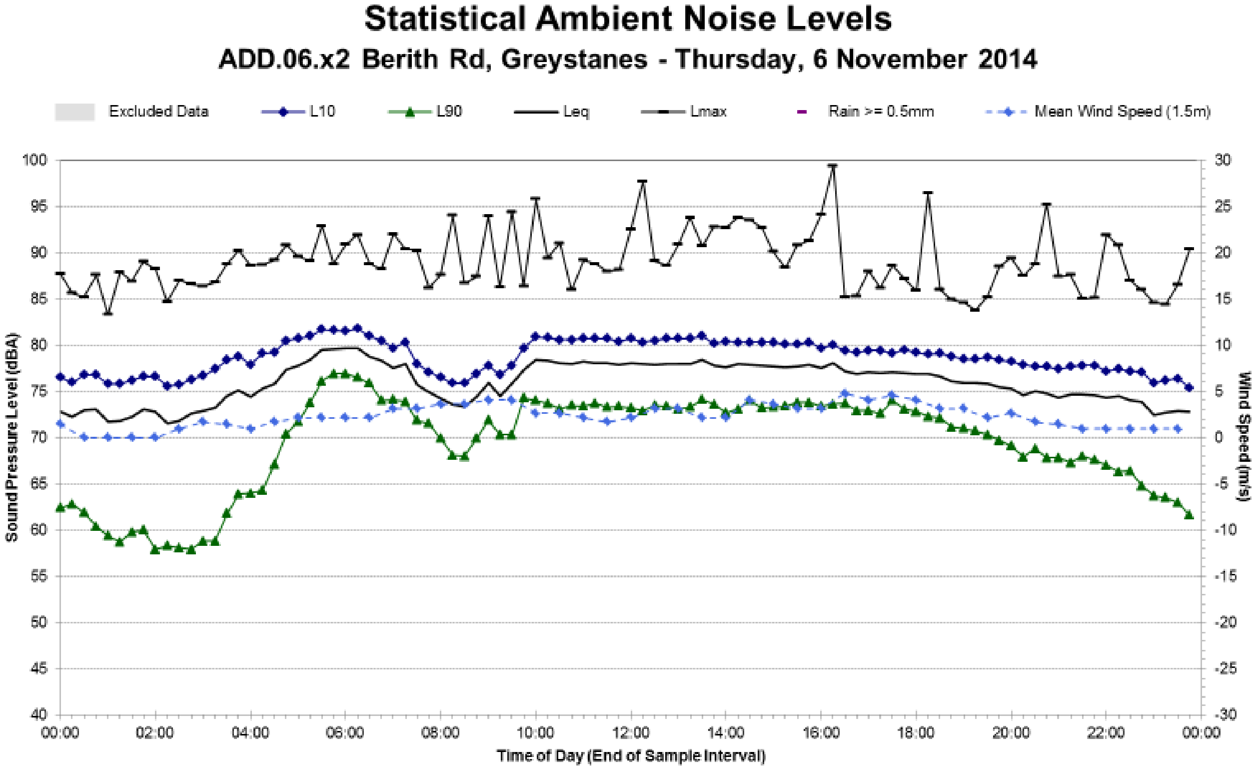
Ambient Noise Logging Results – RNP Defined Time Periods			
Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	76	75	76
Night-time (10pm-7am)	74	72	74

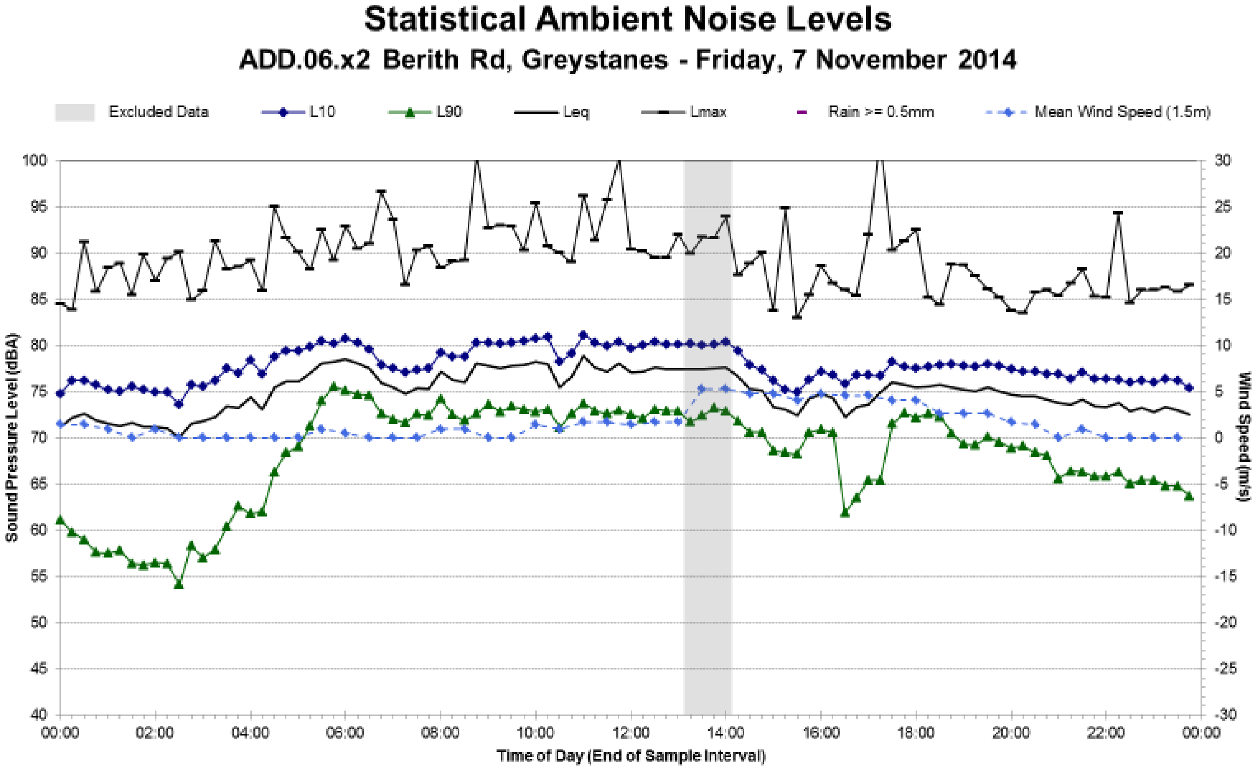
Attended Noise Measurement Results				
Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
04/11/14	07:59am	75	78	94

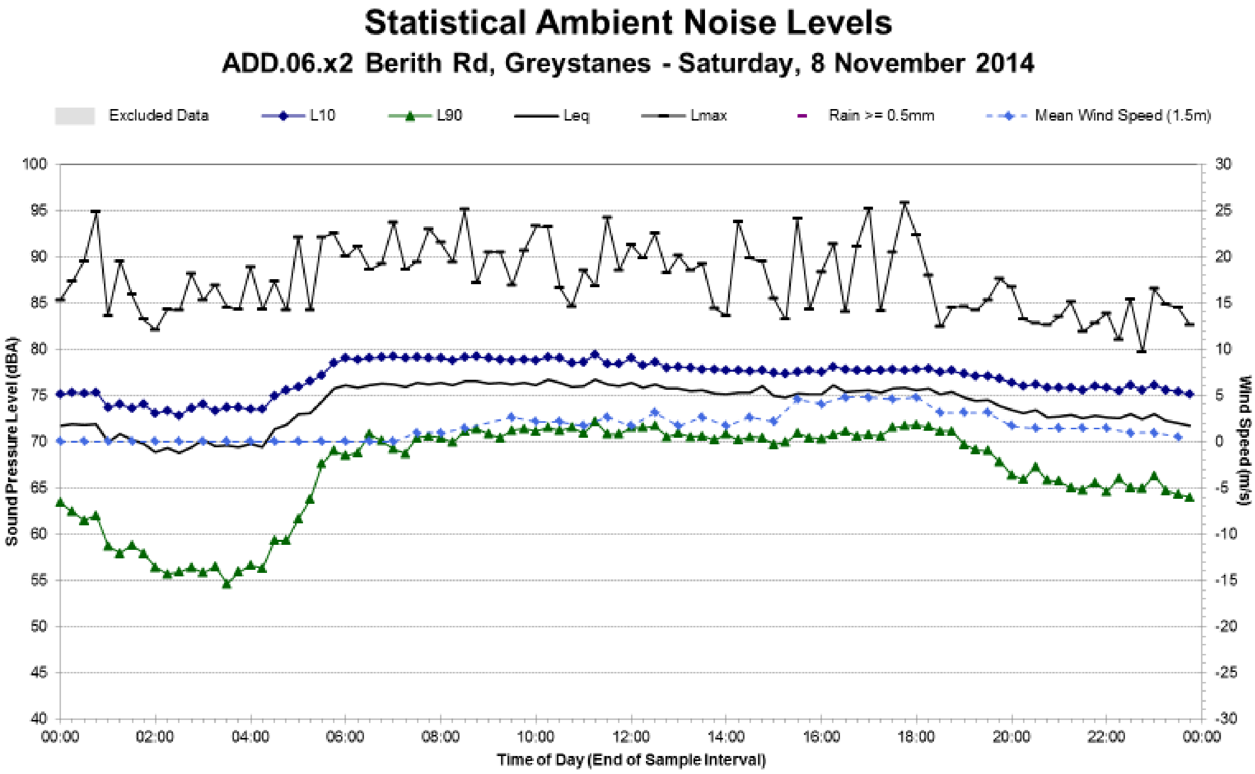
Photo of Noise Monitoring Location


Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Tuesday, 4 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

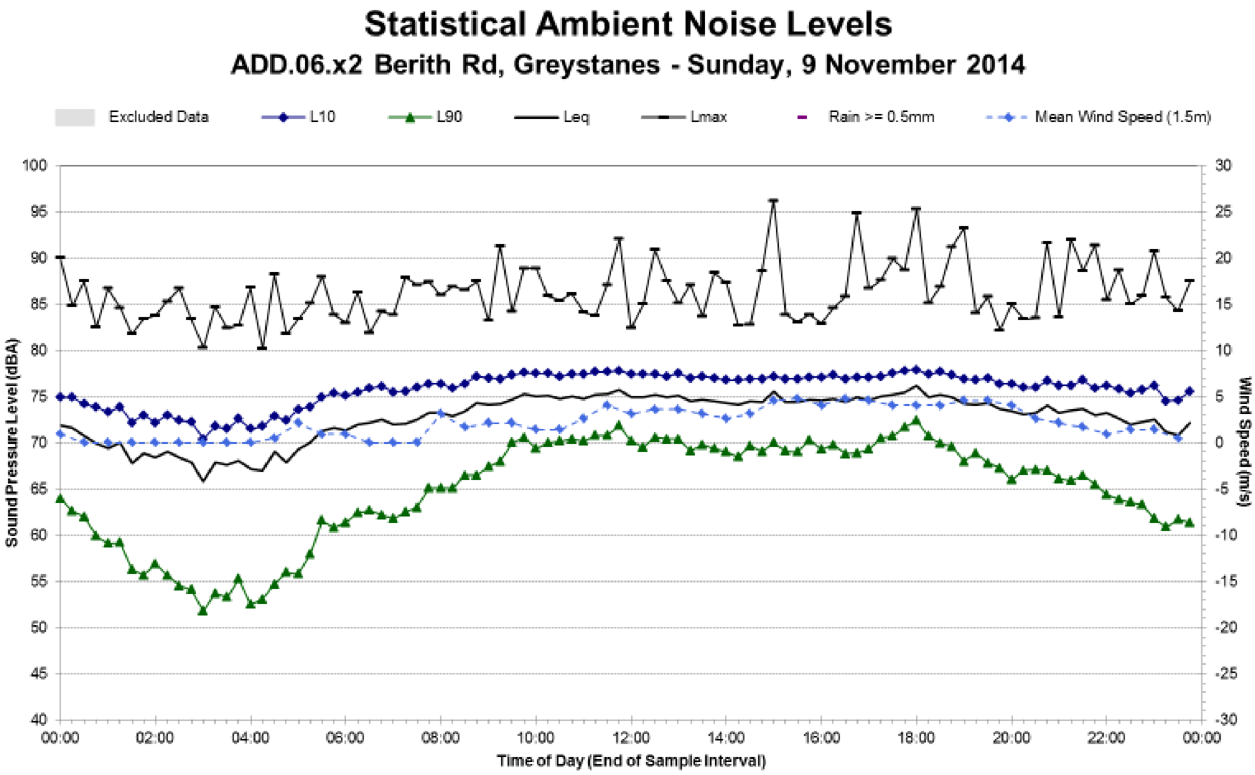

Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Wednesday, 5 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Thursday, 6 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

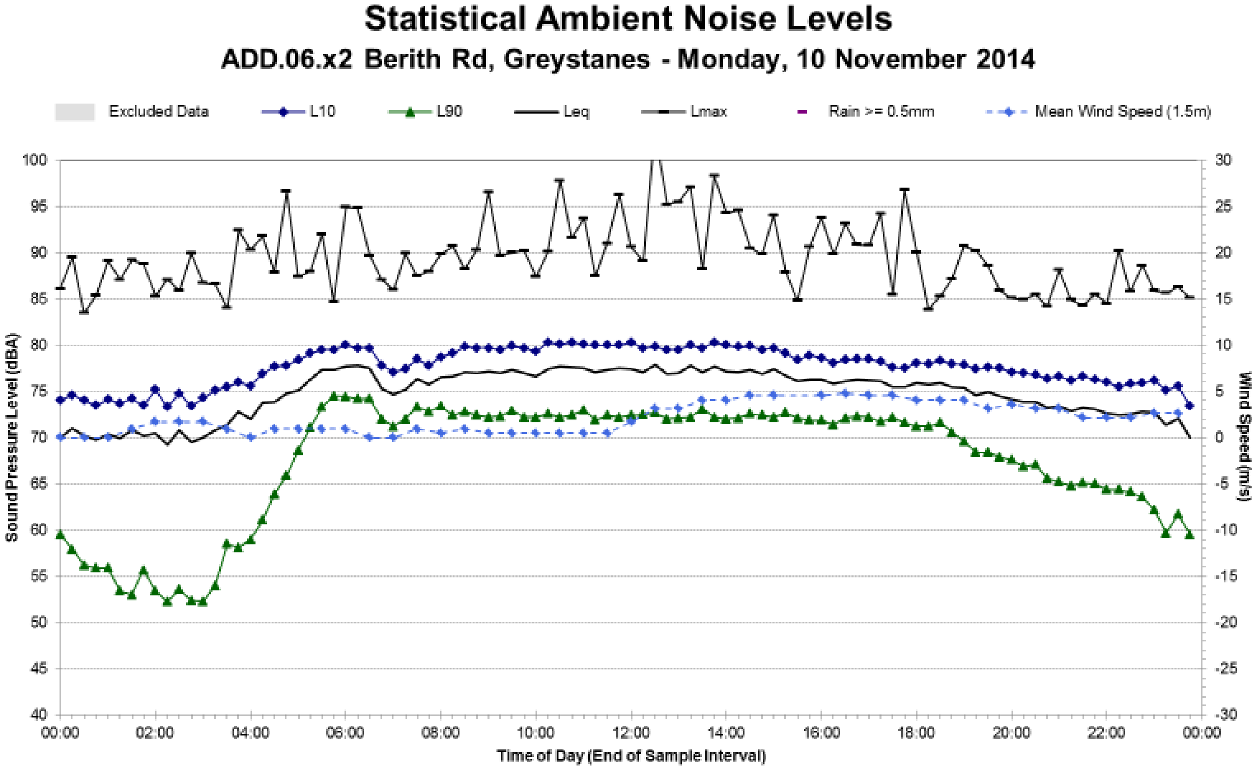

Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Friday, 7 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



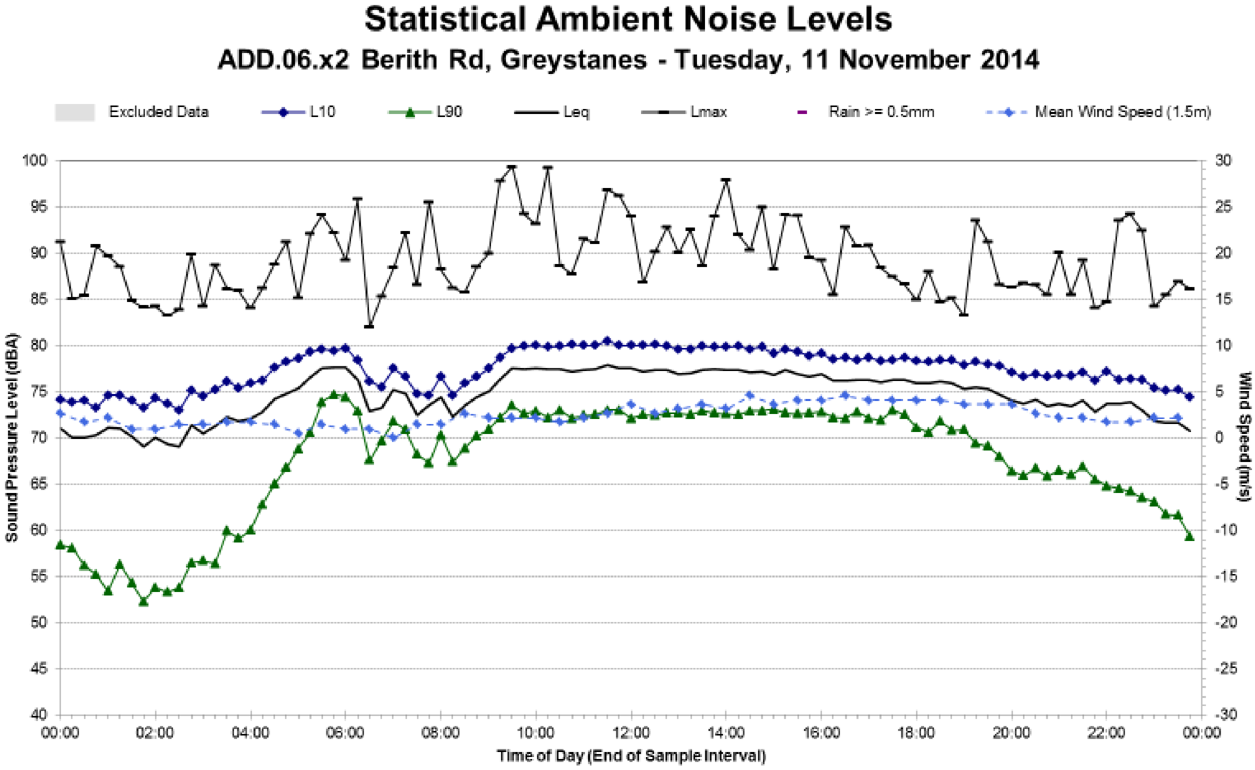
Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Saturday, 8 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Sunday, 9 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



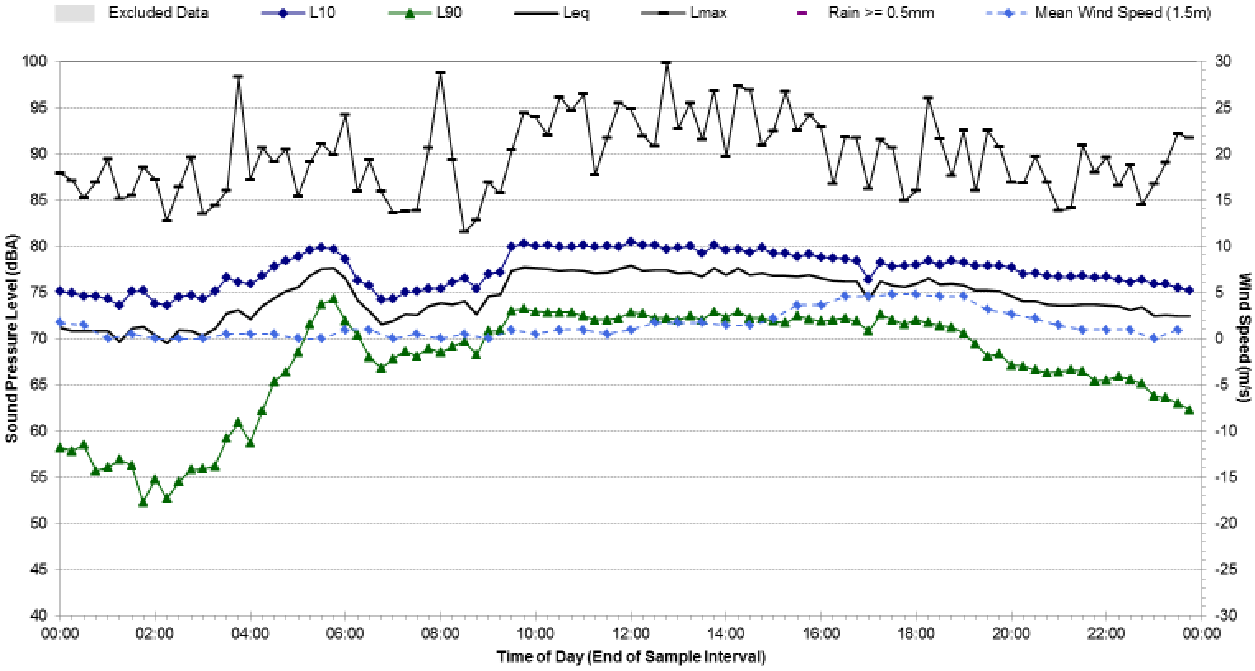
Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Monday, 10 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00



Statistical Ambient Noise Levels
ADD.06.x2 Berith Rd, Greystanes - Tuesday, 11 November 2014
Excluded Data
L10
L90
Leq
Lmax
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

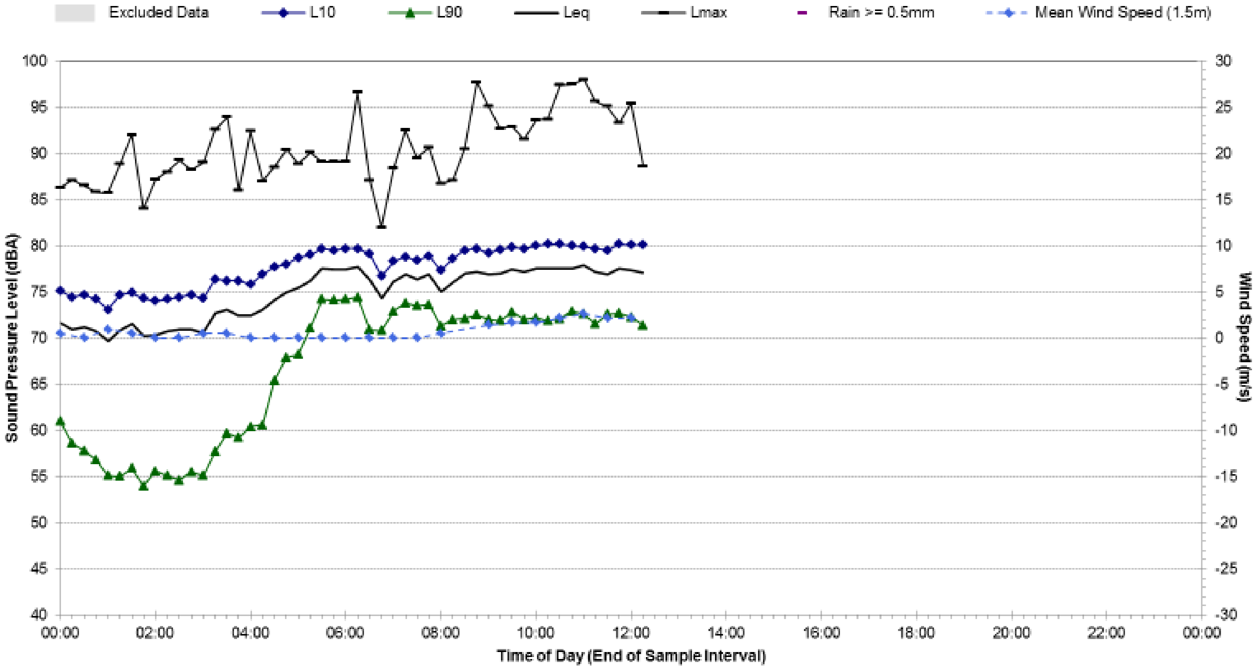
Statistical Ambient Noise Levels

ADD.06.x2 Berith Rd, Greystanes - Wednesday, 12 November 2014



Statistical Ambient Noise Levels

ADD.06.x2 Berith Rd, Greystanes - Thursday, 13 November 2014



Noise Monitoring Location:	**ADD.09.x1**
Noise Monitoring Address:	**RMS Land - Tirage Pl, Minchinbury**

Logger Device Type: ARL316
Logger Serial No: 16-306-044

Ambient noise logger deployed on RMS land adjacent to Tirage Pl. Logger deployed on the mound with direct line of site to the M4 Corridor.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4. Steady flow of traffic for the measurement.

Recorded Noise Levels (LAmax):
M4 Light-vehicle road traffic: typically ~76-80 dBA; M4 Heavy-vehicle road traffic: 80-87 dBA;

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	**Noise Level (dBA)**			
	RBL	**LAeq**	**L10**	**L1**
Daytime	74	78	80	82
Evening	70	76	78	81
Night-time	54	75	76	81

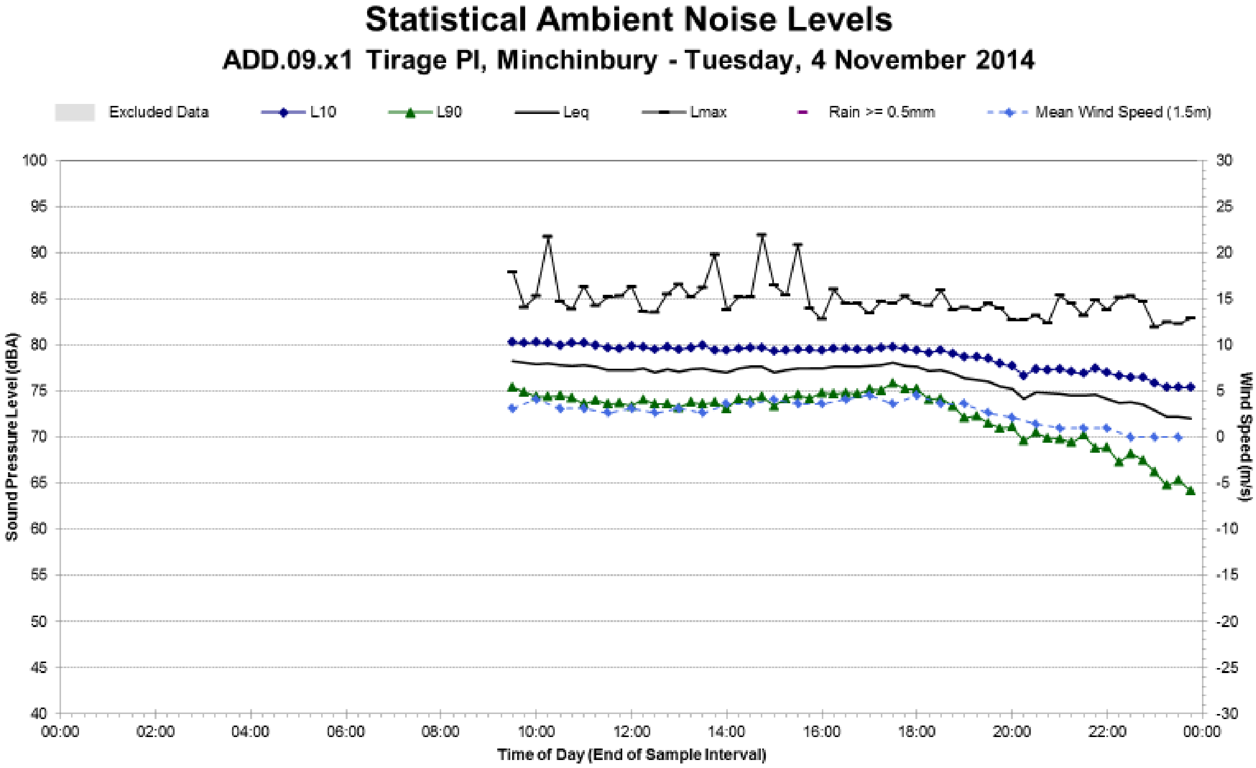
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	**Noise Level (dBA)**		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	78	77	77
Night-time (10pm-7am)	75	74	74

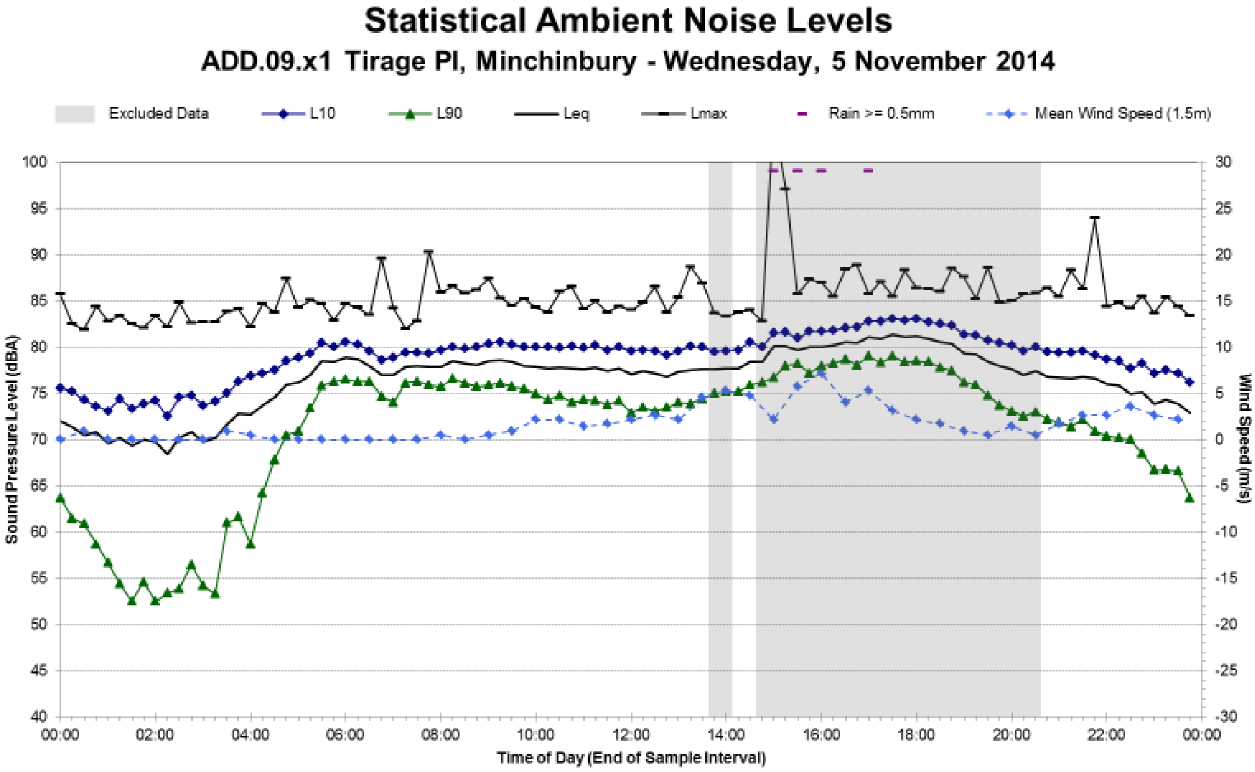
Attended Noise Measurement Results

Date	**Start Time**	**Measured Noise Level (dBA)**		
		LA90	**LAeq**	**LAmax**
04/11/14	09:06am	75	78	87

Photo of Noise Monitoring Location

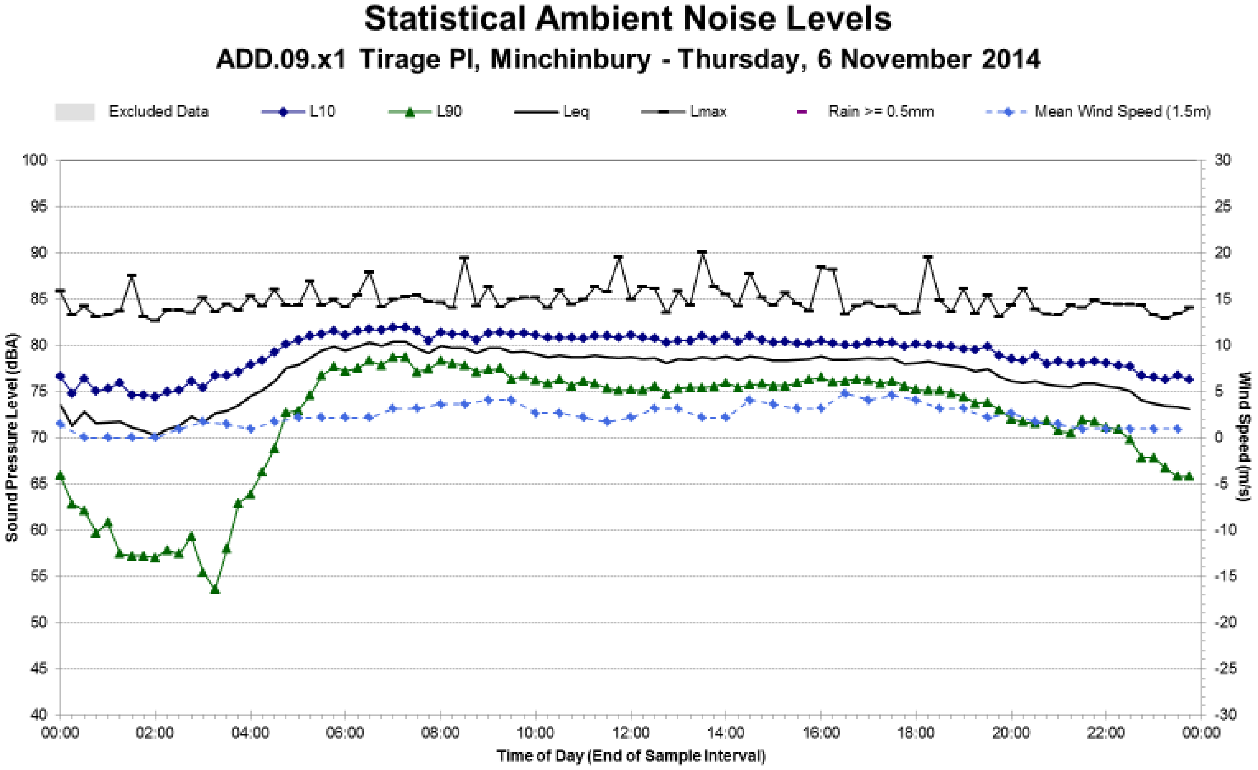


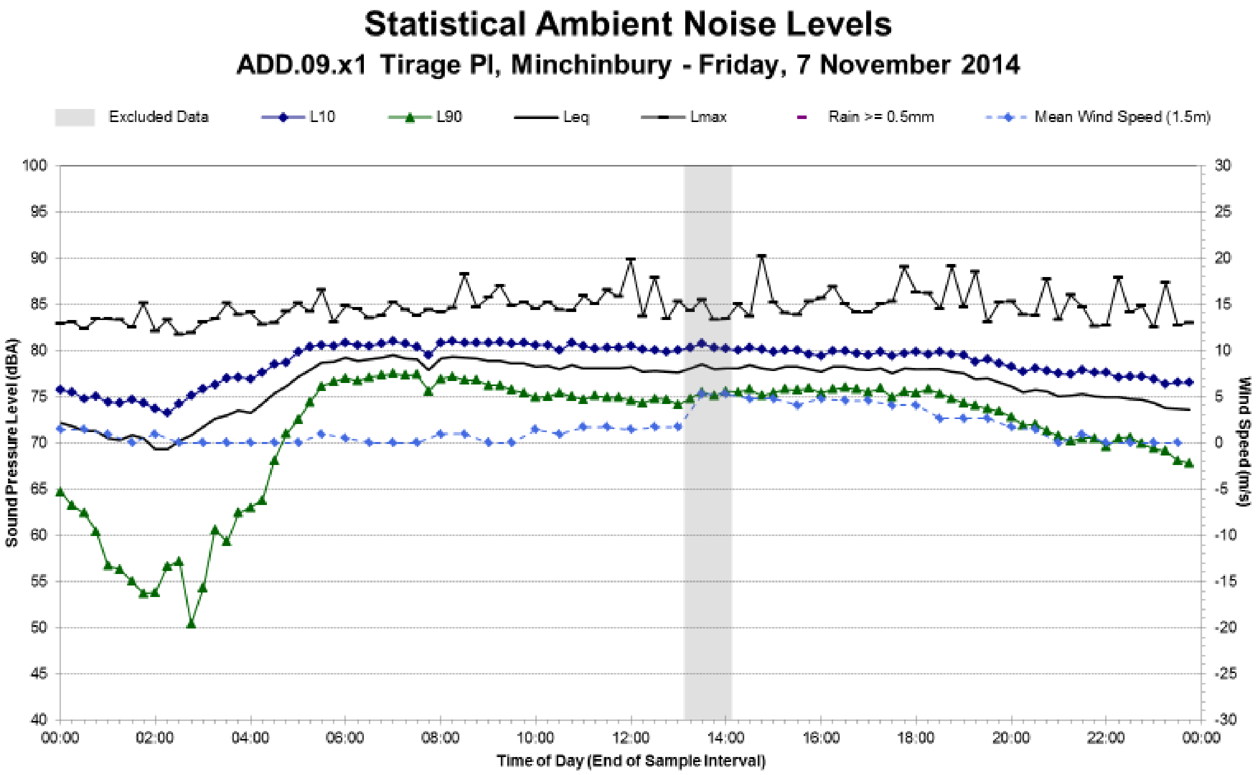
Statistical Ambient Noise Levels
ADD.09.x1 Tirage Pl, Minchinbury - Tuesday, 4 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



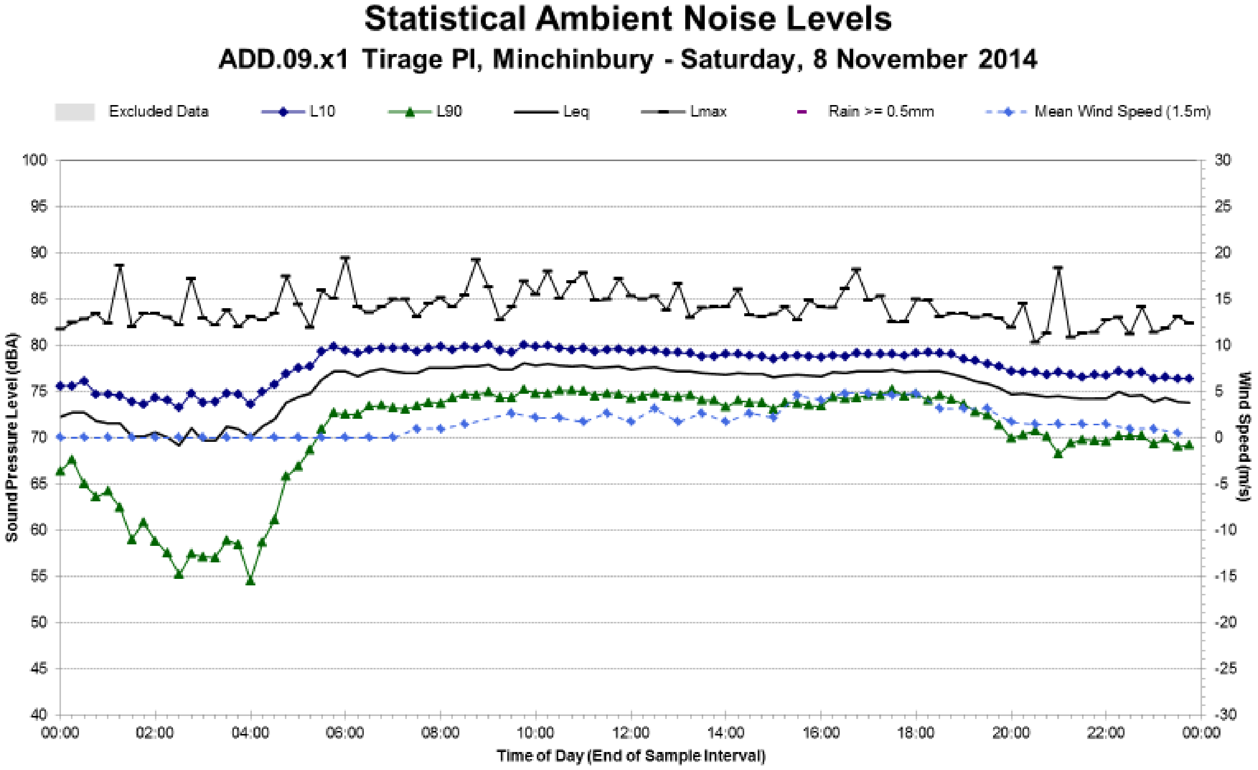
Statistical Ambient Noise Levels
ADD.09.x1 Tirage Pl, Minchinbury - Wednesday, 5 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

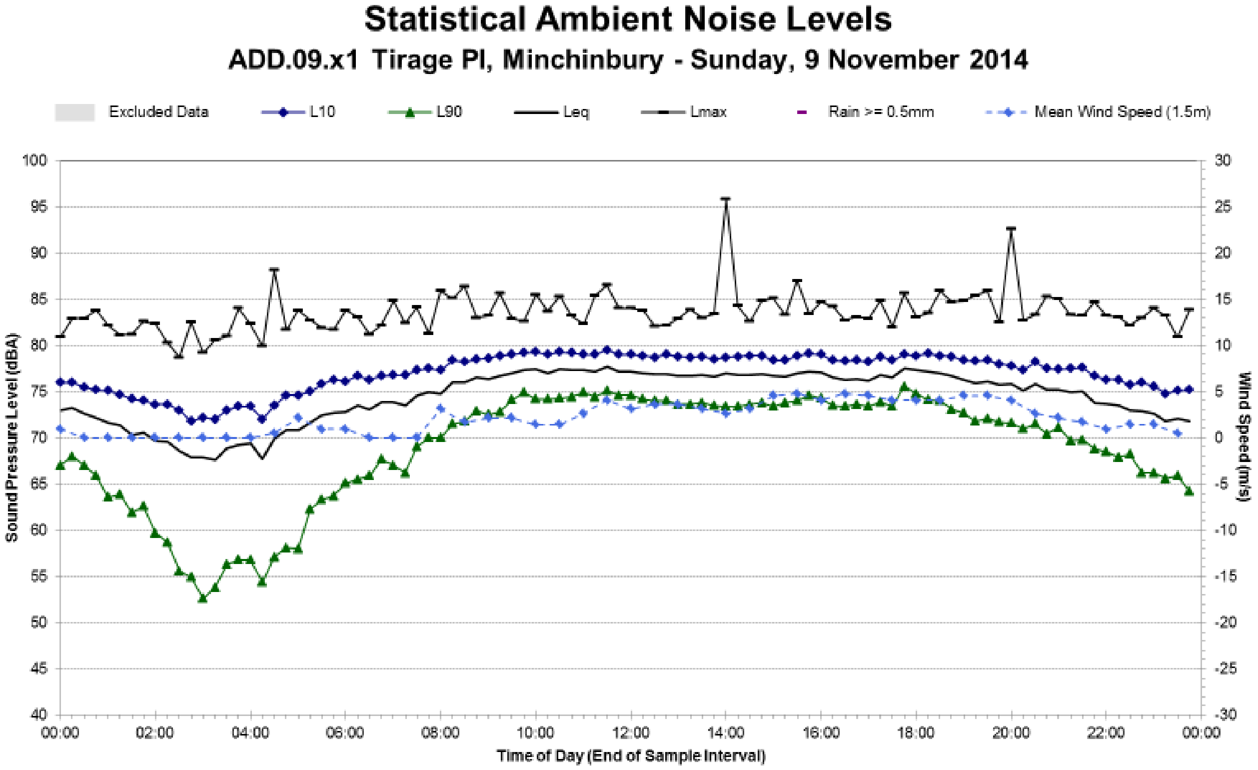
Ambient Noise Monitoring Results

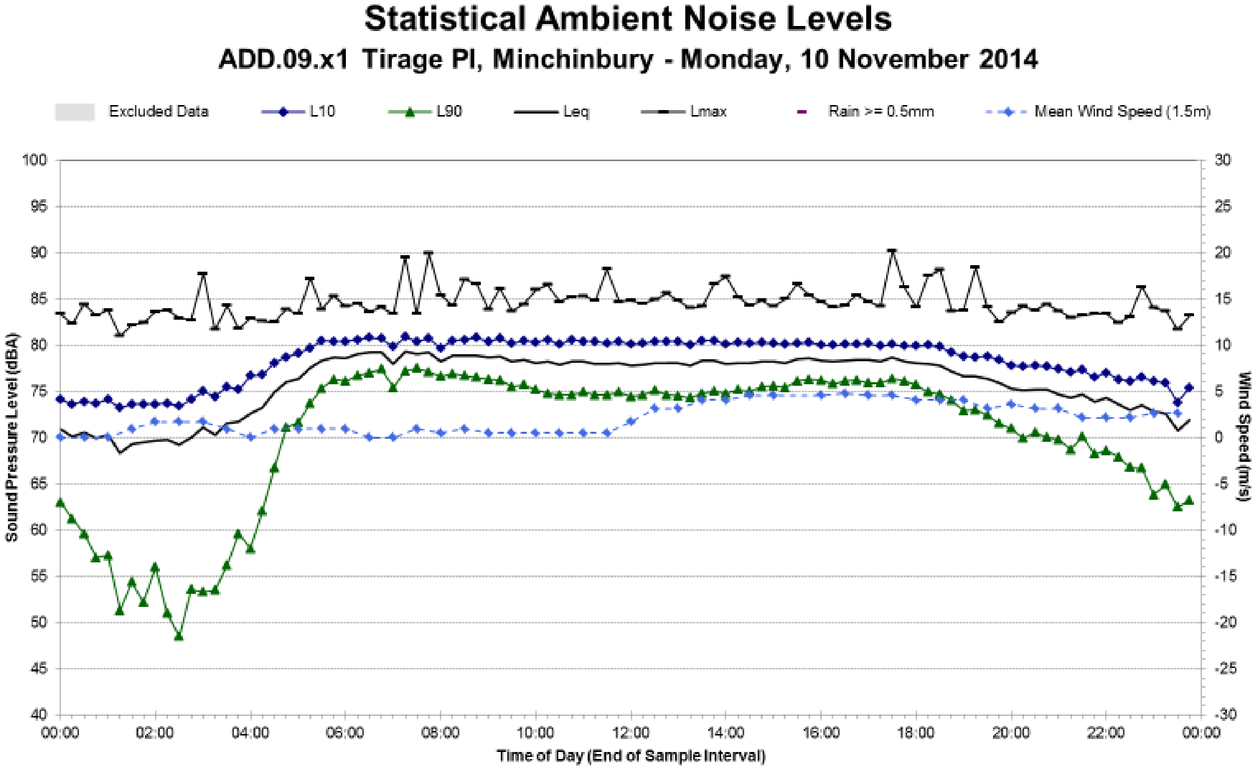




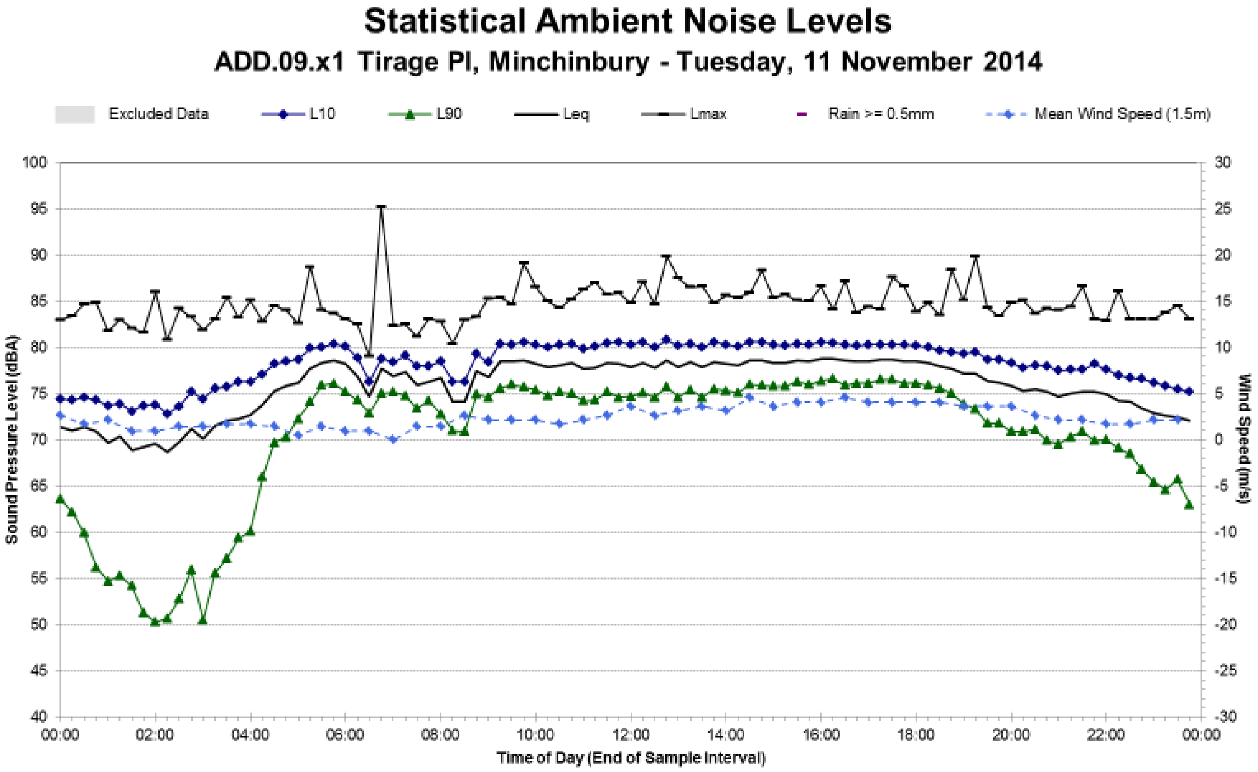
Ambient Noise Monitoring Results



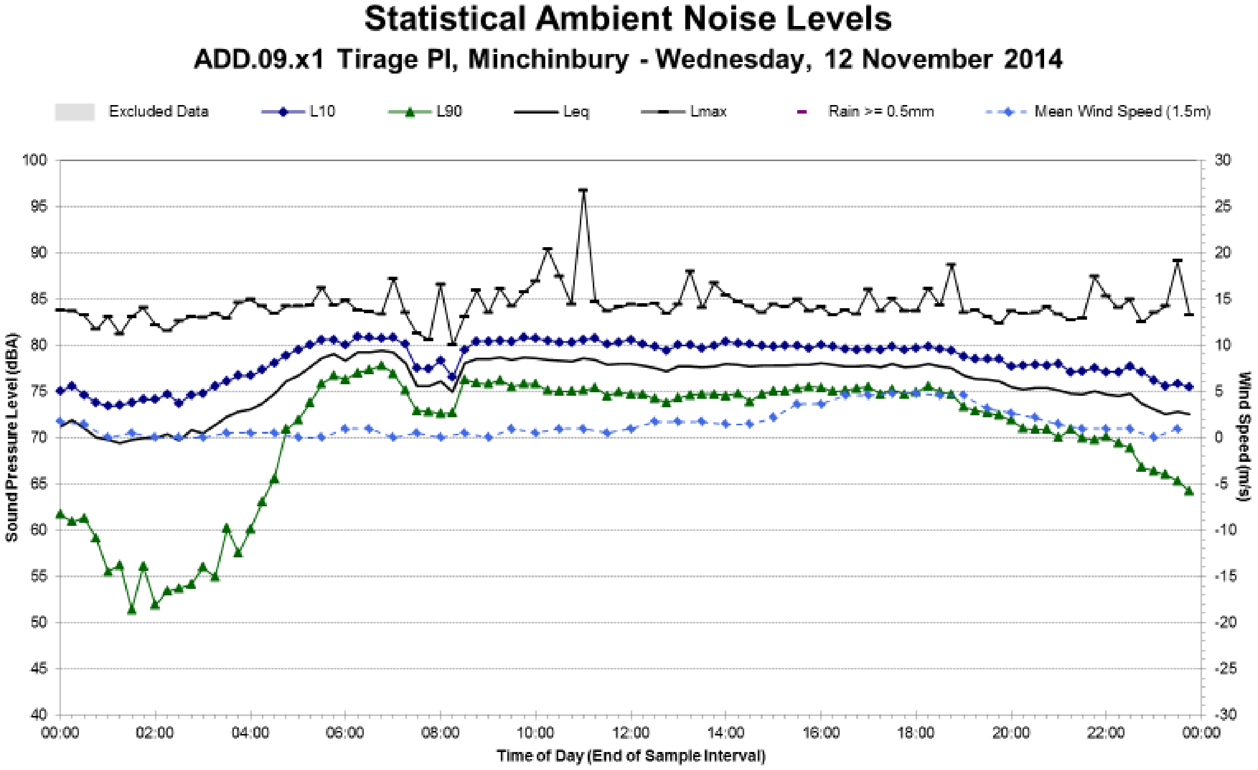


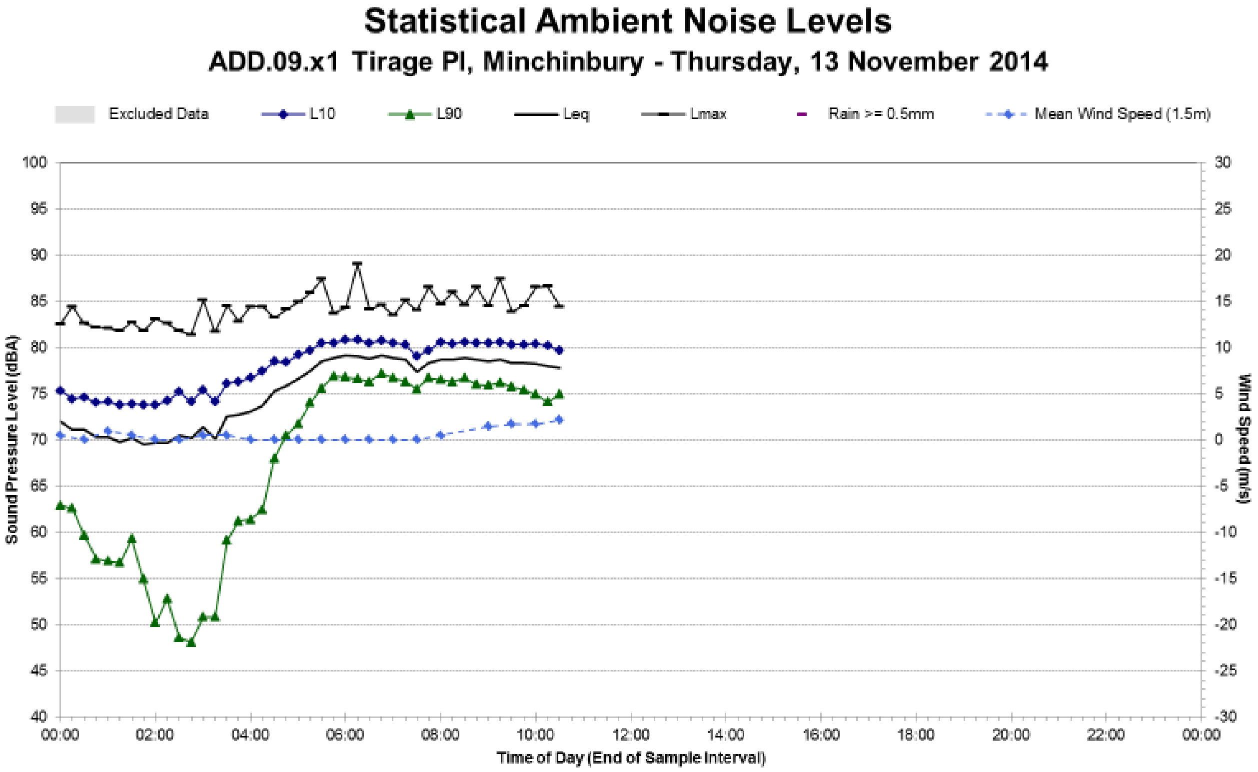


Statistical Ambient Noise Levels
ADD.09.x1 Tirage Pl, Minchinbury - Monday, 10 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
ADD.09.x1 Tirage Pl, Minchinbury - Tuesday, 11 November 2014
Excluded Data
L10
L90
Leq
Lmax
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
ADD.09.x1 Tirage Pl, Minchinbury - Wednesday, 12 November 2014
Excluded Data
L10
L90
Leq
Lmax
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
ADD.09.x1 Tirage Pl, Minchinbury - Thursday, 13 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Ambient Noise Monitoring Results

Noise Monitoring Location:	ADD.09.x2
Noise Monitoring Address:	**RMS Land - Hewitt St, Colyton**

Logger Device Type: ARL316
Logger Serial No: 16-203-526

Ambient noise logger deployed on RMS land adjacent to Hewitt St. Logger deployed on the mound with direct line of site to the M4 Corridor.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from the M4. Steady flow of traffic for the measurement.

Recorded Noise Levels (LAmax):
M4 Light-vehicle road traffic: typically ~75-78 dBA; M4 Heavy-vehicle road traffic: 81-88 dBA;

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	**LAeq**	**L10**	**L1**
Daytime	68	77	80	84
Evening	62	75	78	82
Night-time	43	74	75	81

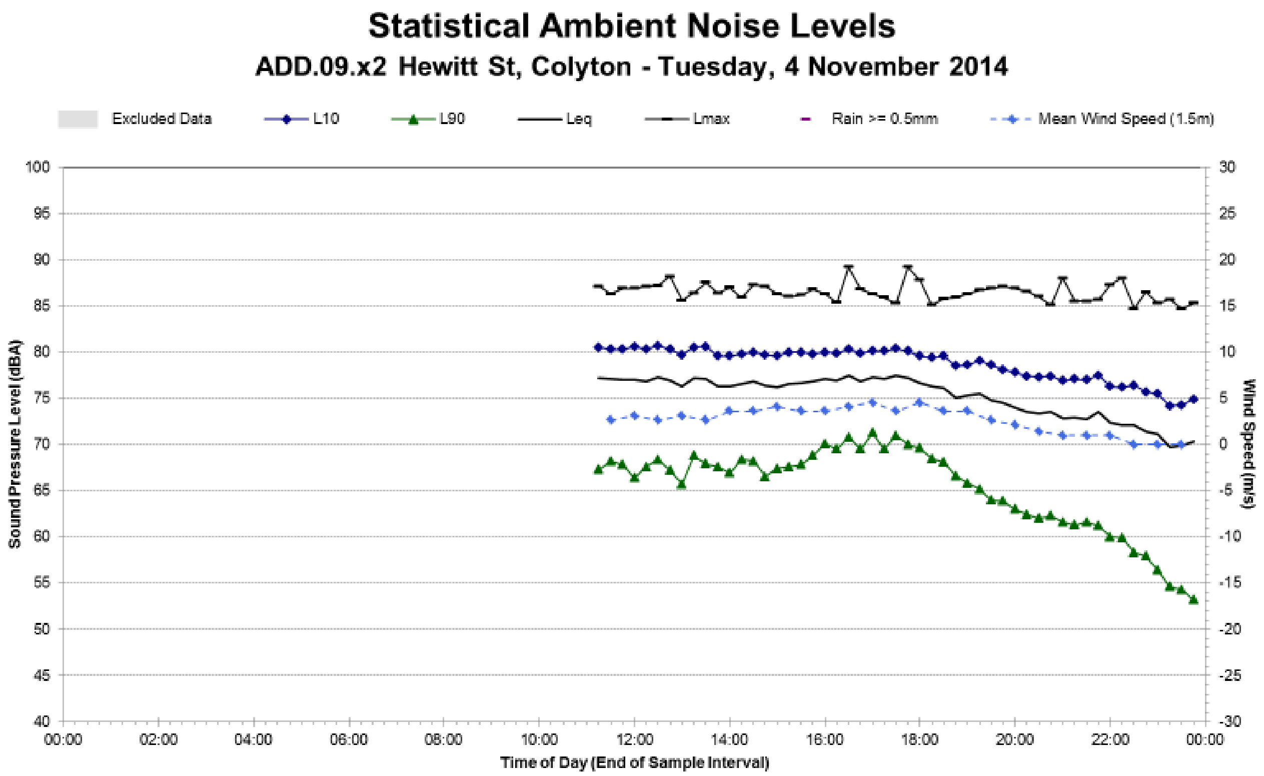
Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)		
	Weekday LAeq(Period)	**Weekend LAeq(Period)**	**Weekly LAeq(Period)**
Number of Valid Days	7	2	N/A
Daytime (7am-10pm)	77	76	77
Night-time (10pm-7am)	74	73	74

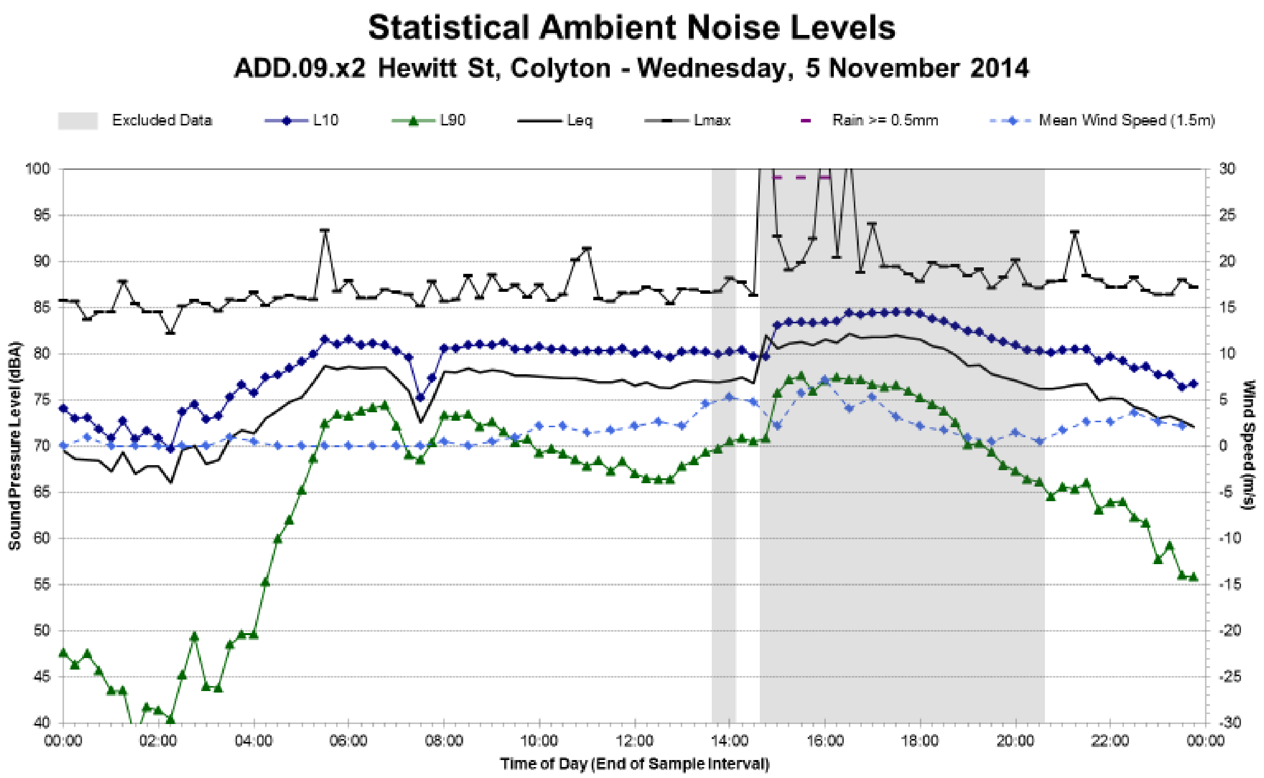
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	**LAeq**	**LAmax**
04/11/14	10:57am	67	78	88

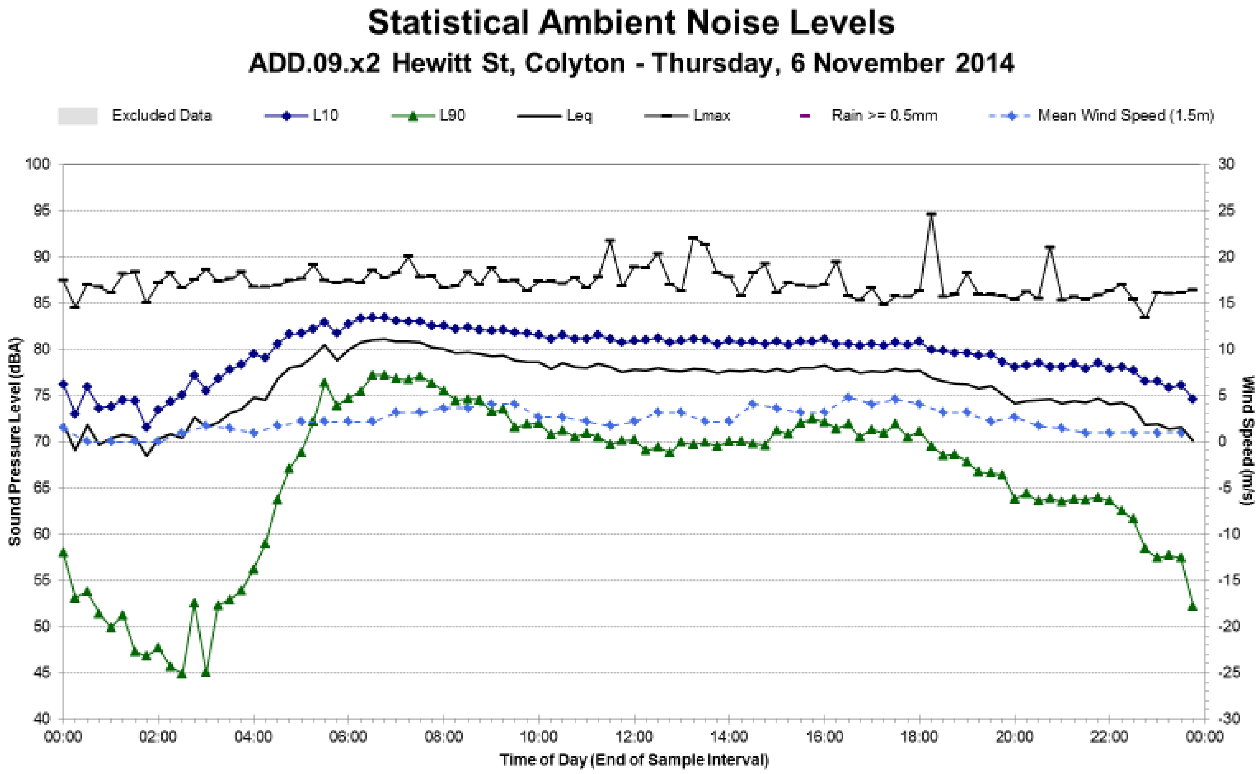
Photo of Noise Monitoring Location

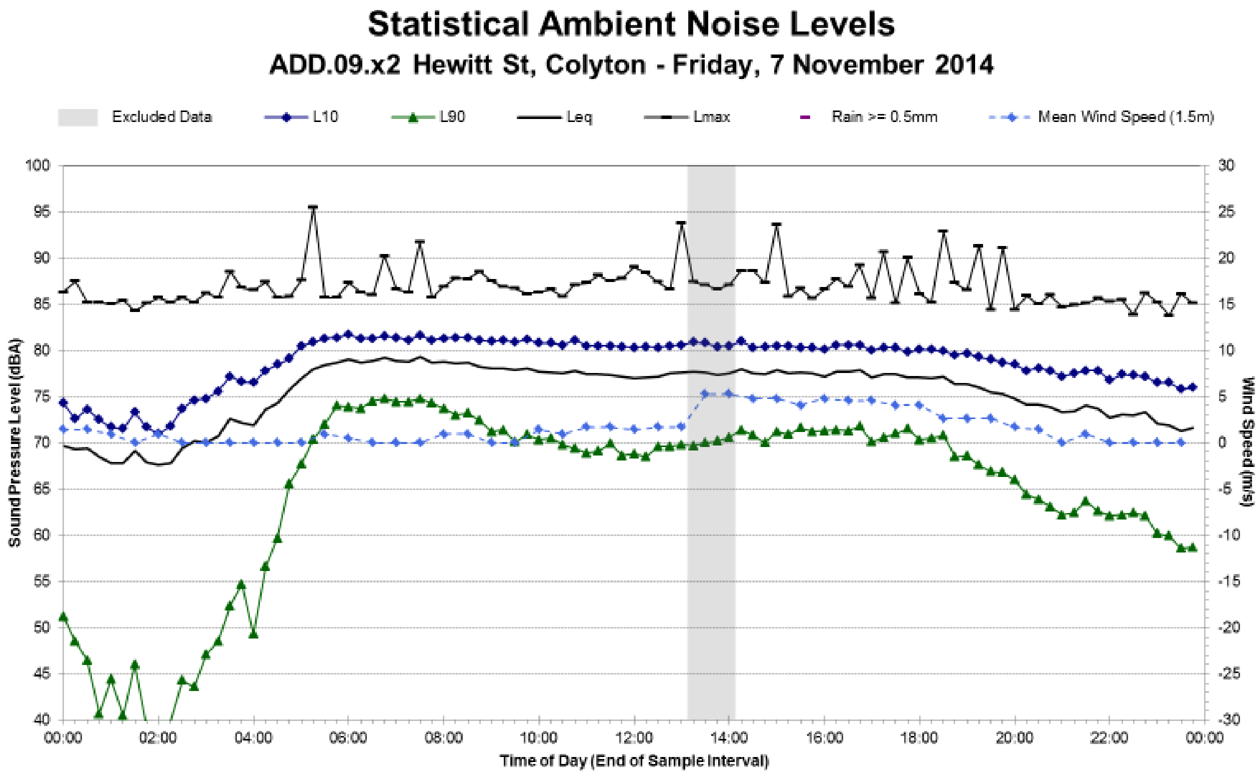


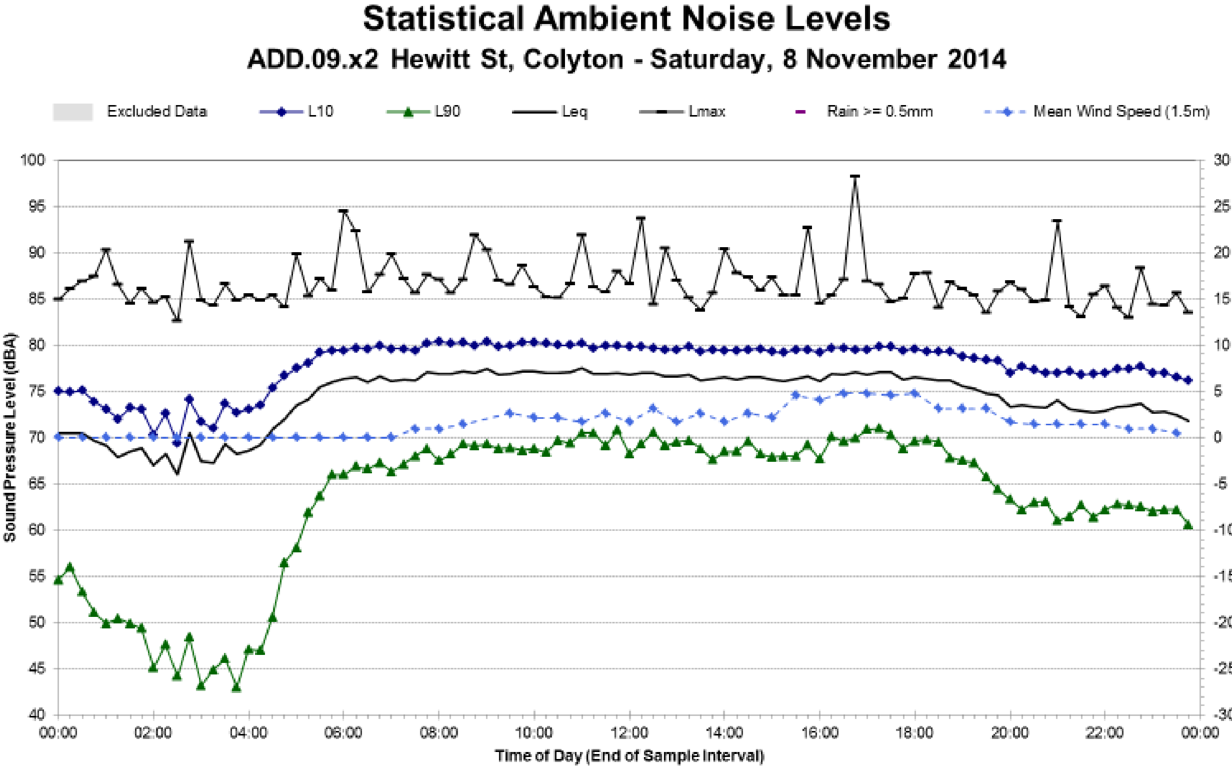
Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Tuesday, 4 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

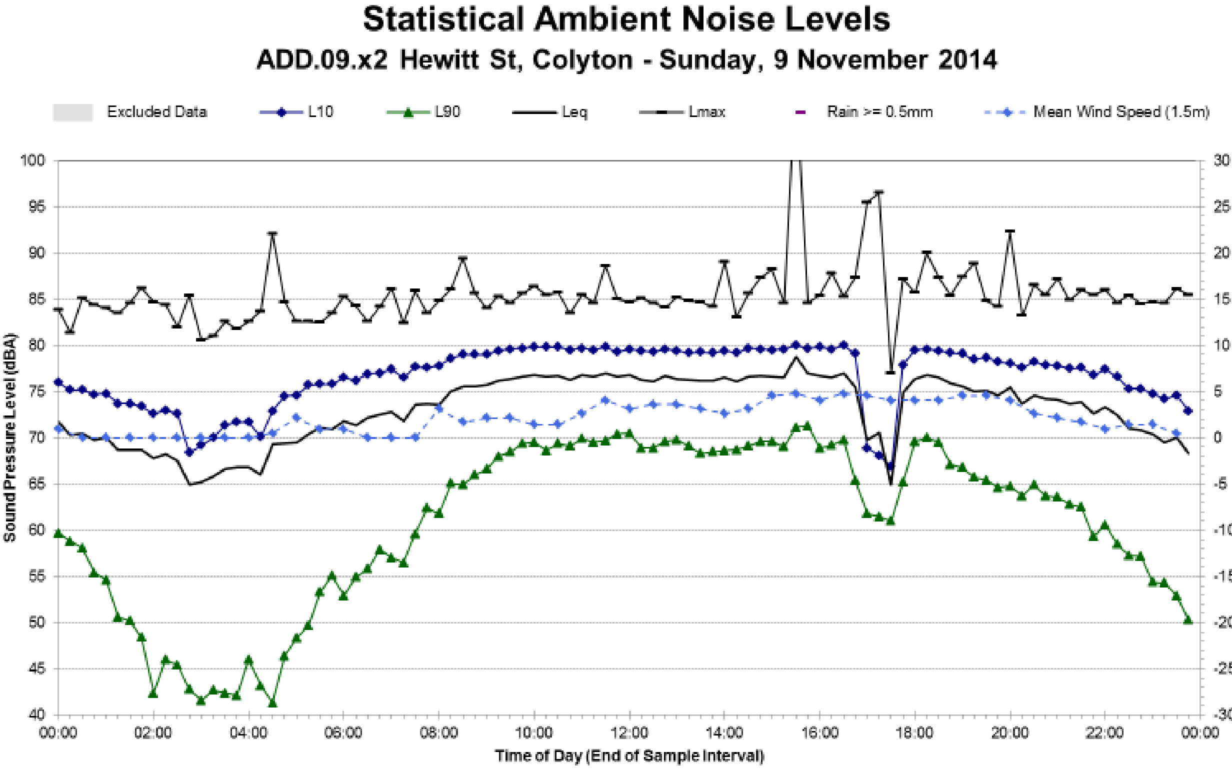


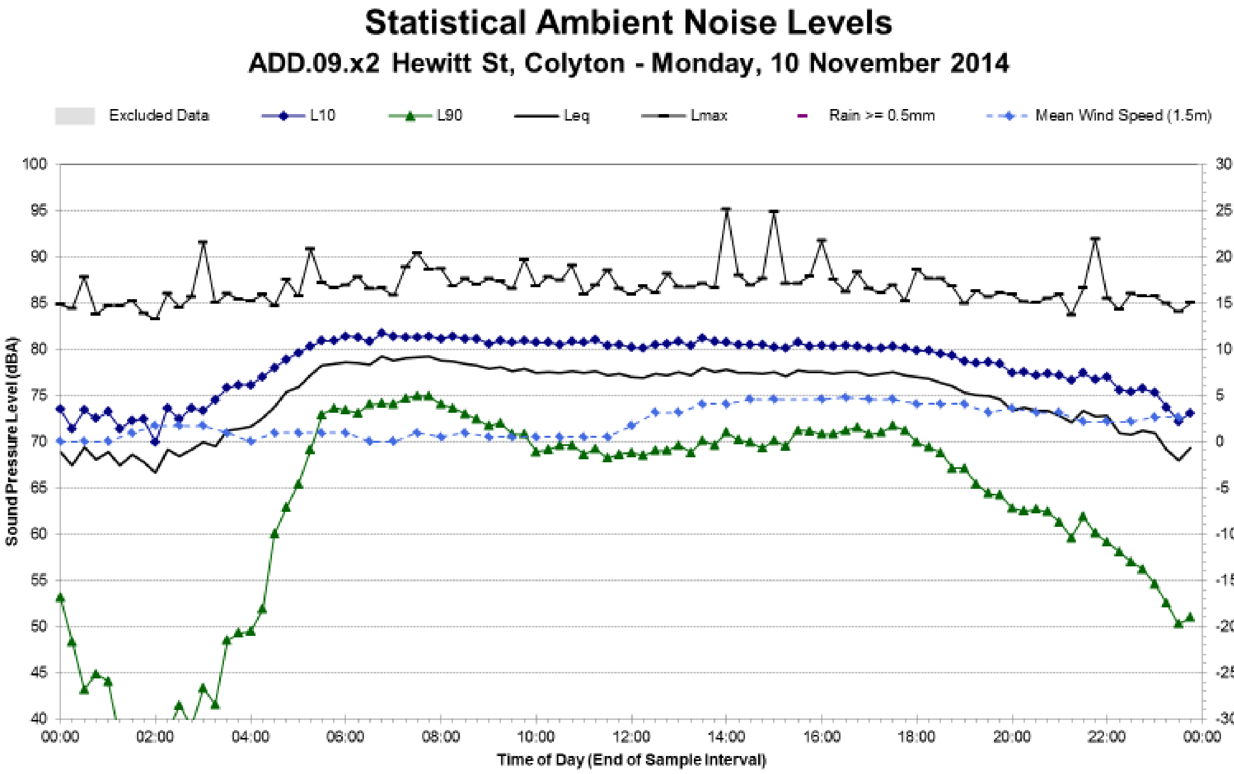
Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Wednesday, 5 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Thursday, 6 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

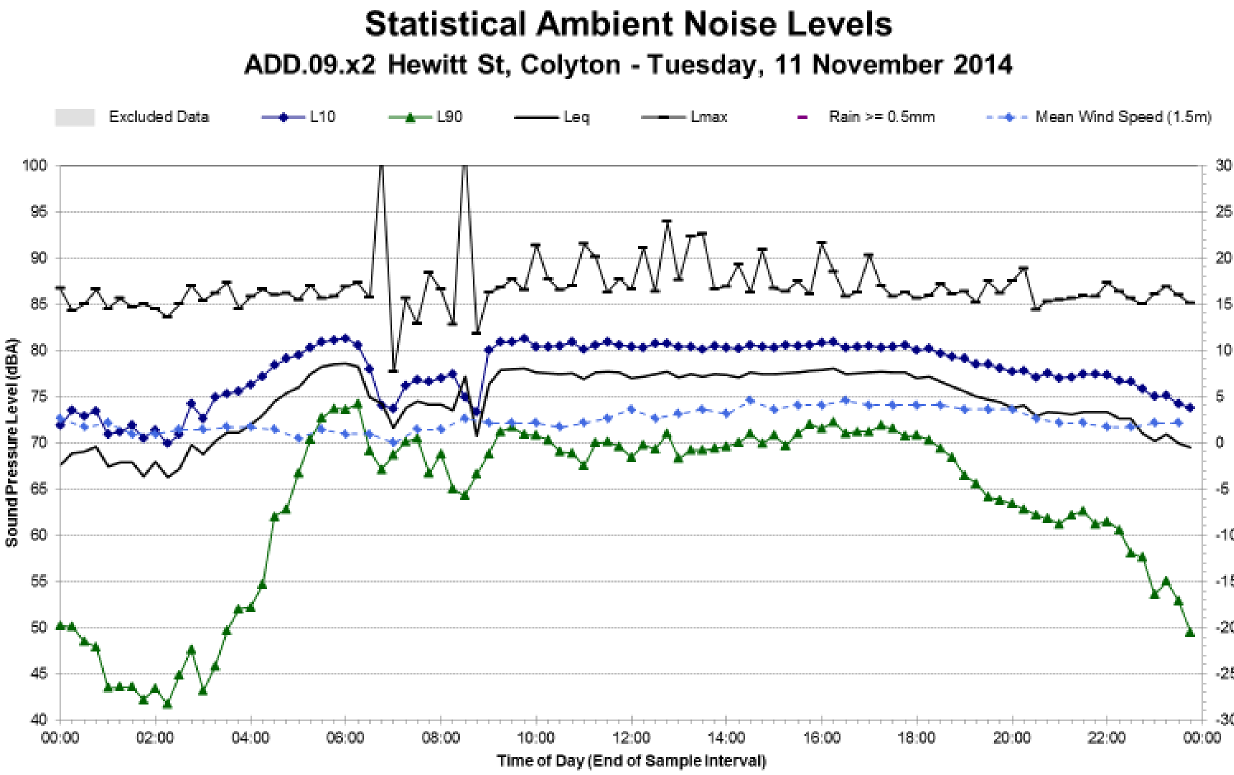

Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Friday, 7 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Saturday, 8 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

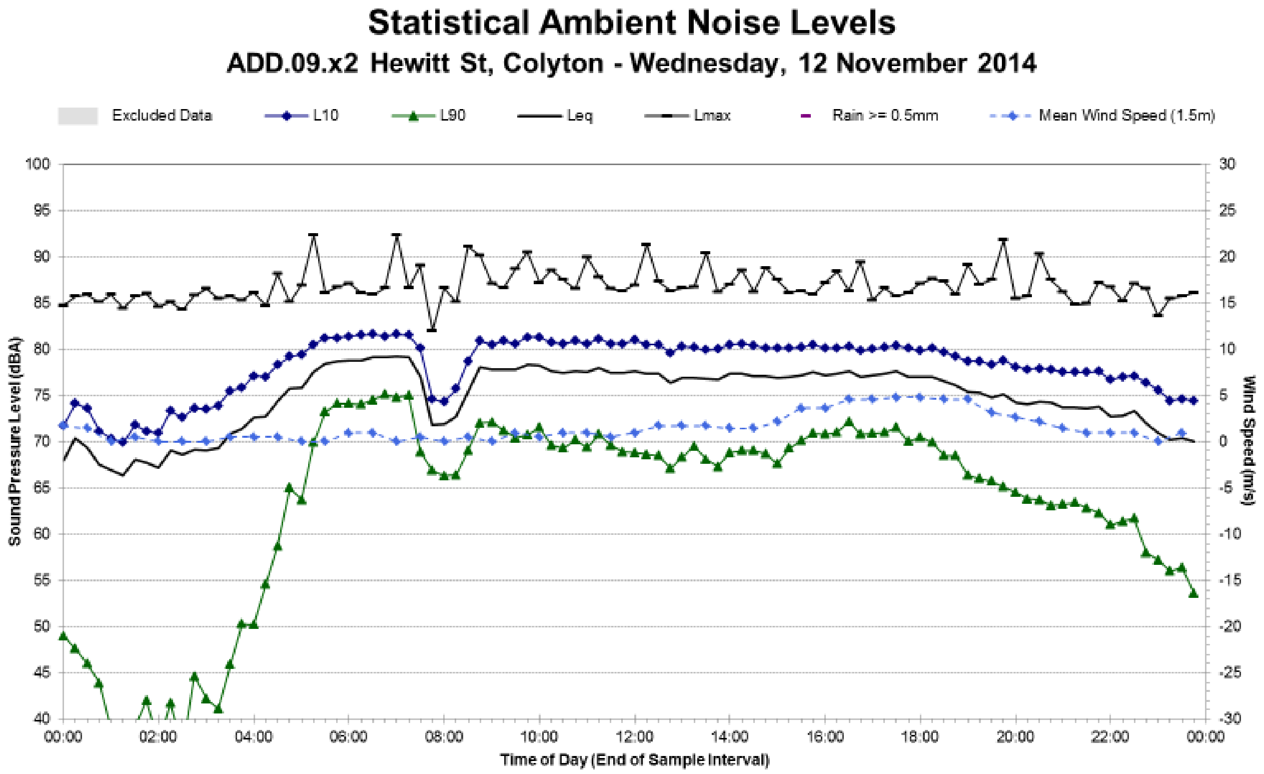

Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Sunday, 9 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

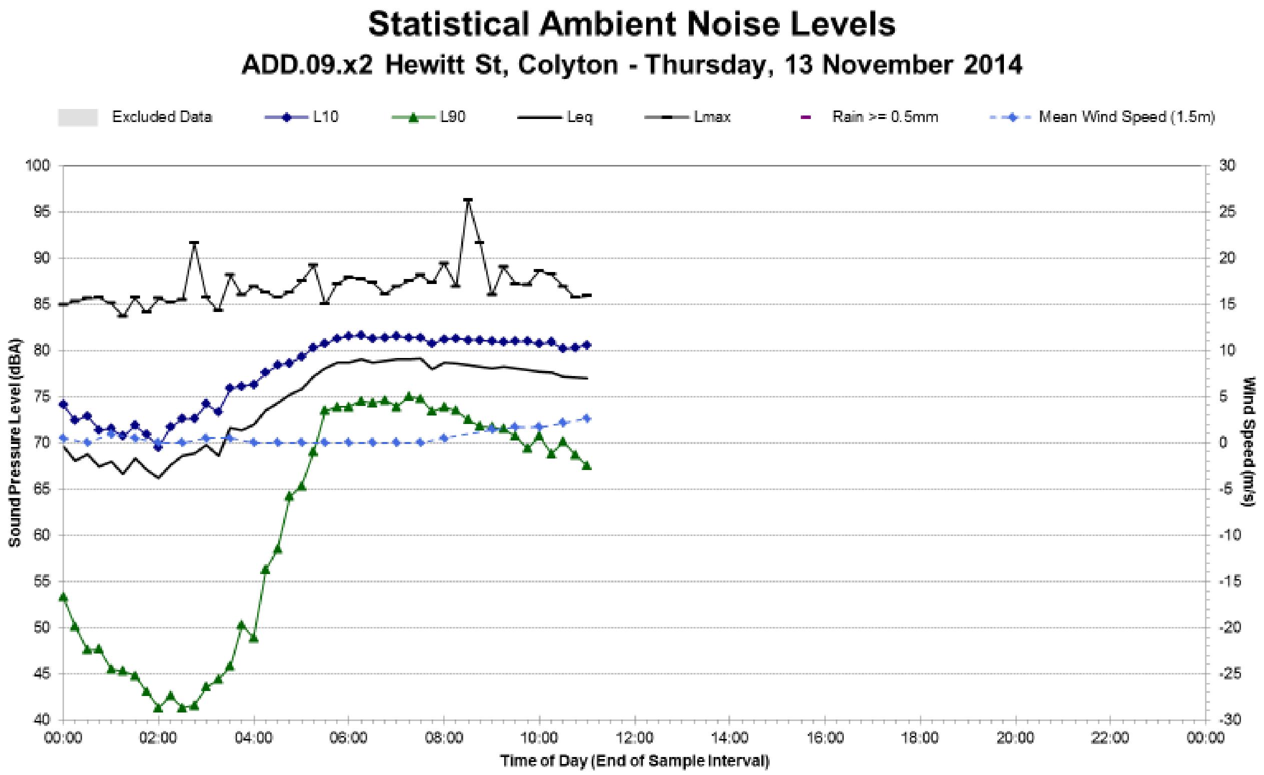


Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Monday, 10 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
ADD.09.x2 Hewitt St, Colyton - Tuesday, 11 November 2014
Excluded Data
L10
L90
Leq
Lmax
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
ADD.09.x2 Hewitt St, Colyton - Wednesday, 12 November 2014
Excluded Data
L10
L90
Leq
Lmax
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
ADD.09.x2 Hewitt St, Colyton - Thursday, 13 November 2014
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)