WATERLOO STATE SIGNIFICANT PRECINCT

Waterloo Metro Quarter
Stage 2 Acoustic Assessment

Prepared for:

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BASIS OF REPORT

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

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Appendix A Acoustic Terminology
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1 Executive Summary

SLR Consulting Australia Pty Ltd (SLR) has undertaken a noise and vibration impact assessment associated with the redevelopment of the Waterloo Metro Quarter on behalf of UrbanGrowth NSW Development Corporation (UGDC). The assessment has been carried out in accordance with NSW regulatory requirements and in consultation with the City of Sydney and other relevant stakeholders, in order to address the relevant Study Requirements for the Precinct.

The scope of the assessment involved deriving and establishing project specific noise goals through consultation with various NSW and Australian guidelines; undertaking a noise impact assessment for the future development with respect to the appropriate criteria; and, where required, providing recommendations for noise control measures.

With respect to operational noise emissions from the Metro Quarter to surrounding noise sensitive locations, there are no proposed uses that are likely to cause exceedances in the required criteria – subject to appropriate design development of the site. Additionally, cumulative noise impacts from the Waterloo Precinct and Sydney Metro Station are expected to comply with noise criteria once investigated further and established as part of the detailed design in a collaborative effort between the Precinct Developers and Sydney Metro.

With respect to noise ingress to the site, the primary issue surrounds the frontage to Botany Road and the proposed Residential areas along this boundary. A 3D model of the site and surrounding roads has been created, and validated to noise measurements taken across the site as part of the Stage 1 Noise & Vibration works for the Project. Numerous iterations of this model have been undertaken in this assessment, working closely with the wider design team and architects to develop massing and floorplate solutions that have the ability to meet the noise intrusion objectives without compromising the ability to naturally ventilate the dwellings.

As a result of the above, all objectives within the Noise & Vibration Study Requirements for the Precinct have been considered to be achieved.

2 Introduction

The Minister for Planning has determined that parts of Waterloo (the Precinct) are of State planning significance which should be investigated for rezoning through the State Significant Precinct (SSP) process. Study Requirements for such investigations were issued by the Minister on 19 May 2017.

Investigation of the Precinct is being undertaken by UrbanGrowth NSW Development Corporation (UrbanGrowth NSW), in partnership with NSW Land and Housing Corporation (LAHC) and Sydney Metro. The outcome of the SSP process will be new planning controls that will enable development applications for renewal of the Precinct.

The Precinct includes two separate, but adjoining and inter-related parts:

- The Waterloo Metro Quarter (the Metro Quarter); and
- The Waterloo Estate (the Estate).

While the study requirements for the Precinct were provided as separate requirements for the Metro Quarter and for the Estate, comprehensive baseline investigations have been prepared for the entire Precinct. However, lodgement of a separate SSP study for the Metro Quarter in advance of the SSP Study for the Estate is proposed to allow construction of Over Station Development (OSD) within the Metro Quarter to be delivered concurrently with the Metro Station, as an Integrated Station Development (ISD).

While this report therefore provides comprehensive baseline investigations for the entire Precinct, it only assesses the proposed Planning Framework amendments and Indicative Concept Proposal for the Metro Quarter.

2.1 Overall Precinct Objectives

The following are the objectives for renewal of the Precinct:

Housing: A fully integrated urban village of social, private and affordable housing
A place that meets the housing needs of people with different background, ages, incomes, abilities and lifestyles – a place where everyone belongs. New homes for social, affordable and private residents that are not distinguishable and are modern, comfortable, efficient, sustainable and adaptable.
Services and Amenities: New and improved services, facilities and amenities to support a diverse community
A place that provides suitable and essential services and facilities so that all residents have easy access to health, wellbeing, community support, retail and government services.
Culture & Design: A safe and welcoming place to live and visit
A place where there is activity day and night, where people feel safe, at ease and part of a cohesive and proud community. A place that respects the land and Aboriginal people by showcasing and celebrating Waterloo's culture, history and heritage.
Open Space & Environment: High quality public spaces and a sustainable urban environment
A place that promotes a walkable, comfortable and healthy lifestyle with high quality, well designed and sustainable buildings, natural features and safe open spaces for everyone to enjoy, regardless of age, culture or ability.
Transport and Connectivity: A well connected inner city location

Housing: A fully integrated urban village of social, private and affordable housing
Integrate the new metro station and other modes of transport in such a way that anyone who lives, works or visits Waterloo can get around easily, safely and efficiently.

2.2 Waterloo State Significant Precinct

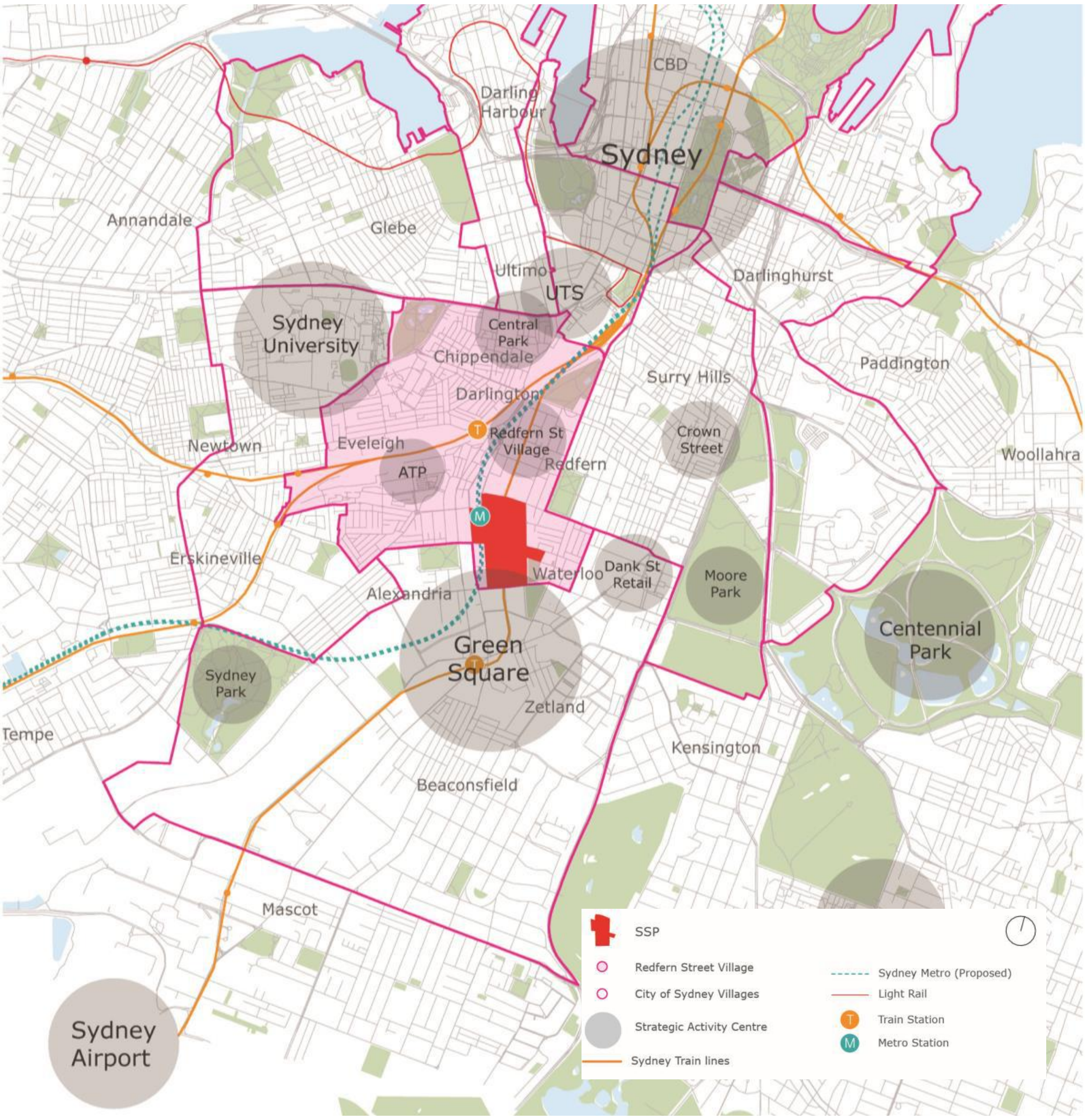
The Precinct is located approximately 3.3 km south-southwest of the Sydney CBD in the suburb of Waterloo (refer **Figure 1**). It is located entirely within the City of Sydney local government area (LGA).

It is bordered by Phillip Street to the north, Pitt Street to the east, McEvoy Street to the south and Botany Road to the west. It also includes one block east of Pitt Street bordered by Wellington, Gibson and Kellick Streets. The Precinct has an approximate gross site area of 20.03 hectares (ha) (including road reserves) and comprises two separate but adjoining parts:

1. The Waterloo Estate (the Estate); and
2. The Waterloo Metro Quarter (the Metro Quarter).

A map of the Precinct and relevant boundaries is presented in **Figure 2**.

Figure 1 Location and Site Plan of the Precinct



Source: Turners Studio

Figure 2 Aerial Photograph

Source: Ethos Urban & Nearmap

2.3 The Metro Quarter

The Metro Quarter comprises land to the west of Cope Street, east of Botany Road, south of Raglan Street and north of Wellington Street. It has an approximate gross site area of 1.91 ha and a developable area of 1.28 ha. The heritage-listed Waterloo Congregational Church located at 103–105 Botany Road is located within the Precinct. However, there are no proposals for physical works or changes to the planning framework applicable to the church.

Formerly privately owned, all land in the Metro Quarter was purchased by the NSW Government to facilitate construction of the Waterloo Metro Station and associated OSD.

2.3.1 Approved Metro Rail Infrastructure

The Waterloo Metro Station will be constructed within the eastern side of the Metro Quarter as part of the Sydney Metro City & Southwest - Chatswood to Sydenham. This section of the Sydney Metro project received planning approval in January 2017 (SSI 15_7400), with construction led by Sydney Metro. While most of the Metro Station will be located beneath finished ground level, two substantial entry/plant structures, with heights equivalent to a 5 storey residential building (up to 20 m), will protrude above finished ground level; one along the northern end of Cope Street, the other along the southern end of Cope Street.

Demolition of existing buildings has been completed and excavation of the Waterloo Metro Station is underway.

2.4 Purpose

The purpose of this report is to address the relevant Study Requirements detailed in **Section 3**.

3 Study Requirements

On 19 May 2017 The Minister issued Study Requirements for the nominated Precinct. The key study requirements relating to air quality are presented in **Table 1**.

Table 1 Waterloo SSP - Study Requirements

Reference	Item Requirement	Refer Section:
18. Noise, Vibration and Pollution		
18.1	*Provide a noise and vibration impact assessment for the proposal. The assessment will address the relevant policies and guidelines in relation to noise including State Environmental Planning Policy (Infrastructure) 2007 and the Development Near Rail Corridors and Busy Roads – Interim Guideline.*	**Section 6** and **Section 7**
18.2	*Consider and assess potential pollution impacts from the proposed rezoning including, but not limited to, water, air, noise and light pollution.*	**Section 6**
18.4	*These assessments should also consider other current local air and noise issues in the Waterloo area, including potential cumulative impacts from the Waterloo Estate.*	**Section 7**
18.5	*Identify and map current and proposed future sensitive receptors (e.g. residential uses, schools, child care centres).*	**Section 5.5**
18.6	*Identify current and likely future noise, vibration and pollution affecting the precinct, including sources and nature and impact. Site monitoring will be required to determine current road noise levels on Botany Road. 3D mapping to clearly communicate these impacts, including demonstrating for example how noise reduces with distance from source, is desirable.*	**Section 7**
18.7	*Model the likely future noise, vibration and pollution scenario based on 3D block envelope diagrams prepared by the urban designer. This is to include road and rail noise.*	**Section 7**
18.8	*Recommend appropriate noise and vibration mitigation measures. The consultant is expected to work with the urban designer, and suggested measures are provided for the protection of future residents of buildings through the careful siting and layout of buildings maintaining natural ventilation through open windows.*	**Section 7**
18.9	*Outline the recommended measures relating to noise, vibration and pollution to minimise the nuisance and harm to people or property within the precinct.*	**Section 7**

4 Baseline Investigations

4.1 Project Overview

Stage 1 of the study involved conducting baseline investigations to identify the existing noise, vibration, air quality, and lighting environment throughout the Waterloo State Significant Precinct.

Stage 2 of the study involves a more detailed assessment regarding the proposed Waterloo Metro Quarter (the Project) design. This Stage 2 noise and vibration report provides information regarding the assessment process in addition to a more detailed assessment, including noise and vibration impact predictions and preliminary recommendations with respect to the proposed design.

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

4.2 Existing Noise Environment

4.2.1 Existing Noise Sources

4.2.1.1 Road Traffic Noise

The existing noise environment throughout the project area is generally controlled by road traffic noise. The major arterial road near the project is Botany Road, which passes adjacent to the Metro Quarter, on the west side of the project. This road becomes quite congested during peak hours. Vehicle speeds are limited to 60 km/h which generally remains free-flowing outside peak hours. The surface appears to be a worn dense-graded asphalt (DGA) pavement and is likely to perform consistent with the standard DGA pavement correction.

Other collector roads include Raglan Street, Pitt Street, Cope Street and McEvoy Street. These roads are all limited to 50 km/h. Lower traffic volumes on the arterials result in generally lower noise levels. Traffic calming measures including roundabouts and speed humps reduce speeds below the posted speed limits which reduce tyre noise. Conversely, engine noise is increased as a result of these measures as the vehicles accelerate away from these measures.

McEvoy Street serves as a collector road between Botany Road, Elizabeth Street and Bourke Street which results in a higher noise generation than other collector roads.

The overall road noise environment throughout the project area sees the majority of noise emitted from Botany Road to the east of the project, with a lesser degree of noise emanated from the south.

4.2.1.2 Railway Noise

At street level, existing rail noise is generally not audible in the project area due to shielding provided by the surrounding buildings. While the rail noise may be audible at times, due to the significant road network in closer proximity to these buildings it is unlikely to be a controlling noise source.

4.2.1.3 Aircraft Noise

The precinct is not located directly under the flight path and is not directly impacted by aircraft noise.

The Australian Noise Exposure Index (ANEI) is a parameter used to describe the noise impact by airports in Australia. The ANEI is an equal energy noise index, similar to the L_{eq} from 7 pm to 7 am. The Australian Noise Exposure Forecast (ANEF) is the future predicted ANEI. Typically, the ANEF 20 contour and higher defines an area where additional noise mitigation may be required for new residential buildings.

While 364 residents exceeded the ANEI 20 contour (approximately 55 dB) in 2015 in the Waterloo-Beaconsfield area, no receivers exceeded this contour in 2016. This may be a result of changes to flight paths or operations.

Noise mitigation from aircraft noise would not be required throughout the project area.

The N70 noise contours illustrate the number of events above 70 dBA for an annual average day. These maps provide an indication of the likelihood of annoyance from aircraft noise. The N70 chart for the Sydney airport in 2016 indicates less than 10 noise events of greater than 70 dBA were experienced on an average day. This exposure is very low compared to other regions in Sydney and is not considered to be appreciably noise affected. Additionally, Sydney airport only operates between the hours of 0600 h to 2300 h and as such noise events greater than 70 dBA would generally occur during the less sensitive daytime period.

4.2.1.4 Industrial Noise Sources

While there is some light industry such as warehousing and car mechanics adjacent to the project area, there have been no noise generating industrial sources identified that would have a significant impact on the noise environment.

4.2.2 Ambient Noise Surveys and Monitoring Locations

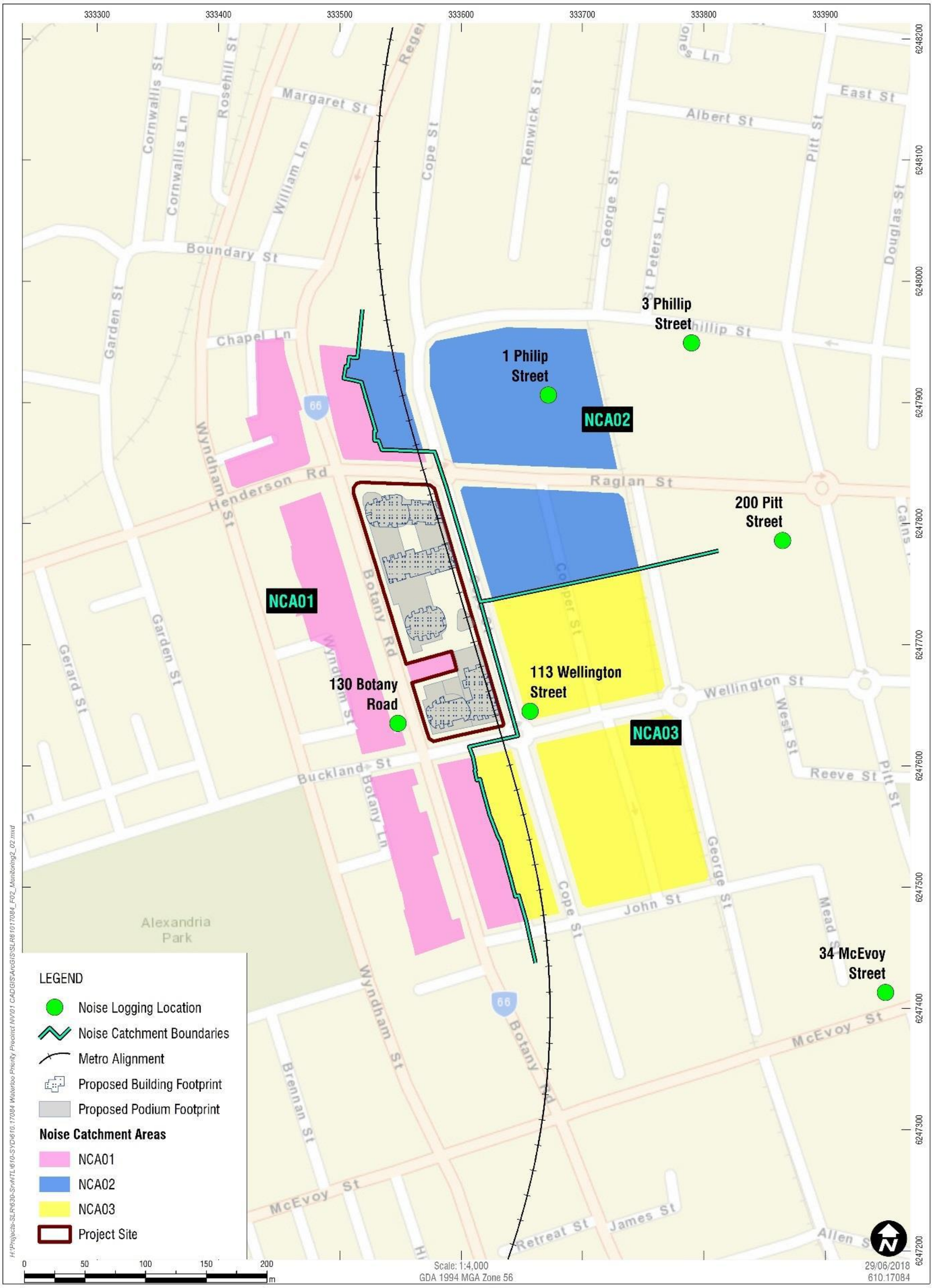
To quantify and characterise the existing ambient noise environment across the project area, a baseline noise monitoring survey was undertaken from 8 to 15 June 2016. The measured noise levels have been used to establish existing ambient noise levels throughout the project area and to develop a detailed understanding of the existing noise environment.

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 presented in **Table 2** and **Figure 3**.

Table 2 Ambient Noise Survey Locations

Noise Monitoring Location ID	Noise Monitoring Location Address	Equipment Serial Number
L1	1 Phillip Street, Waterloo	20663
L2	3 Phillip Street, Waterloo	3004636
L3	200 Pitt Street, Waterloo	3003632
L4	113 Wellington Street, Waterloo	3005908
L5	130 Botany Road, Waterloo	3005904
L6	34 McEvoy Street, Waterloo	3003389

Figure 3 Waterloo State Significant Precinct, Noise Catchment Areas and Noise Logging Locations



4.2.3 Unattended Noise Monitoring

4.2.3.1 Methodology

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 a combination of Svantek 957 and Bruel and Kjaer 2250L 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*[i] 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 (such as strong wind or rain) so as to establish representative noise levels in each area.

4.2.3.2 Noise Monitoring Results

The results of the unattended ambient surveys are summarised in **Table 3** as the Rating Background Level (RBL) noise levels for the *Noise Policy for Industry* (NPfI) daytime, evening and night-time periods, and the L_{Aeq} (energy averaged) noise levels for the *NSW Road Noise Policy* RNP daytime and night-time periods. The 24 hour daily noise levels at each monitoring location are presented graphically in **Appendix B**.

Table 3 Summary of Unattended Noise Logging Results

Noise Monitoring Location	Measured Noise Level (dB)							
	NPfI Time Periods[1]						RNP Time Periods[2]	
	Daytime - RBL	Evening - RBL	Night-time - RBL	Daytime - L_{Aeq}	Evening - L_{Aeq}	Night-time - L_{Aeq}	Daytime - $L_{Aeq(15hour)}$	Night-time - $L_{Aeq(9hour)}$
L1	50	46	40	57	53	50	56	51
L2	48	42	38	57	52	50	56	50
L3	47	43	37	61	58	59	60	59
L4[3]	50	46	41	65	57	54	64	54
L5	60	57	46	72	70	69	72	69
L6[4]	Failed	-	-	-	-	-	-	-

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

Note 2: Road Noise Policy (RNP) Assessment Time Periods – Day: 7.00 am to 10.00 pm; Night: 10.00 pm to 7.00 am (weekly data).

Note 3: Attended noise measurements at this location identified a bird feeder located on the wall of the residential building. This was not identified at the time the noise logger was deployed as it was raining. At the time of the attended measurements the bird feeder attracted a large number of Rosellas which were generating noise levels over 100 dBA. This significant noise source is the reason that the RNP noise levels for L4 are higher than other comparable noise environment areas of the Waterloo project area.

Note 4: The noise logger at location L6 was damaged during the logging survey and no data was recorded.

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.

4.2.4 Attended Airborne Noise

4.2.4.1 Methodology

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 2270 Precision Sound Level Meter (S/N:3008204). 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.

4.2.4.2 Attended Noise Measurement Results

The noise environment at each of the attended monitoring locations is summarised in **Table 4**.

Table 4 Summary of Attended Noise Monitoring Results

Measurement Location	Measured Noise Levels (dB)			Description of Ambient Noise Source - Typical LAmax Levels
	L_{A90}	L_{Aeq}	L_{Amax}	
1 Phillip Street	48.2	58.2	74.5	Constant nature sounds with regular pedestrian movements. Intermittent traffic from Raglan Street and Phillip Street. Aircraft pass-bys are dominant sound source when present.
3 Phillip Street	51.7	60.7	84.8	Constant nature sounds with regular pedestrian movements. Intermittent traffic from Phillip Street. Dominant sound source is landscaping works in the area and aircraft pass-bys when present.
200 Pitt Street	55.1	61.9	80.6	Intermittent traffic noise from Raglan Street, particularly from vehicles travelling uphill. Landscaping works are dominant sound source during measurement
34 McEvoy	58.2	66.4	80.0	Dominant sound source McEvoy Street traffic, with occasional pedestrian activity. Limited aircraft passbys during measurement.
113 Wellington Street	51.1	63.3	92.4	Constant parrot activity during measurement. Intermittent traffic noise from Wellington Road with some aircraft passby noise. Limited pedestrian activity.
130 Botany Road[1]	64.9	72.5	87.7	Traffic noise from Botany Road is dominant sound source, with limited aircraft passby.

Note 1: Monitoring location near to building facade. Measured noise levels considered to represent facade affected noise levels which are up to 2.5 dBA higher than the equivalent free-field condition.

4.3 Existing Vibration Environment

4.3.1 Existing Vibration Environment

There are currently no major existing vibration sources in the project area. Road traffic typically generates very low vibration levels which are well below applicable criteria. Where large discontinuities such as potholes, road plates or joins in the pavement occur, vibration levels can be perceived in close proximity to the road when heavy vehicles travel over them. Those vibration generating circumstances are a maintenance issue, rather than a design issue and are not assessed.

5 Proposal

This report relates to:

- An SSP Study to create a new suite of planning controls; and
- an Indicative Concept Proposal

for the Waterloo Metro Quarter ISD.

5.1 Proposed Planning Framework

The existing and proposed planning controls for the Metro Quarter are:

	Existing	Proposed
Zoning	B4 Mixed Use	B4 Mixed Use
Height of Buildings	Part 12, Part 15 metres	- Part RL 116.9 (AHD) - North - Part RL 104.2 (AHD) - Central - Part RL 96.9 (AHD) - South
Floor Space Ratio	1.75:1	6.1:1 (including Metro Station)

5.2 Indicative Concept Proposal

The Indicative Concept Proposal for the Metro Quarter ISD comprises:

- Approximately 69,000 square metres (m^2) of gross floor area (GFA), comprising:
  - approximately 56,500 m^2 GFA of residential accommodation, providing for approximately 700 dwellings, including 5 to 10% affordable housing and 70 social housing dwellings;
  - Approximately 4,000 m^2 of GFA for retail premises and entertainment facilities.
  - Approximately 8,500 m^2 GFA for business and commercial premises and community, health and recreation facilities (indoor).
- Publicly accessible plazas fronting Cope Street (approximately 1,400 m^2) and Raglan Street (580 m^2).
- A three storey mixed-use, non-residential podium, including a free standing building within the Cope Street Plaza.
- Three taller residential buildings of 23, 25 and 29 storeys, and four mid-rise buildings of four to ten storeys above the podium and/or the approved metro station infrastructure.
- Parking for approximately 65 cars, 700 residential bicycles and 520 public bicycles.
- Two east-west, through-block pedestrian connections.

Approval has already been separately granted for a Sydney Metro Station on the site, which will comprise approximately 8,415 m^2 of GFA. The total GFA for the ISD, including the metro station GFA is approximately 77,500 m^2. Transport interchange facilities including bus stops on Botany Road and kiss and ride facilities on Cope Street will be provided under the existing CSSI Approval.

The above figures are deliberately approximate to accommodate detailed design resolution.

While the existing heritage-listed Waterloo Congregational Church is within the SSP Study Area, there are no proposals for physical works or changes to the planning framework applicable to the church.

Three dimensional drawings of the Concept Proposal are included as **Figure 4** and **Figure 5**.

Figure 4 Three-Dimensional Drawing of the Indicative Concept Proposal, Viewed from the East

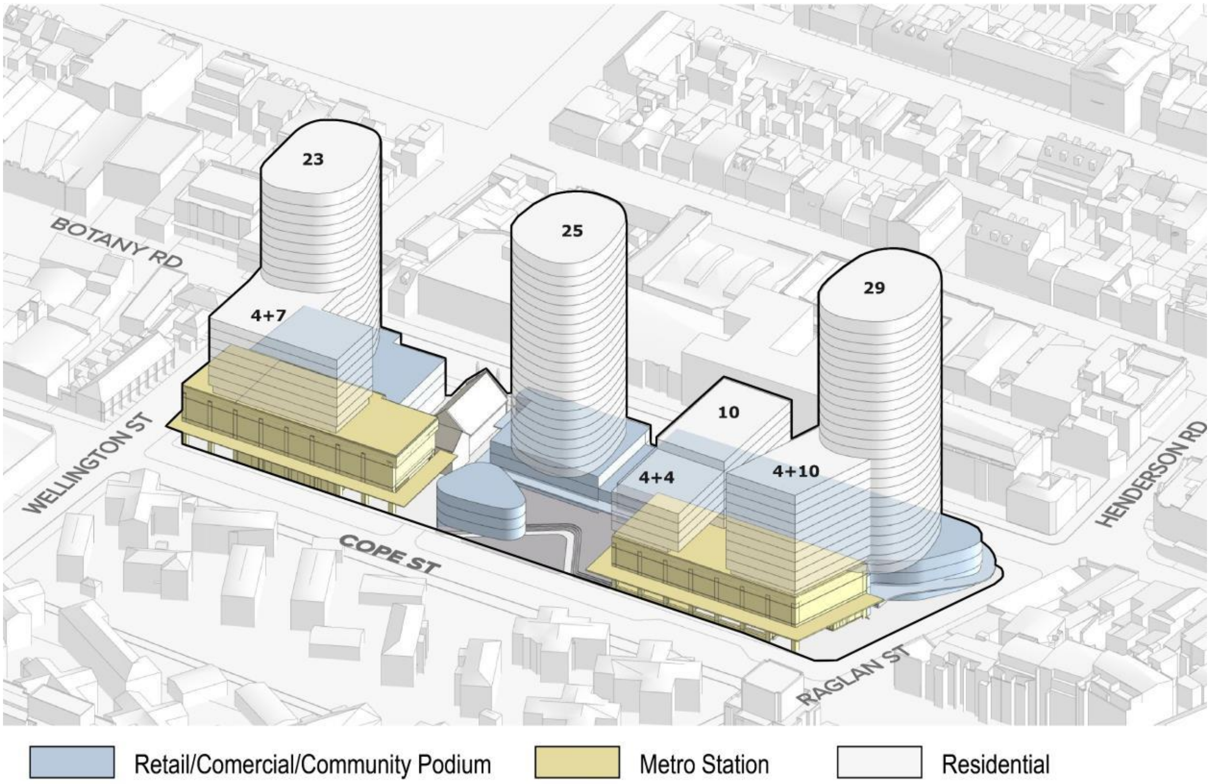
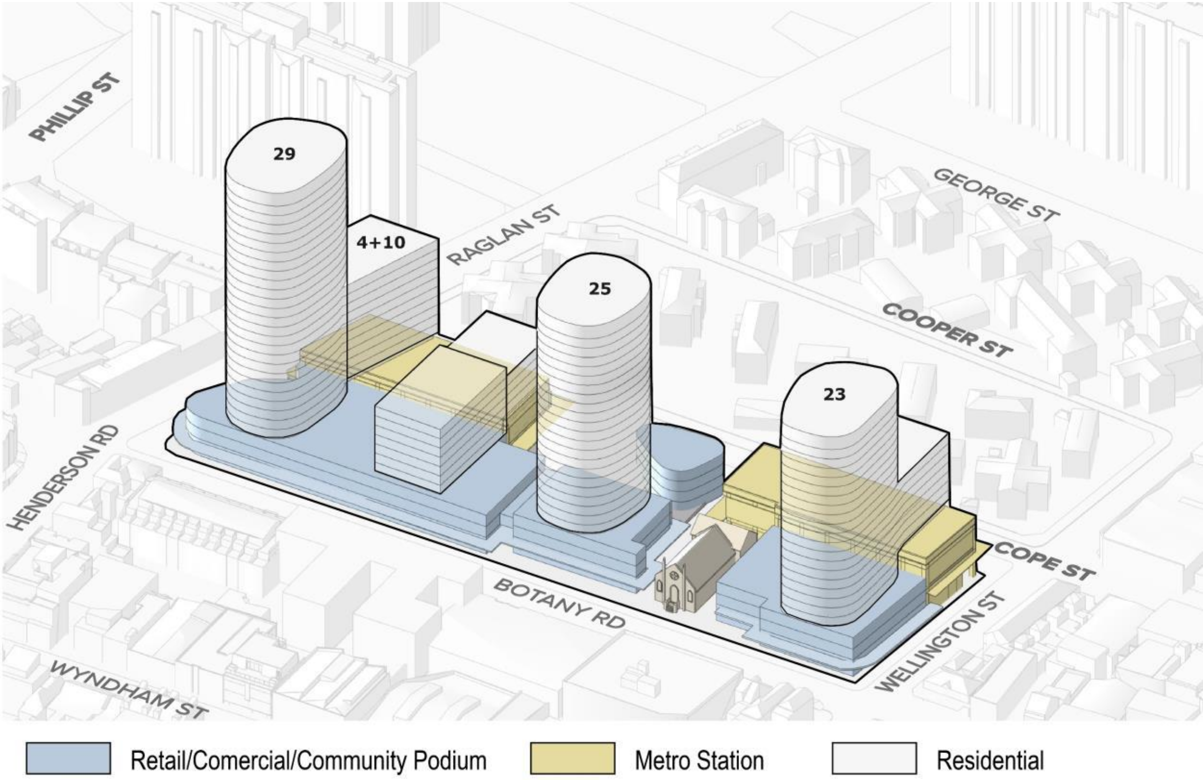


Figure 5 Three-Dimensional Drawing of the Indicative Concept Proposal, Viewed from the West



The concept design of the Metro Quarter incorporates a number of measures in order to reduce the likelihood of air quality impacts. These include:

- Locating no sensitive receptors within a 20 m radius of Botany Road and at elevations above 12 m.
- Minimising the formation of urban canyons[1] by having buildings of different heights interspersed with open areas, and setting back the upper stories of multi-level building.
- Orienting living areas and bedrooms as far as practicable from Botany Road.
- Using vegetative screens to assist in maintaining local ambient air amenity.

5.3 Noise and Vibration Specific Site Overview and Proposed Works

The proposed Project area is located above and immediately surrounding the proposed future Sydney Metro Waterloo Station, between Cope St and Botany Road, south of Raglan Street and north of Wellington Street. The Project site will accommodate six new mixed-use high-rise buildings which are identified in **Figure 6**. The building numbers (B01 – B06) in **Figure 6** relate to those which have been adopted in residential noise intrusion predictions shown in **Appendix C**.

[1] a street that is flanked on either side with tall buildings creating a structure that's similar to a canyon. Within an urban canyon, air recirculation is poor and there is a risk of pollutant accumulation.

Figure 6 Site Layout and Proposed Project Buildings Containing Residential Receivers

Note 1: Development will preserve the heritage-listed Congregational Church (highlighted in red)

5.4 Potential Noise and Vibration Impacts

The following noise and vibration features with the potential to affect the surrounding environment and sensitive receivers are presented in this report:

- Noise and vibration impacts at the surrounding noise-sensitive receivers during Project construction.
- Noise impacts at the surrounding noise-sensitive receivers from mechanical plant and other Project related noise sources during operation.

Additionally, the following noise impacts and acoustic design requirements with respect to the proposed Project buildings are outlined, with recommendations provided where appropriate.

- Potential noise intrusion impacts from external sources (ie road traffic and rail noise).
- Building facade constructions and sound insulation requirements.
- Potential operational noise and vibration impacts from the currently under construction Sydney Metro City & Southwest project, due to the Metro Quarter being situated over and adjacent to the project.

Note that the scope of this report is to assess the feasibility of the potential future buildings to achieve the criteria associated with the above. Designs would be further developed for the site by the contractor and design team undertaking the development as the project progresses through detailed design.

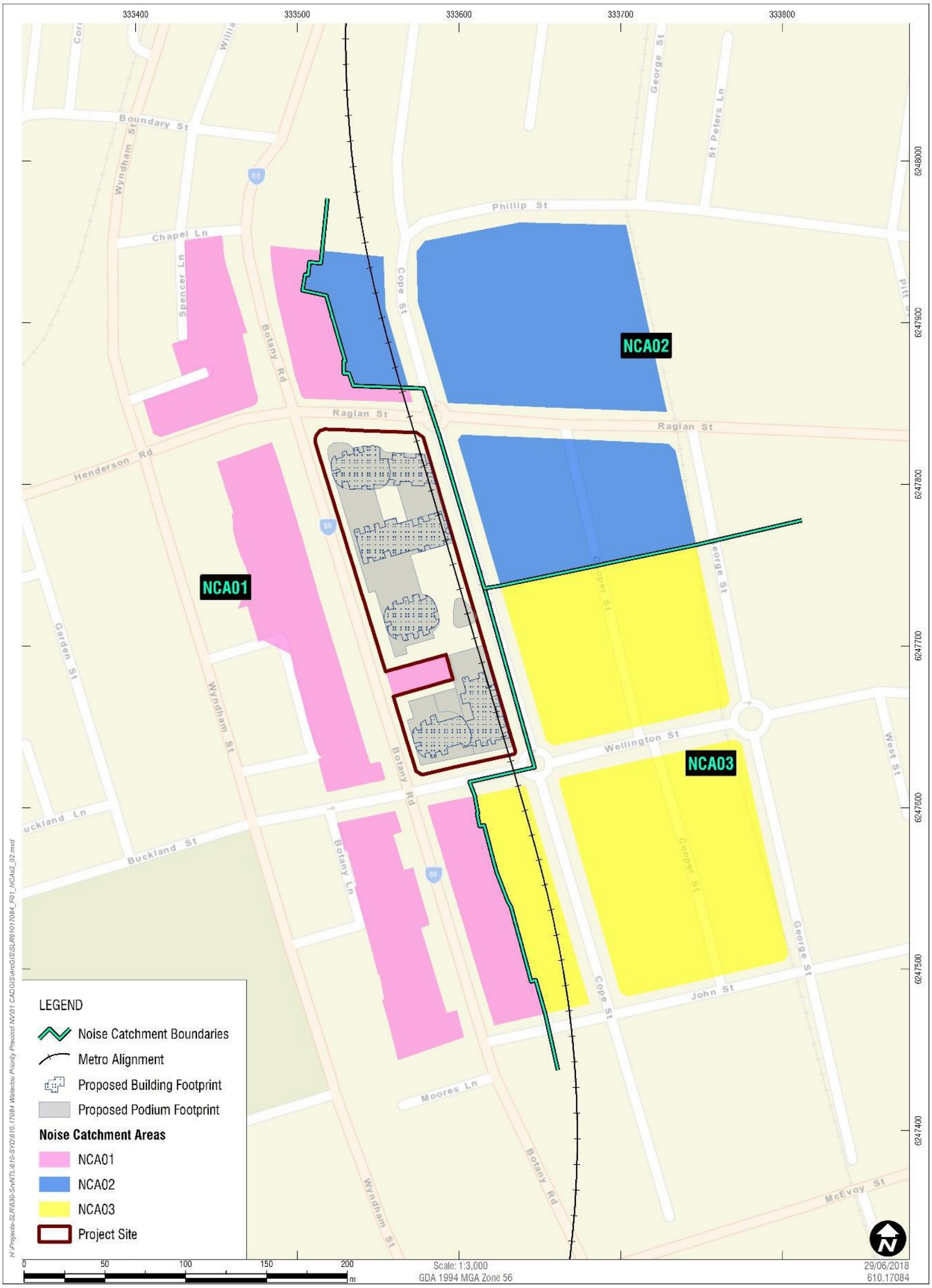
5.5 Noise Catchment Areas (NCAs)

Due to the urban density and colocation of different land uses surrounding the Project site in addition to the differences in the surrounding existing noise environments, Noise Catchment Areas (NCAs) have been established, containing different receiver types that may potentially be affected by noise and vibration impacts from the proposed Project. Within each NCA, appropriate noise goals have been defined for each receiver type based on the following:

- The receiver’s surroundings and sensitivity to noise and vibration.
- The receiver’s location relative to the proposed Project site.
- The results of the existing ambient noise surveys (presented in **Section 4.2.3.2**)
- Relevant NSW noise assessment policies and guidelines.

The defined NCAs containing different receiver types are presented in **Figure 7**.

Figure 7 Project Site and Nearby-Noise Sensitive Receivers



Note 1: The heritage-listed Congregational Church which is to be preserved as part of the redevelopment is located within the Project site however has been assigned to NCA01 for the purpose of this assessment.

The different land uses and receiver types within each NCA were identified through site inspection and aerial photography and are presented in **Table 5**.

Table 5 Noise Catchment Areas and Associated Land Uses

Noise Catchment Area (NCA)	Receiver Types/Land Uses identified within NCA
NCA01	Commercial premises
	Residential
	Place of worship (Congregational Church)
	Studio building (FBi Radio)
NCA02	Active recreation area
	Residential
NCA03	Commercial premises
	Residential

6 Implementation Plan & Strategy

6.1 Construction Noise Criteria

6.1.1 Construction Noise Guidelines

The noise guidelines and management levels for construction works are based on the publications managed by the NSW Environment Protection Authority[2] (EPA). The EPA construction guidelines applicable to this project include:

- *Interim Construction Noise Guideline* (DECC 2009).
- *Chatswood to Sydenham, Construction Noise and Vibration Strategy* (Sydney Metro 2017)

6.1.2 Recommended Standard Construction Hours

The EPA's *Interim Construction Noise Guideline* (ICNG) recommends restricting construction works to the times outlined in **Table 6**.

Table 6 ICNG - Recommended Standard Hours of Construction

Day	Recommended Construction Hours
Monday to Friday	7.00 am to 6.00 pm
Saturdays	8.00 am to 1.00 pm
Sundays or Public Holidays	No construction

6.1.3 Construction Noise Management Levels

6.1.3.1 Residential Receivers

The ICNG recommends that the $L_{Aeq(15minute)}$ noise levels from a construction project, measured within the curtilage of an occupied noise-sensitive residence (ie at the boundary or within 30 m of the residence, whichever is the lesser) should not exceed the levels indicated in **Table 7**.

Table 7 Recommended ICNG Noise Management Levels for Residences Affected by Construction Works

Period of Noise Exposure	$L_{Aeq(15minute)}$ Construction Noise Management Level
Recommended Standard Hours	Noise affected[1] RBL[2] + 10 dBA
	Highly Noise Affected[3] 75 dBA
Outside Recommended Standard Hours	Noise affected[1] RBL[2] + 5 dBA

Note 1: The noise affected level represents the point above which there may be some community reaction to noise.

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

Note 3: The highly noise affected level represents the point above which there may be strong community reaction to noise.

2 Noise and Vibration guidelines managed by EPA are available at the following web address http://www.environment.nsw.gov.au/noise/noise_legislation.htm.

Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level during recommended standard hours, the proponent should apply all feasible and reasonable work practices to meet the NMLs. 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.

Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the Highly Noise Affected, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours during which highly noisy intensive 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.

Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level outside recommended standard hours, consultation with the community is required and negotiations should be considered.

The Project specific residential receiver NMLs for each defined NCA (discussed in **Section 5.5** and shown in **Figure 7**) were derived from the relevant unattended noise monitoring results. The airborne construction NMLs for residences surrounding the proposed Project site are shown in **Table 8**.

Table 8 Construction Noise Management Levels – Residential

Residential receivers within Noise Catchment Area (NCA)[1]	Rating Background Level (dBA)			Recommended Standard Hours		Outside Recommended Standard Hours[3]		
				Noise Affected (RBL + 10 dB)	Highly Noise Affected (75 dB)	Noise affected (RBL + 5 dB)		
	Day[2]	Evening[2]	Night[2]			Day (dBA)	Evening (dBA)	Night (dBA)
NCA01	60	57	46	70	75	65	62	51
NCA02	50	46	40	60	75	55	51	45
NCA03	50	46	41	60	75	55	51	46

Note 1: Subdivision of noise catchment areas (containing residential receivers) surrounding the Project site discussed in **Section 5.5**.

Note 2: Rating Background Levels (RBL) shown with respect to the *Noise Policy for Industry (NPfI)* assessment periods – Daytime: 7:00 am to 6:00 pm Monday to Saturday, 8:00 am to 6:00 pm Sundays and Public Holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 8:00 am Monday to Saturday, 10:00 pm to 8:00 am Sundays and Public Holidays.

Note 3: EPA's recommended standard construction hours are 7.00 am to 6.00 pm Mon-Fri; 8.00 am to 1.00 pm Sat.

6.1.3.2 Other Sensitive Land Uses

To minimise disturbance to the characteristic activities of these other sensitive land uses, the ICNG recommends construction Noise Management Levels through a combination of internal design levels and the assessment of external noise levels. In accordance with the ICNG, the recommended airborne construction NMLs for other sensitive land uses within the defined NCAs surrounding the Project site are presented in **Table 9**.

Table 9 Construction Noise Management Levels – Other Sensitive Land Uses

Noise Catchment Area	Other Sensitive Land Use within Noise Catchment Area (NCA)	$L_{Aeq(15minute)}$ Construction Noise Management Level[1]
NCA01	Places of worship	Internal noise level[2] 45 dBA
NCA02	Active recreation area	External noise level[3] 65 dBA

Note 1: Applies when properties are being used.

Note 2: Internal noise levels are to be assessed at the centre of the occupied room.

Note 3: External noise levels are to be assessed at the most affected point at the property boundary or 30 m from the residence (whichever is the lesser).

6.1.3.3 Commercial and Industrial Premises

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the ICNG outlines the process of defining management levels by separating them into the following three categories:

- Industrial premises: external L_{Aeq} 75 dBA
- Offices, retail outlets: external L_{Aeq} 70 dBA
- Other businesses that may be very sensitive to noise (eg theatres and child care centres): determine suitable noise levels on a project-by-project basis; consultation with the 'upper-limit' internal noise levels in AS 2107 *Acoustics – Recommended design sound levels and reverberation times for building interiors may assist in determining relevant noise levels* (Standards Australia 2016) is recommended.

In accordance with the ICNG, the recommended airborne construction NMLs for commercial and industrial premises within the defined NCAs surrounding the Project are presented in **Table 10**.

Table 10 Construction Noise Management Levels – Commercial and Industrial Premises

Noise Catchment Area	Land Use	$L_{Aeq(15minute)}$ Construction Noise Management Level[1]
NCA01	Commercial	External noise level 70 dBA
	Other – Radio studio	Internal noise level 25 dBA[2]
NCA03	Commercial	External noise level 70 dBA

Note 1: As outlined in the ICNG, construction NMLs are to be assessed externally at the most-affected occupied point of the premises.

Note 2: Internal noise level derived from AS 2107 *Acoustics – Recommended design sound levels and reverberation times for building interiors may assist in determining relevant noise levels* as recommended in the ICNG.

6.2 Construction Vibration Criteria

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

6.2.1 Human Comfort Vibration

The DECCW's *Assessing Vibration: a technical guideline* dated February 2006 (DEC, 2006) recommends the use of British Standard BS 6472-1992 for the purpose of assessing vibration in relation to human comfort.

BS 6472-1992 *Guide to evaluation of human exposure to vibration in building* nominates guideline values for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a "low probability of adverse comment" from occupants.

BS 6472-1992 provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV), rather than a continuous vibration level. The vibration dose value is dependent upon the level and duration of the short term vibration event, as well as the number of events occurring during the daytime or night-time period.

The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in **Table 11**.

Table 11: Vibration Dose Value Ranges which Might Result in Various Probabilities of Adverse Comment within Residential Buildings

Place and Time	Low Probability of Adverse Comment ($m/s^{1.75}$)	Adverse Comment Possible ($m/s^{1.75}$)	Adverse Comment Probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Note: For offices and workshops, multiplying factors of 2 and 4 respectively would be applied to the above vibration dose value ranges for a 16 hr day.

6.2.2 Structural Damage Vibration

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 goals, Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* recommends the frequency dependent guideline values and assessment methods given in 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 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% probability of no effect.

Sources of vibration that are considered in the Standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

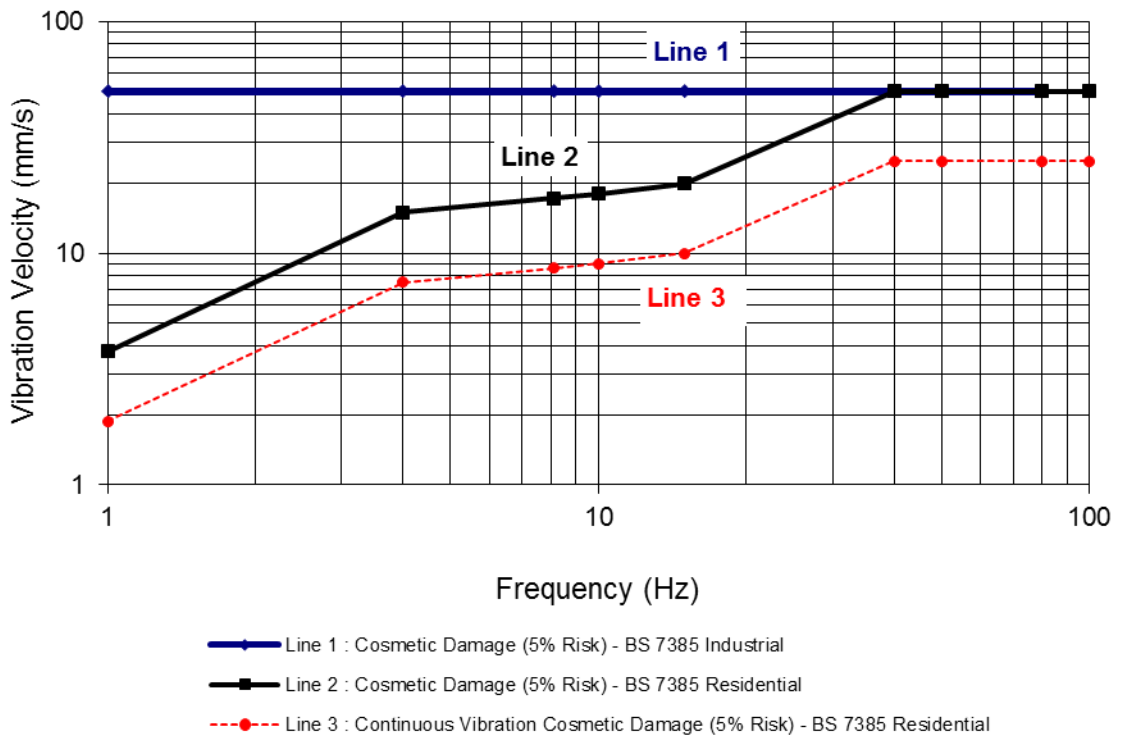
6.2.3 Cosmetic Damage Vibration

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 12** and graphically in **Figure 8**.

Table 12 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

Figure 8 Graph of Transient Vibration Guide Values for Cosmetic Damage



The Standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 12**, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the Standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 12** would not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measured would be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) would be compared with the guidance curves presented in **Figure 8**.

It is noteworthy that in addition to the guide values nominated in **Table 12** the Standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

6.2.4 General Vibration Screening Criterion

The Standard states that the guide values in **Table 12** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 12** may need to be reduced by up to 50%.

Note: rockbreaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may therefore be appropriate to reduce the transient values by 50%.

Therefore for most construction activities involving intermittent vibration sources such as rockbreakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

6.2.5 Heritage

Heritage buildings and structures would be assessed as per the above screening criteria as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage criteria of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered

6.3 Operational Noise Criteria

This section outlines criteria for assessing the potential impacts of noise generated by the proposed development on the surrounding noise sensitive receivers.

6.3.1 Operational Noise – Industrial Noise Emissions

The *Noise Policy for Industry* (NPfI) (EPA, 2017) outlines the procedure for assessing noise emissions from industrial noise sources, such as mechanical plant and equipment. The process involves determining project noise trigger levels at existing noise-sensitive receivers surrounding a proposed development, predicting whether emissions from the development are likely to exceed the established levels and result in potential noise impacts, and reducing the predicted levels through feasible and reasonable mitigation strategies.

The Project Noise Trigger Level is the lower (ie the more stringent) value of the project intrusiveness noise level and project amenity noise level. The project intrusiveness noise level aims to protect against significant changes in noise levels, whilst the project amenity noise level seeks to protect against cumulative impacts from industry and maintain amenity for particular land uses.

Typically, the intrusiveness level will inform the project noise trigger level in areas with little industry (and/or ambient noise levels), whereas the amenity level will inform the project noise trigger level in areas with higher existing background noise levels.

6.3.1.1 Intrusiveness Noise Level

The intrusiveness noise level is based on the measured existing background noise levels. In accordance with the NPfI, the equivalent continuous noise level (L_{Aeq}) of the source should not exceed the measured Rating Background Level (RBL) at a residence by more than 5 dBA over any 15 minute period within any assessment period. Intrusive noise levels are only applied to residential receivers (residences). For other receiver types, only the amenity levels apply.

6.3.1.2 Amenity Noise Level

The recommended amenity noise level represents the total industrial noise at a receiver location, whereas the project amenity level represents the objective for noise from a single industrial development. The project area is considered to be urban.

6.3.1.3 Project Noise Trigger Levels

The results of the unattended noise monitoring, summarised in **Section 4.2.3.2** of this report, have been used to establish the Project Noise Trigger Levels which will be used to assess the potential industrial impacts associated with the Project at the surrounding receivers. The project noise trigger levels are the more stringent of the intrusiveness and amenity noise levels and are marked in bold and shaded as shown below in **Table 13**.

Table 13 Indicative Project Noise Trigger Levels for Surrounding Receivers

NCA	Receiver Type	Period	Recommended Amenity Noise Level (dBA)	Measured Noise Level (dBA)		Indicative Project Noise Trigger Levels $L_{Aeq(15minute)}$ (dBA)	
				RBL	$L_{Aeq(period)}$	Intrusiveness	Amenity [1,2]
NC01	Residential	Day	60	60	72	65	**60**[3]
		Evening	50	57	70	62	**58**[3]
		Night	45	46	69	**51**	57[3]
	Commercial	When in use	65	n/a	72	n/a	**63**
	Place of worship – external[4]	Day	50[3]	n/a	72	n/a	**60**[3]
		Evening	50[3]	n/a	70	n/a	**58**[3]
		Night	50[3]	n/a	69	n/a	**57**[3]
NC02	Residential	Day	60	50	57	**55**	58
		Evening	50	46	53	51	**48**
		Night	45	40	50	45	**43**
	Active recreation area	When in use	55	n/a	57	n/a	**53**
NC03	Residential	Day	60	50	65	55	**58**
		Evening	50	46	57	51	**48**
		Night	45	41	54	46	**43**
	Commercial	When in use	65	n/a	65	n/a	**63**

Note 1: The project amenity noise levels have been converted to 15 minute levels by adding 3 dB.

Note 2: The recommended amenity noise levels have been reduced by 5 dB to give the project amenity noise levels due to future sources of industrial noise potentially being built in the area.

Note 3: The NPfI notes that where the existing traffic noise level is 10 dB or more above the recommended amenity noise level, then the High Traffic project amenity noise level is the existing traffic L_{Aeq} minus 15 dB.

Note 4: Internal noise levels have been converted to external noise levels using a typical 10 dB external to internal transmission loss factor.

As no other guidance is provided in the NPfI regarding recommended amenity levels for other sensitive land uses, the Radio station located directly northwest of the Project site has been classified as a commercial receiver. Based on the general sound insulation requirements of such facilities and the high existing level of road traffic noise on Botany Road, noise ingress from Project related industrial noise is considered to likely be negligible and a commercial receiver type classification is suitable.

At this early stage of the project, the criteria presented in **Table 13** should be regarded as indicative and will be confirmed during the next stages of the project. While the NPfI has been used to determine the above indicative trigger levels for the Metro Quarter, it is acknowledged that the Sydney Metro was approved under the now superseded *Industrial Noise Policy* and careful consideration of both guidelines will be required in the next stages of the project.

The final project trigger levels will be determined in collaboration with the Precinct Developer and Sydney Metro, noting that the cumulative industrial noise levels from the Metro Quarter, Sydney Metro Waterloo Station and Sydney Metro Tunnel Ventilation systems will be required to meet the final project triggers levels.

6.4 Internal Noise Level Criteria – Residential

This section establishes appropriate internal noise criteria for the residential areas of the proposed development in order to protect the amenity of future occupants from external noise intrusion.

6.4.1 State Environment Planning Policy

The *State Environment Planning Policy* (Infrastructure) 2007 (Infrastructure SEPP) provides guidelines to ensure that the development of new residential buildings protects the occupants adequately from noise associated with existing road and railway infrastructure. The key objectives of the provisions are to:

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

The key clauses of the Infrastructure SEPP are:

Rail Corridors

Clause 86 Any development (other than development to which clause 88 of the Infrastructure SEPP applies) that involves the penetration of the ground to a depth of at least 2 m below ground level (existing) on land that is:

a. Within or above a rail corridor; or

b. Within 25 m (measure horizontally) of a rail corridor); or

c. Within 25 m (measure horizontally) of the ground directly above an underground rail corridor

Note: the consent authority must not grant consent without consulting with the rail authority and obtaining concurrence consistent with clauses 86(2)-(5)

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

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

Road Corridors

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

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

Clause 103 Any development which involves penetration of the ground to a depth of at least 3m below ground level (existing) on land that is the road corridor of roads or road projects as specified in schedule 2 of the SEPP.

For Clauses 87 (Rail) and 102 (Road)

- If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} noise levels are not exceeded:
  - In any bedroom in the building: 35 dB(A) at any time (10pm – 7am)
  - Anywhere else in the building (other than a garage, kitchen, bathroom, or hallway): 40dB(A) at any time

6.4.2 City of Sydney Development Control Plan 2012

The *City of Sydney Development Control Plan* (SDCP 2012) provides noise criteria for the development of new residential houses and units. Provided below is a summary of the requirements pertinent to the consideration of external noise.

- The repeatable maximum $L_{Aeq(1\ hour)}$ for residential buildings and serviced apartments must not exceed the following levels:

  a. for closed windows and doors:
  (i) 35 dB for bedrooms (10pm-7am); and
  (ii) 45 dB for main living areas (24 hours).

  b. for open windows and doors:
  (i) 45 dB for bedrooms (10pm-7am); and
  (ii) 55 dB for main living areas (24 hours)
- Where natural ventilation of a room cannot be achieved, the repeatable maximum $L_{Aeq\ (1hour)}$ level in a dwelling when doors and windows are shut and air conditioning is operating must not exceed:
  - 38dB for bedrooms (10pm-7am); and
  - 48dB for main living areas (24 hours)
- These levels are to include the combined measured level of noise from both external sources and the ventilation system operating normally.

6.4.3 Apartment Design Guideline and City of Sydney Consultation

As part of the development of the proposal for the site, UGDC and SLR has undertaken consultation with City of Sydney and Department of Planning and Environment (DP&E). Based on this consultation, it is understood that the project should be designed to meet the requirements of DP&E's *Apartment Design Guide* (ADG) Objective 4B-1 for natural ventilation.

As a result, residential areas should comply with the “windows open” (item 1 b) noise criteria of the CoS DCP as repeated in **Section 6.4.2**.

6.4.4 Ground-borne Noise – Sydney Metro

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

6.4.5 Vibration Criteria

Although vibration requirements aren’t specified in the Infrastructure SEPP, impacts from vibration associated with transport infrastructure are commonly translated into ground-borne noise. Vibration transmission into the buildings will need to be controlled to ensure that ground-borne noise levels comply with the internal airborne noise criteria for residential buildings discussed in **Section 6.4**.

6.5 Internal Noise Criteria – Non-residential uses

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

7 Assessment

7.1 Construction Noise and Vibration Impacts

At this stage the specific construction methodology and selection of construction plant and equipment is unknown. Once further details surrounding the proposed construction methodology, equipment and phasing is known, it is recommended that the managing contractor produces a comprehensive Construction Noise and Vibration Management Plan incorporating mitigation and management strategies developed through consultation with the surrounding community and regulatory authority that is also in accordance with the framework for compliance established in this report (outlined in **Section 6.1.3**).

When completing these assessments reference should be made to the requirements and criteria defined in the *Chatswood to Sydenham Construction Noise and Vibration Strategy* (Sydney Metro, 2017).

7.1.1 Construction Noise Mitigation and Management

If required, the Construction Contractor will need to, where feasible and reasonable, implement best practice noise mitigation measures including measures such as:

- Judicious selection of mechanical plant and equipment (eg quieter machinery and power tools).
- Maximising the offset distance between noisy plant items and nearby noise sensitive receivers.
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers.
- Orienting equipment away from noise-sensitive areas.
- Carrying out loading and unloading away from noise-sensitive areas.
- Localised shielding of noisy equipment.
- Minimising consecutive works in the same locality.
- Considering periods of respite.

7.1.2 Construction Vibration Impacts

As details surrounding the proposed construction methodology, equipment and phasing are unknown, a detailed construction vibration assessment is not possible at this stage. However, it is recommended to mitigate any potential impacts using the recommended safe working distances for vibration intensive plant as indicated in **Table 14**, taken from Transport for NSW's *Construction Noise Strategy* (2012).

Table 14 Recommended Safe Working Distances for Vibration Intensive Plant

Equipment Item	Rating/ Description	Safe Working Distance	
		Cosmetic Damage[1]	Human Response
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (Typically > 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	300 kg – 18 to 34t excavator	2 m	7 m
Medium Hydraulic Hammer	1,600 kg – 5 to 12t excavator	7 m	23 m
Large Hydraulic Hammer	1,600 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)	4 m
Jackhammer	Hand held	1 m (nominal)	2 m

Note 1: More stringent conditions may apply to heritage or other sensitive structures.

7.2 Operational Noise Impacts

7.2.1 Operational Noise – Industrial Noise Impacts

A review of the most recent architectural drawings provided by UGDC indicates that typical sources of industrial noise that may be associated with the commercial premises component of the Project area may include:

- Noise from mechanical equipment including Heating Ventilation Air Conditioning (HVAC), carpark ventilation fans, corridor ventilation systems and carpark entry gates, substation, fire pump and fire control equipment.

At this stage, the technical specifications and layout of the proposed mechanical plant and other equipment have not been defined and potential impacts from these sources should be assessed (in accordance with the indicative project noise trigger levels outlined in **Section 6.3.1**) during the detailed design stage of the Project.

Operational noise emissions from mechanical plant associated with the Project should be controlled to reduce noise impacts upon neighbouring residential receivers and occupants within the proposed development. Detailed assessment and verification of mechanical noise emissions should be carried out during the detailed design stage of the project ensuring that the nominated criteria for mechanical plant emissions are met.

As noted previously, the final project trigger levels will be determined in collaboration with the Precinct Developer and Sydney Metro during detailed design, noting that the cumulative industrial noise levels from the Metro Quarter, Sydney Metro Waterloo Station and Sydney Metro Tunnel Ventilation systems will be required to meet the final project triggers levels.

Furthermore, a maximum noise level assessment for potential sleep disturbance, and corrections for annoying noise characteristics should be investigated once more information regarding the Project associated industrial noise sources is known.

7.2.1.1 In-Principle Acoustic Treatment Recommendations

It is envisaged that the industrial noise sources will be able to achieve compliance with the nominated criteria through common engineering methods that may consist of:

- Selection of low-noise mechanical plant and other noise generating equipment.
- Judicious location of mechanical plant and equipment with respect to nearby noise-sensitive receivers.
- Barriers/enclosures (eg plant rooms).
- Silencers and acoustically lined ductwork.

The required noise mitigation measures would be reviewed during detailed design when more information regarding sources of industrial noise are available.

7.3 Noise Ingress

Due to the location of the Project site with respect to Botany Road, road traffic noise impacts on the proposed Project buildings (shown in **Figure 9**) have been predicted to confirm whether natural ventilation could be achieved while complying with the requirements of the Infrastructure SEPP and CoS SDCP 2012 acoustic amenity requirements for residential properties outlined in **Section 6.4**

7.3.1 Noise Model

A SoundPLAN computer noise model was developed to predict road traffic noise levels at the proposed future Metro Quarter building facades, shown in **Figure 9**.

SoundPLAN is a software package which allows noise predictions to be made in a 3D environment and includes a digitised ground map (containing ground contours and significant structures, where appropriate), the location and acoustic power levels of significant noise sources, and the location of noise-sensitive receivers.

7.3.2 Methodology

The computer model generates noise emission levels accounting for factors such as road traffic volume flows, attenuation due to distance, ground and air absorption and shielding attenuation, as well as meteorological conditions.

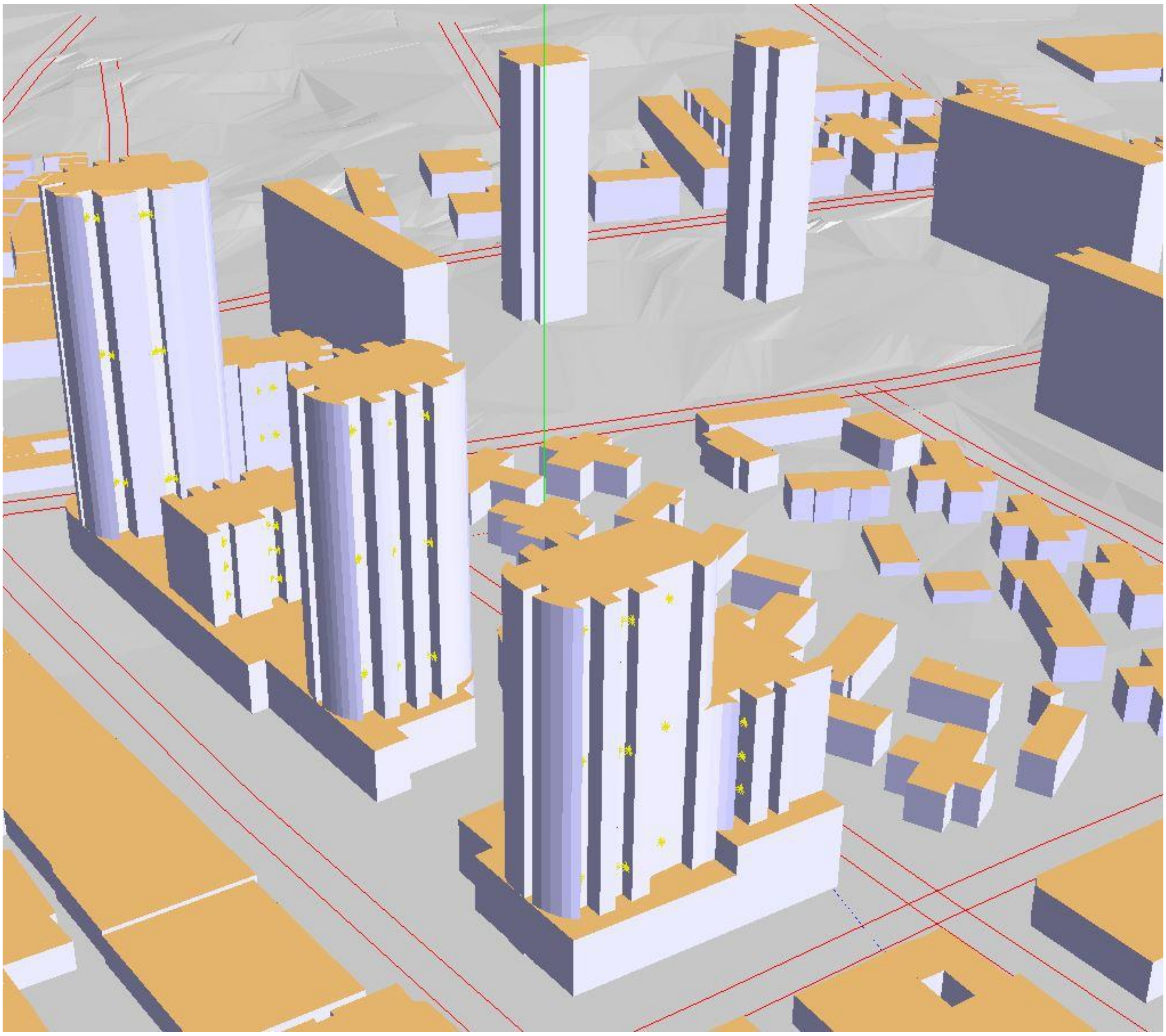
Heights of buildings, screens and other structures were estimated based on architectural drawings provided by UGDC, site inspection and aerial photography. Daytime (15 hour) and night-time (9 hour) two-way traffic volumes were assigned to the road traffic sources and are presented in **Appendix D**.

For each of the six proposed Project buildings, single point receivers were positioned at selected facades (refer to figures in **Appendix C**). The receivers were located at three discrete heights (shown graphically in **Figure 9** and presented numerically in **Appendix C**) to predict the potential impact of road traffic noise levels at different facade heights.

SLR has worked closely with the design team in order to develop tower massing which provides localised screening to openings by way of balcony shapes. These are included within the computer model as shown in **Figure 9.**

A 2.5 dB correction was added to the predicted receiver levels to account for increased levels due to facade and balcony reflections. Additionally, a 15 dB facade loss was applied to the receiver level to predict the internal road traffic noise levels.

Figure 9 Waterloo Metro Quarter SoundPLAN 3D Model



Note 1: Road traffic sources are shown in red.

Note 2: Single point receivers were located at each of the proposed building facades and are shown in yellow.

7.3.3 Internal Road Traffic Noise Prediction Results

The purpose of this noise and vibration assessment is to demonstrate that compliance with the nominated criteria can be achieved. This section summarises the assessment undertaken and resulting recommendations to achieve compliance.

7.3.3.1 Residential Areas

As summarised in **Section 6.4**, the driving internal noise targets for residential are the "window open" criteria of:

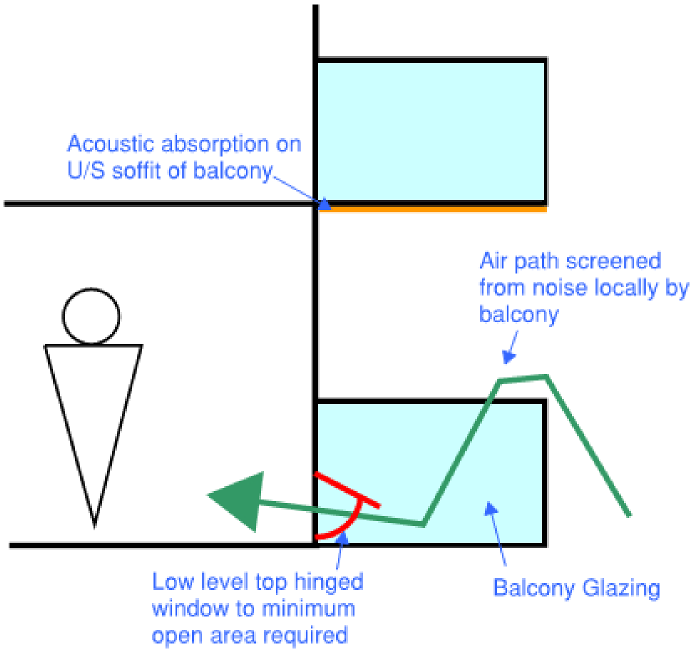
- 45 dBA $L_{Aeq(9hour)}$ for bedrooms (10pm-7am)
- 55 dBA $L_{Aeq(24hour)}$ for main living areas (24 hours)

The predicted internal road traffic noise levels are presented in **Appendix B**, and these predictions assume a 15 dBA outdoor-to-indoor loss.

Outdoor-to-Indoor Loss

The 15 dBA outdoor-to-indoor loss used to determine internal road traffic noise levels is noted as being higher than would typically be applied for a standard open window (typically taken to be 10dB), however based on previous experience and available literature, is considered reasonable when including the effect of localised screening on the balcony with low-level windows and acoustic absorption that could be applied to the balcony surfaces. The conceptual design is as shown in **Figure 10**.

Figure 10 - Concept of attenuated balcony openings (section view)



The figure of 15 dBA is considered suitable based on a review of available research into mitigating road noise intrusion through acoustically screened openings and balconies. In particular a paper authored by the Queensland University of Technology "*Investigations on road noise level spatial variability within a specially designed acoustic balcony*" (Daniel A. NAISH, Andy C. C. TAN, F. Nur DEMIRBILEK, Inter.Noise 2014) showed that at certain positions at residential windows in appropriately designed balconies, noise levels can be up to 12 dBA lower than at the facade of the building without a balcony.

This result, combined with the typical 10 dBA 'outdoor-to-indoor' loss implies that up to 22 dBA overall reduction from facade predicted noise levels may be achievable. As a result, SLR has used 15 dBA as a conservative figure and to allow design flexibility in the next stages of the project.

It will be the responsibility of the design team to demonstrate and validate any opening system to achieve a minimum of 15 dBA external to internal noise reduction (for a road traffic frequency spectrum noise source).

Summary of Results for Residential Areas

With this approach, the results in **Appendix B** indicate that compliance with the internal noise goals (outlined in **Section 6.4**) for residential receivers can be achieved during the daytime period (07:00 am – 22:00 pm). Compliance with the internal noise goals for residential receivers during the night-time period (10:00 pm – 07:00 am) was also achieved in the majority of locations, however exceedances of the internal noise goals of up to 3 dB were predicted at 16 out of the sample 222 receivers. Exceedances were predicted at building B01 (facade B, D and M) and B05 (facade B, G, H, I and K). These locations face north or south respectively and are exposed to high levels of traffic noise from Botany Road.

To achieve compliance at these receivers, the internal floorplate layout should be developed such that living spaces (not bedrooms) are located at the opening locations which are found to not comply with the night-time criteria.

All glazing and solid areas of the external building fabric should also be designed such as to achieve compliance with the "windows closed" criteria in **Section 6.4.2** for periods when occupants choose to close windows. This is considered to be possible with standard (ie "off-the-shelf") construction materials including acoustic laminate glazing.

7.3.3.2 Non-Residential Areas

It is considered that all non-residential (commercial) uses within the precinct will be sealed and mechanically ventilated. All glazing and solid areas of the external building fabric should be designed to achieve compliance with the AS2107:2016 criteria as referred to in **Section 6.5**. This is considered to be possible with standard (ie "off-the-shelf") construction materials including acoustic laminate glazing.

7.4 Sydney Metro

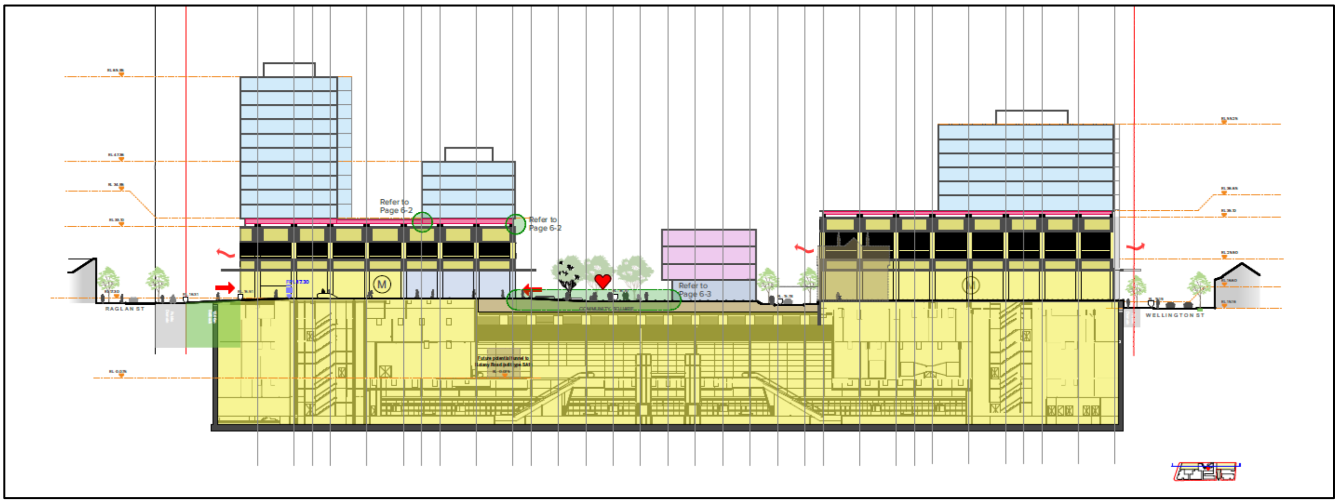
The Metro Quarter is situated over and adjacent to the Sydney Metro City & Southwest project, including Waterloo Station. There is potential for vibration and re-radiated ground-borne noise impacts at future receivers in the Metro Quarter from metro trains operating in the underground tunnels.

The Environmental Impact Statement for Sydney Metro assessed the potential impacts in this location, however residential usages were not proposed at The Metro Quarter at that time so no specific assessment was completed.

7.4.1 Assessment of Potential Future Impacts

The potential impacts on the Metro Quarter from the Sydney Metro have been assessed to the future residential sections of the project. Reference to the cross section of the project in **Figure 11** shows the first level of residential usage is nominally around six floors above rail level (ie around three floors above ground level and around three levels below ground). The floors below the first residential level would be for commercial/retail or station usage.

Figure 11 Metro Quarter – Waterloo Station Cross Section



A high level assessment of the potential impacts has been completed using standard trackform and high attenuation trackform (in the form of Delkor Eggs), using source spectra detailed in the Sydney Metro EIS. No coupling loss has been included in the analysis as the station and residential structures are integrated and a conservative vibration reduction of 1 dB per level has been used. Train speeds have been assumed to be 60 km/h. A summary of the assessment is provided in **Table 15**.

Table 15 Sydney Metro – Potential Noise and Vibration Impacts

Receiver	Trackform	Vibration (RMS)		Ground-borne Noise ($L_{Amax,slow}$)	
		Criteria	**Predicted**	**Criteria**	**Predicted**
First level of residential	Standard	0.4 mm/s[1]	<0.1 mm/s	35 dBA (night-time)	44 to 49 dBA
	High attenuation (Delkor Eggs)		<0.1 mm/s		40 to 45 dBA

Note 1: Criteria based on continuous vibration levels detailed in *Assessing Vibration: a Technical Guideline.*

The above conservative assessment indicates:

- Tactile vibration from Sydney Metro trains is unlikely to exceed the proposed threshold levels.
- Ground-borne noise levels from trains may exceed the night-time criteria for residential receivers, with the track types assessed above.

7.4.2 Mitigation

Vibration and ground-borne noise impacts from trains can be controlled at source through the use of trackforms which incorporate vibration-isolating components. In slab or embedded track sections, this can take the form of a resilient rail fastener, booted sleeper, floating track slab or a combination of approaches. The resilience is typically in the form of elastic/resilient pads or mats, or moulded rubber elements in the resilient baseplates/fasteners.

Further investigation of the impacts from trains on the Metro Quarter would be completed as the project progresses, and the Metro Quarter developers would work closely with Sydney Metro to ensure the impacts are adequately assessed and mitigated. It is anticipated that the criteria can be met through the use of resilient trackforms (higher performing than those investigated in **Table 15)**, building isolation in the form of bearings at the base of the buildings, or a combination of both.

7.5 Cumulative Impacts

7.5.1 Additional Road Traffic Noise

The NSW *Road Noise Policy* (RNP) requires consideration of noise mitigation where new land use developments increase road traffic noise by more than 2 dB. For a 2 dB increase in noise to be apparent a corresponding increase in traffic volumes of approximately 60% is required (assuming road speeds and other factors remain unchanged).

Peak two-way traffic volume data on Botany Road has been provided by Jacobs for the existing situation together with volumes associated with the Metro Quarter and Waterloo Estate. These are shown below in **Table 16**.

Table 16 Traffic Volumes on Botany Road

Existing Traffic Flows	Metro Quarter	Waterloo Estate
23,175 vehicles (15 hour)	Provision for approximately 65 car spaces	770 vehicles (15 hour)
6,428 (9 hour)		146 vehicles (9 hour)

The above shows that the cumulative increases in traffic from the Metro Quarter and Waterloo Estate are small in comparison to the high existing traffic volumes during the daytime and night-time. As such, potential cumulative increases in road traffic noise due to the Project are expected to be significantly less than 2 dB.

7.5.2 Industrial Noise

As noise sources and locations within and surrounding the precinct area are unknown at this early stage in the project, a cumulative impact assessment of potential operational noise from future industrial sources within the precinct cannot be completed.

The potential cumulative impacts from all sources of industrial noise from the Metro Quarter, Sydney Metro and the Waterloo Estate will be undertaken the future stages of the project when more information regarding the various noise sources and locations are known.

It is anticipated that compliance with the final project trigger levels from cumulative industrial noise impacts will be achievable with standard noise mitigation measures.

8 Conclusion

SLR has undertaken a noise and vibration impact assessment associated with the redevelopment of the Waterloo Metro Quarter. The assessment has been carried out in accordance with NSW regulatory requirements and in consultation with City of Sydney and other relevant stakeholders.

The scope of the assessment involved deriving and establishing project specific noise goals through consultation with various NSW and Australian guidelines; undertaking a noise and vibration impact assessment for the future development with respect to the appropriate criteria; and, where required, providing recommendations for noise control measures.

With the recommendations included within this report adopted, compliance with all established noise and vibration criteria is expected.

APPENDIX A

Acoustic Terminology

1 Sound Level or Noise Level

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

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

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-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

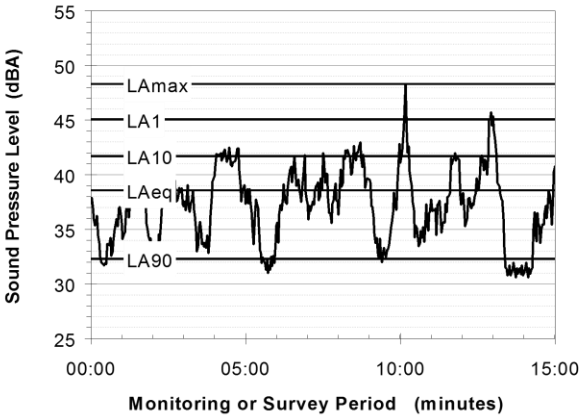
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or Lw, or by the reference unit 10^{-12}W.

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 LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

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



Of particular relevance, are:

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

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

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

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

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’ LA90 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 (LAeq, LA10, 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

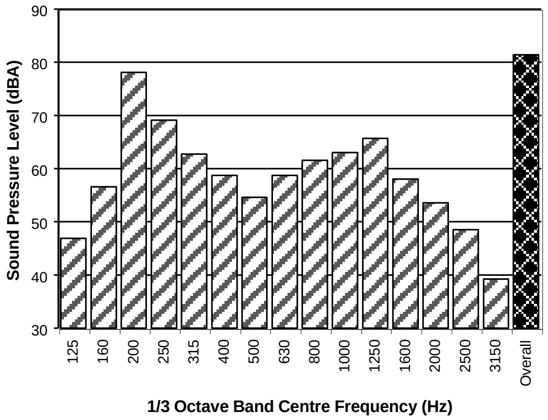
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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.



7 Vibration

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

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

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. 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/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

2 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.

3 Over-Pressure

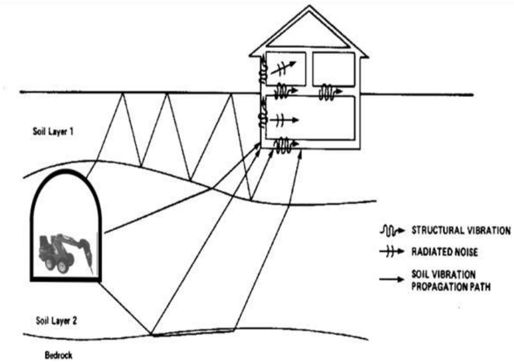
The term ‘over-pressure’ is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

4 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).

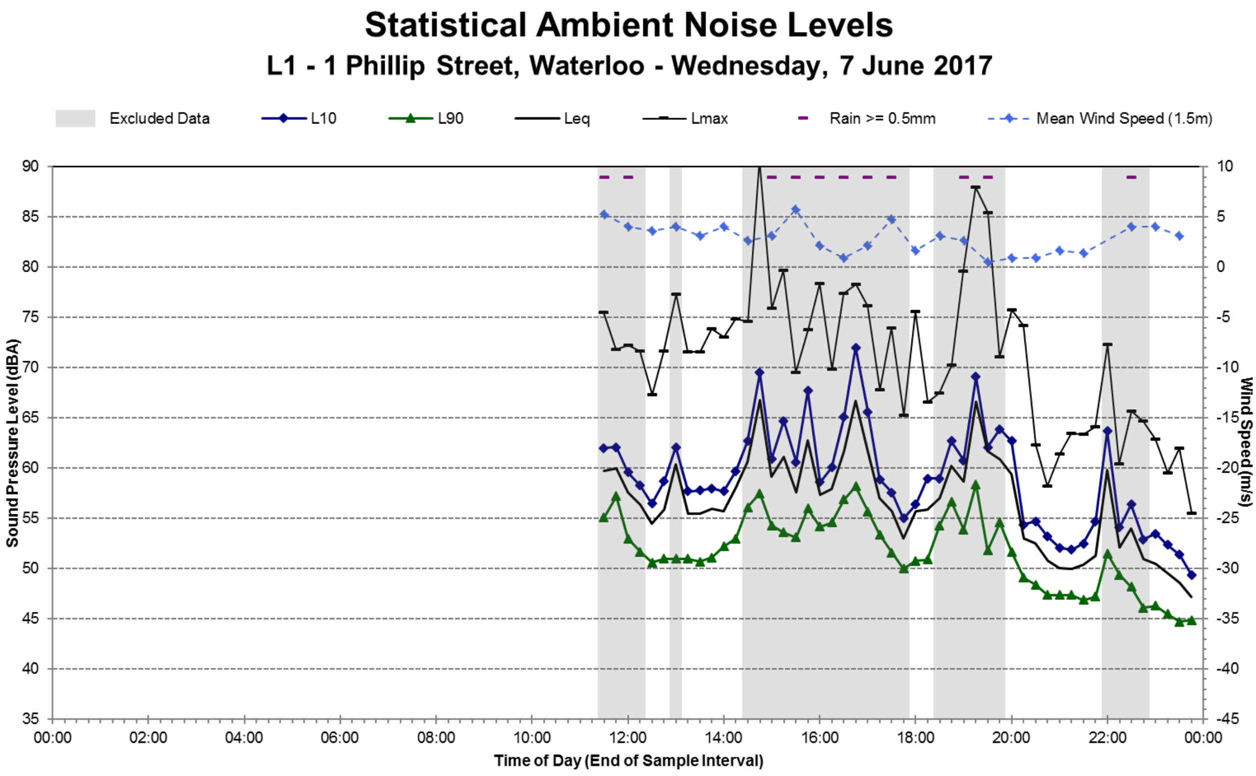
The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



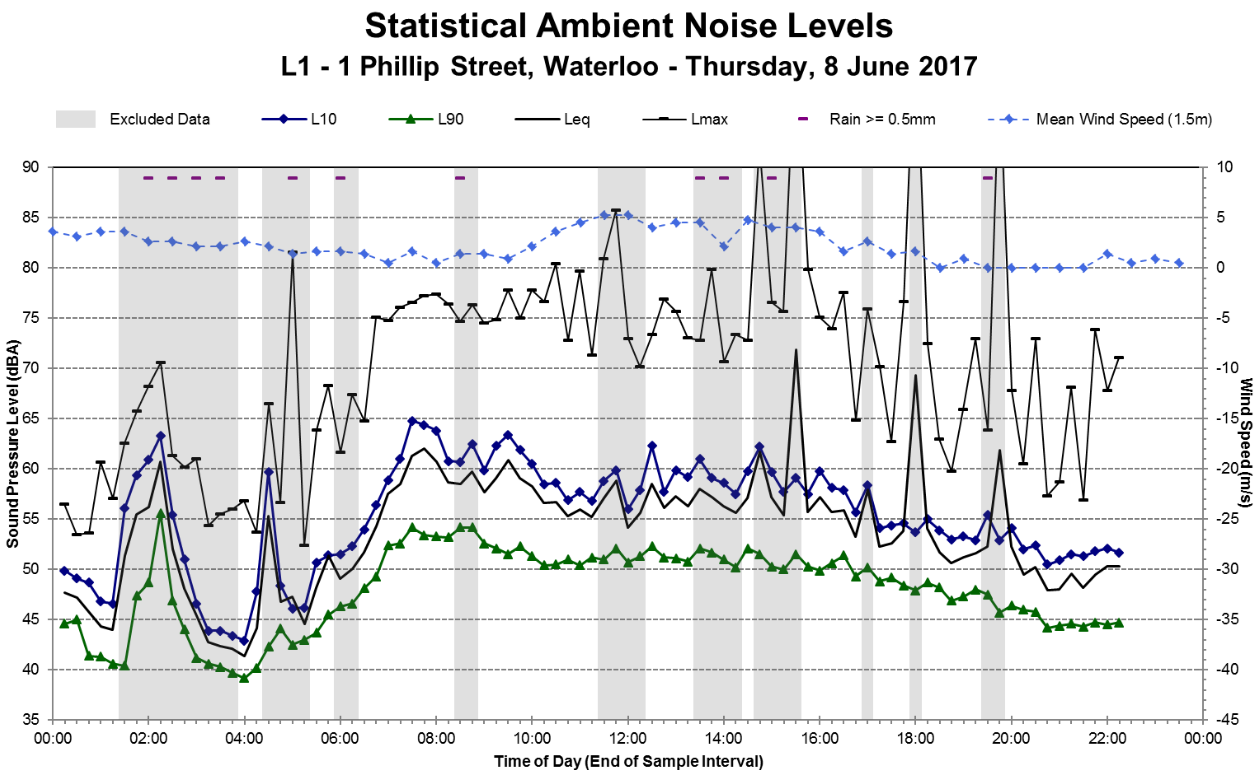
The term ‘regenerated noise’ is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect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

APPENDIX B

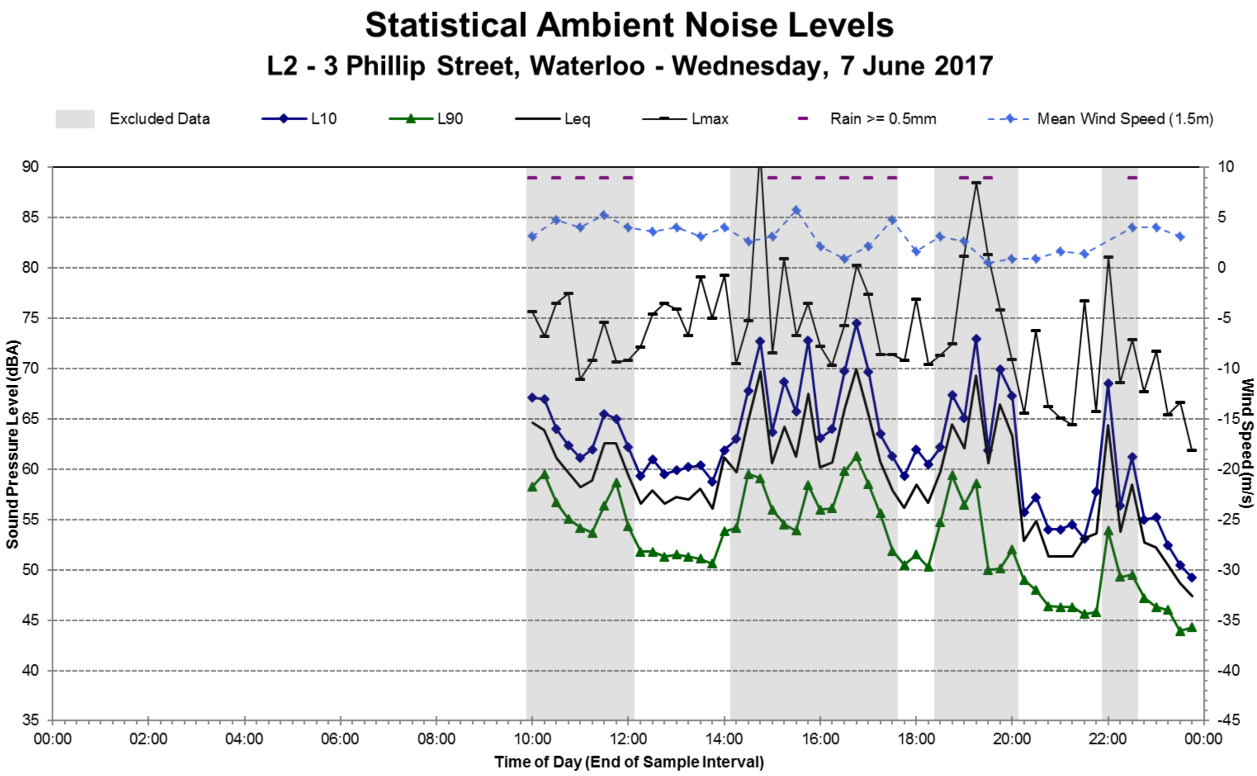
Ambient Noise Monitoring Results

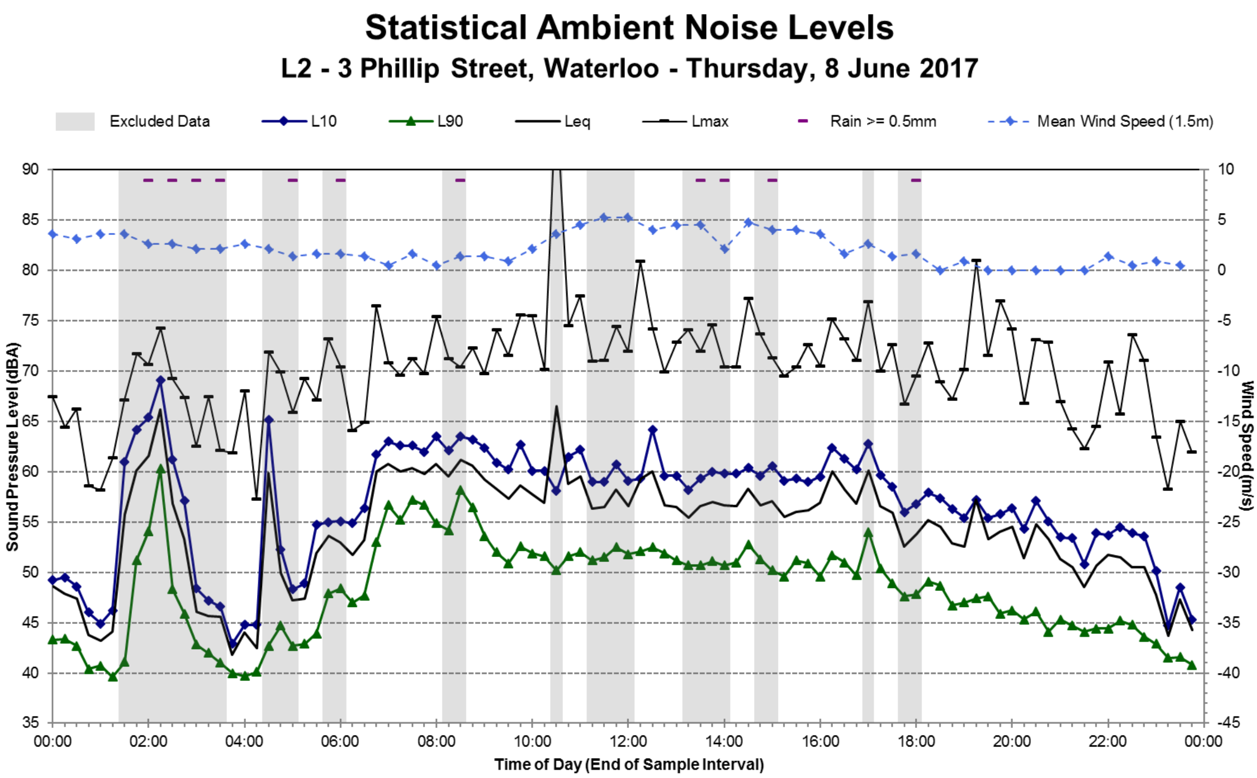


Statistical Ambient Noise Levels
L1 - 1 Phillip Street, Waterloo - Wednesday, 7 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



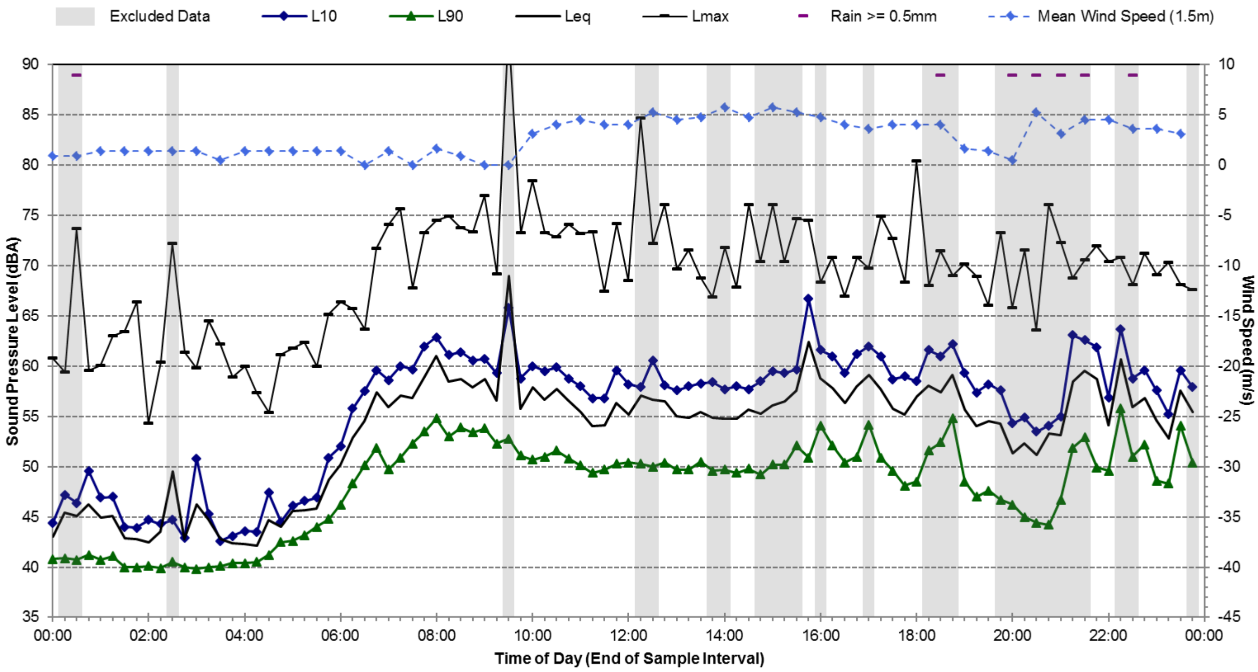
Statistical Ambient Noise Levels
L1 - 1 Phillip Street, Waterloo - Thursday, 8 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L2 - 3 Phillip Street, Waterloo - Wednesday, 7 June 2017
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
L2 - 3 Phillip Street, Waterloo - Thursday, 8 June 2017
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)

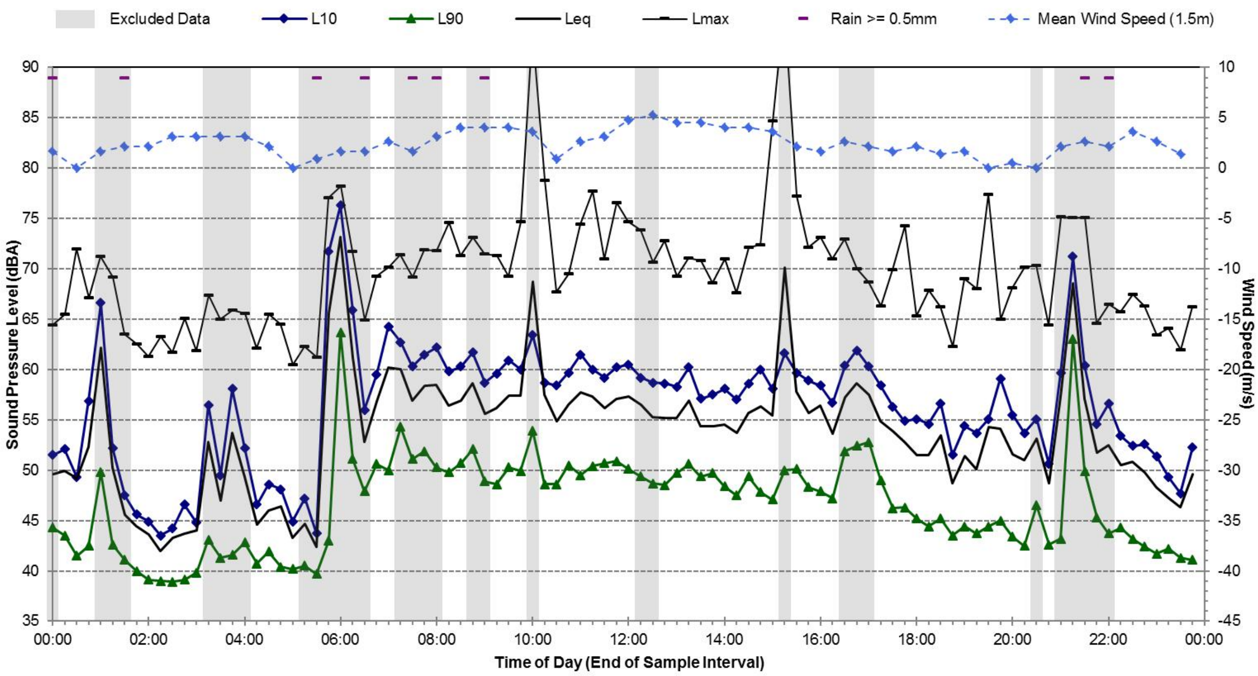
Statistical Ambient Noise Levels

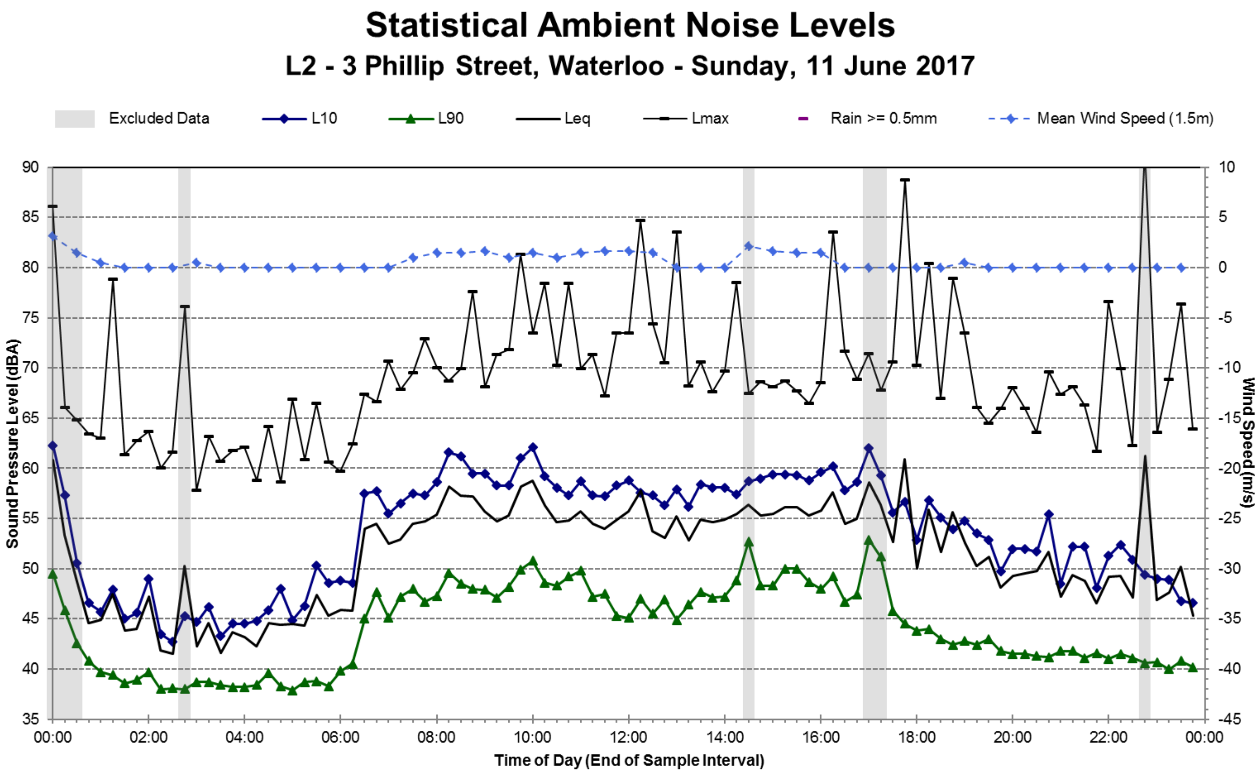
L2 - 3 Phillip Street, Waterloo - Friday, 9 June 2017



Statistical Ambient Noise Levels

L2 - 3 Phillip Street, Waterloo - Saturday, 10 June 2017




Statistical Ambient Noise Levels
L2 - 3 Phillip Street, Waterloo - Sunday, 11 June 2017
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
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
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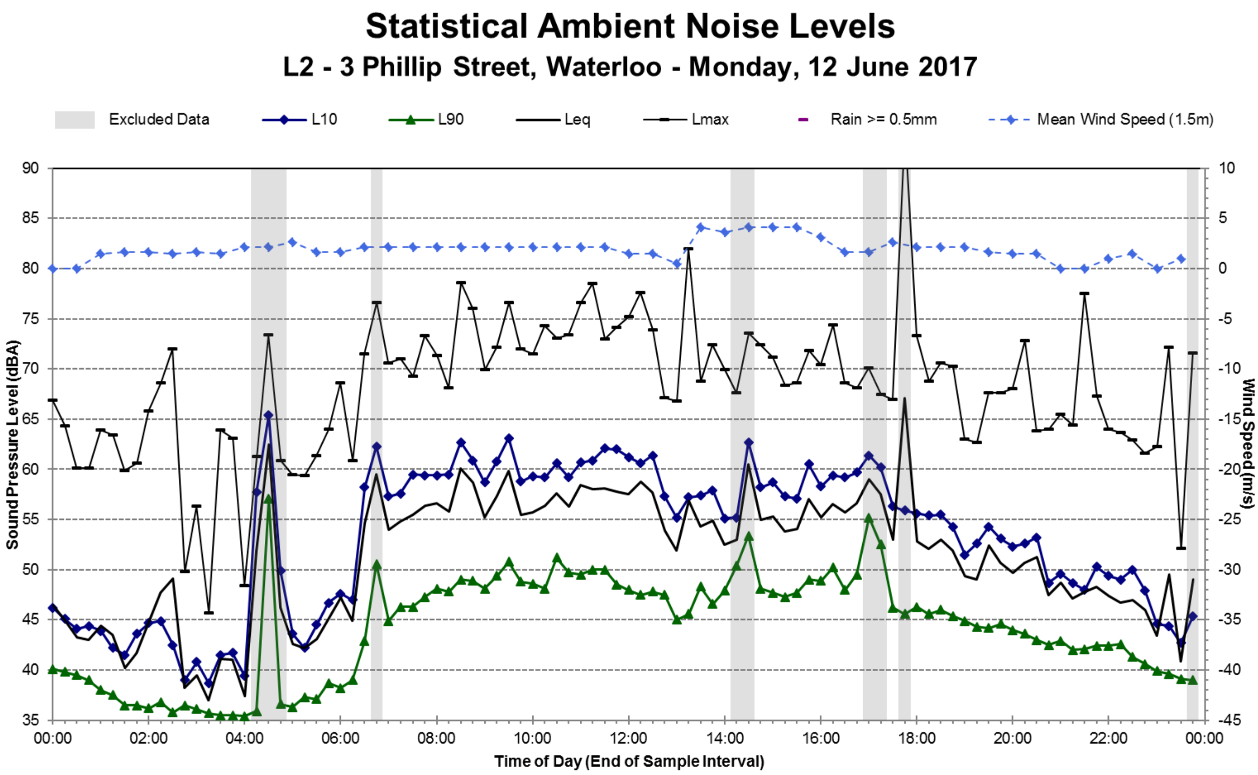
20:00
22:00
00:00


Statistical Ambient Noise Levels
L2 - 3 Phillip Street, Waterloo - Monday, 12 June 2017
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)
90
85
80
75
70
65
60
55
50
45
40
35
10
5
0
-5
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-15
-20
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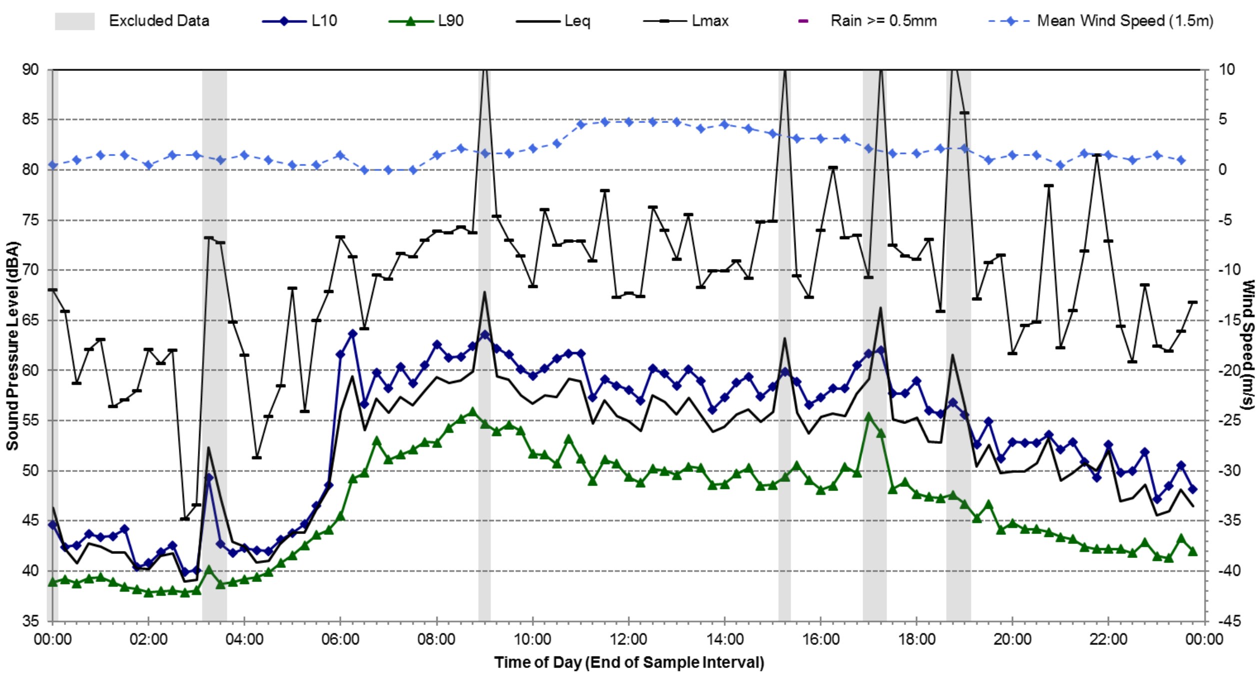
-45
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

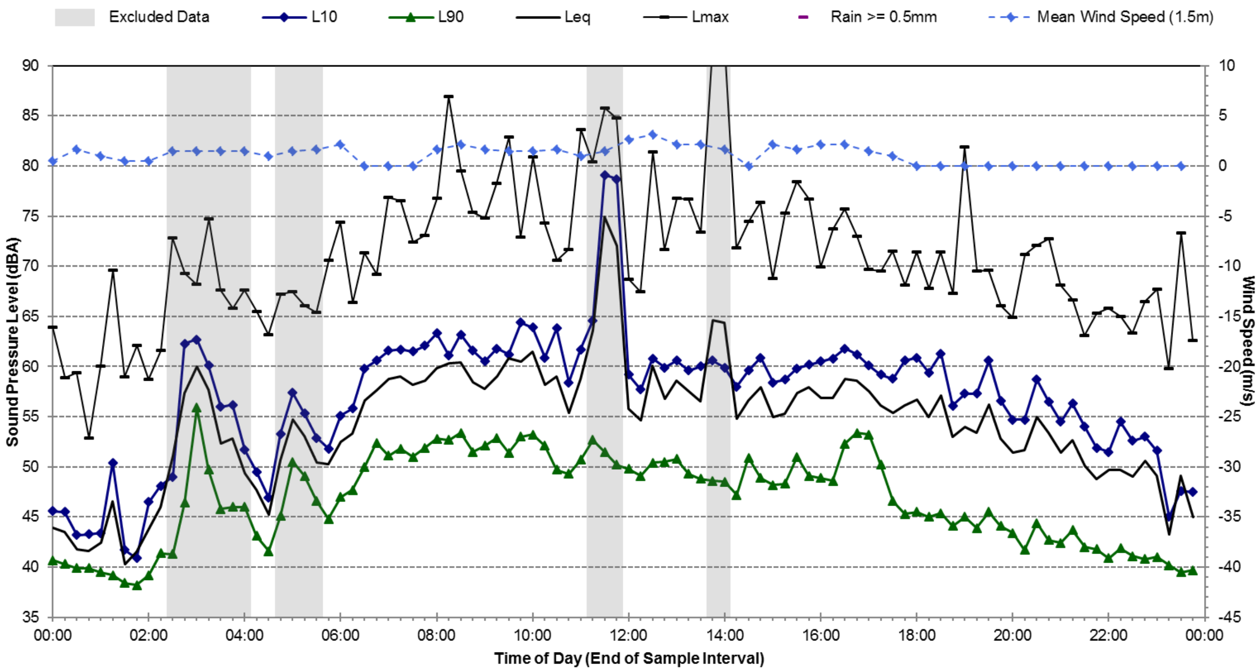
Statistical Ambient Noise Levels

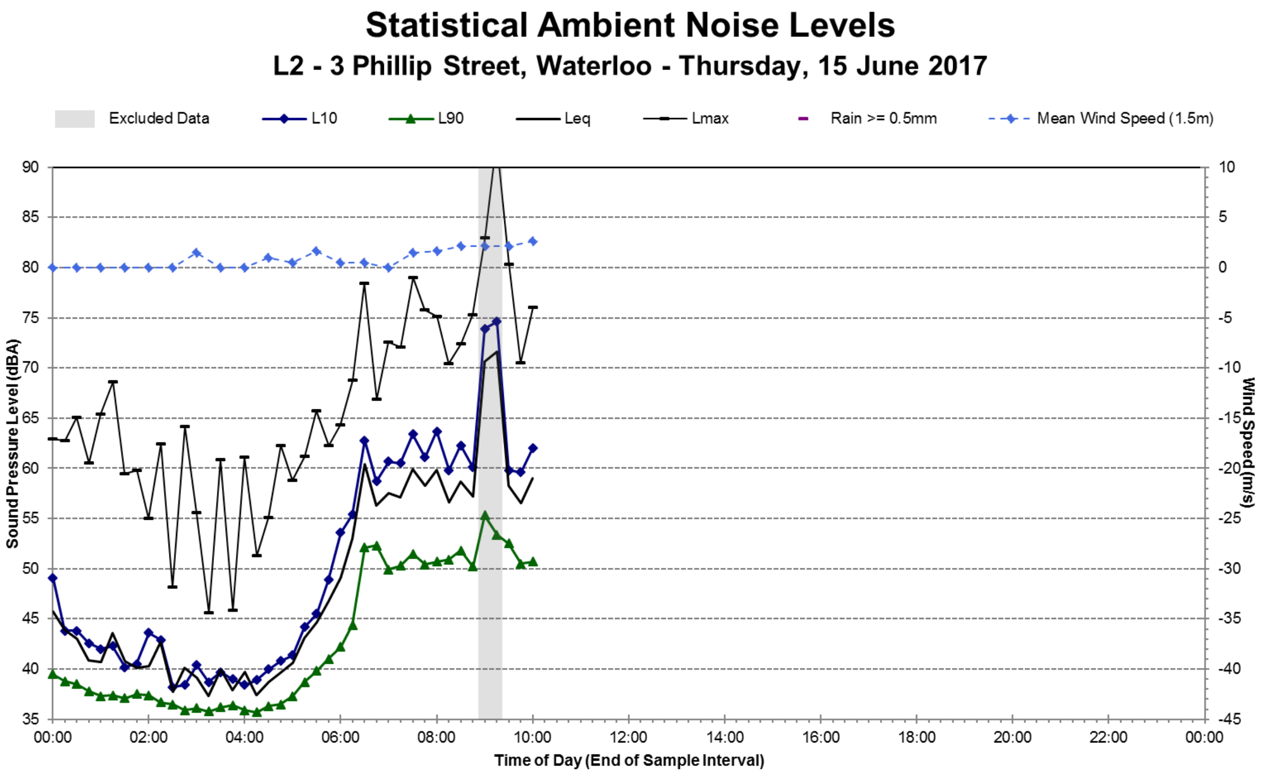
L2 - 3 Phillip Street, Waterloo - Tuesday, 13 June 2017



Statistical Ambient Noise Levels

L2 - 3 Phillip Street, Waterloo - Wednesday, 14 June 2017

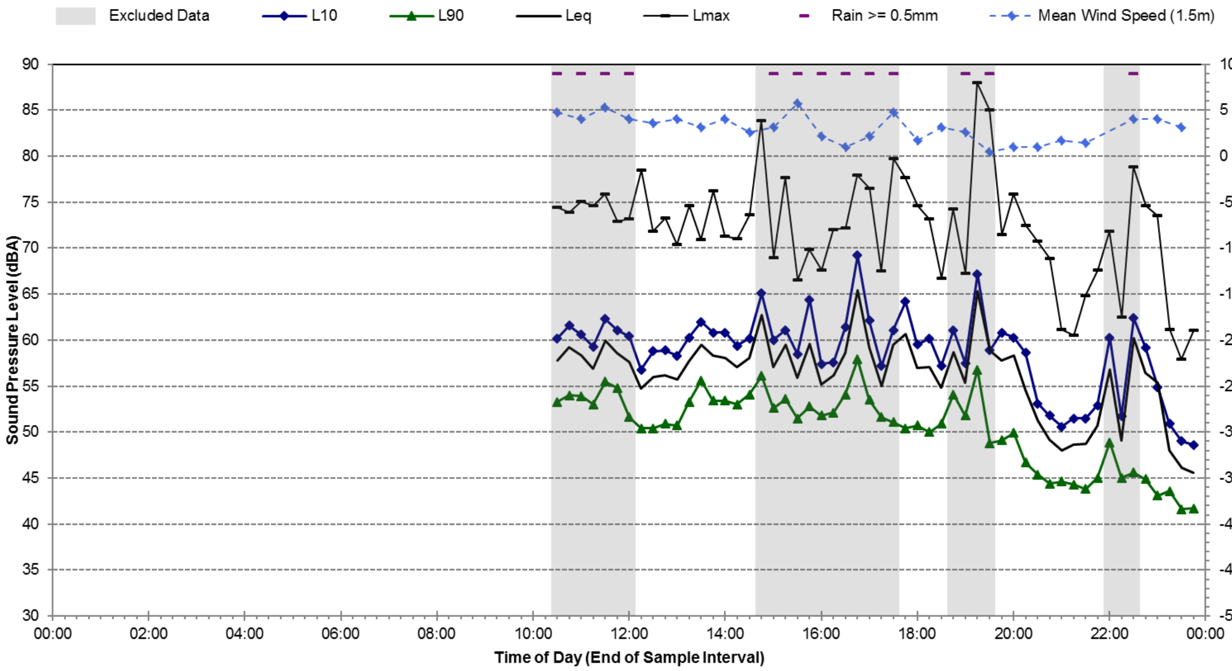




Statistical Ambient Noise Levels
L2 - 3 Phillip Street, Waterloo - Thursday, 15 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

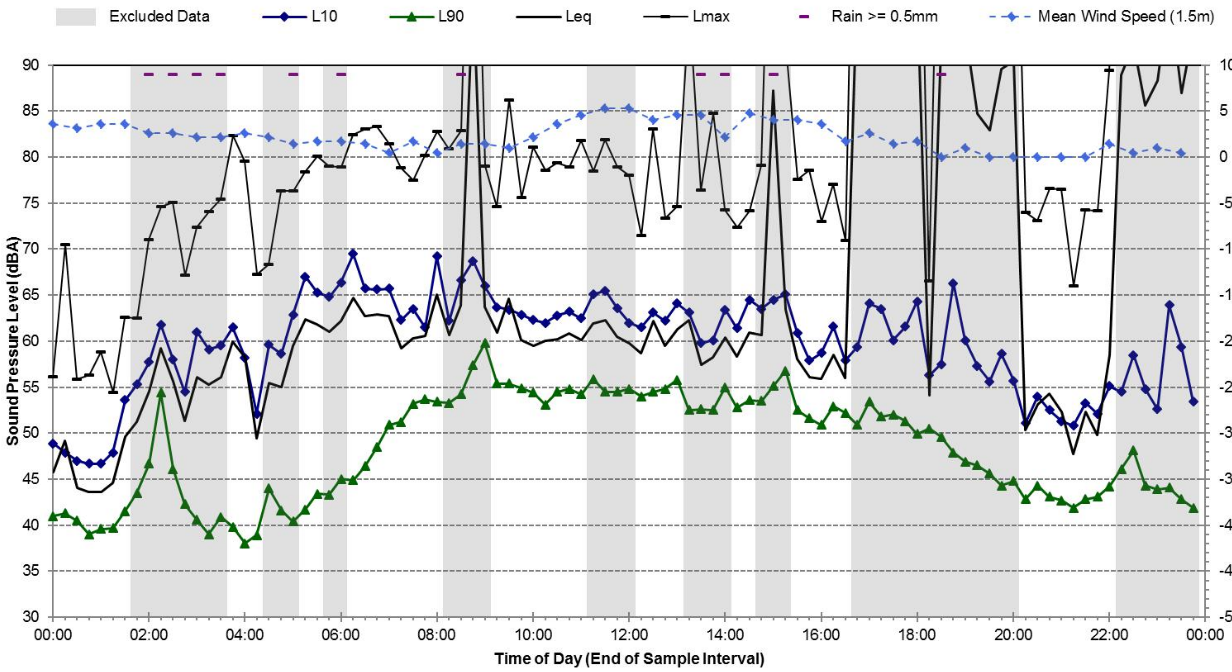
Statistical Ambient Noise Levels

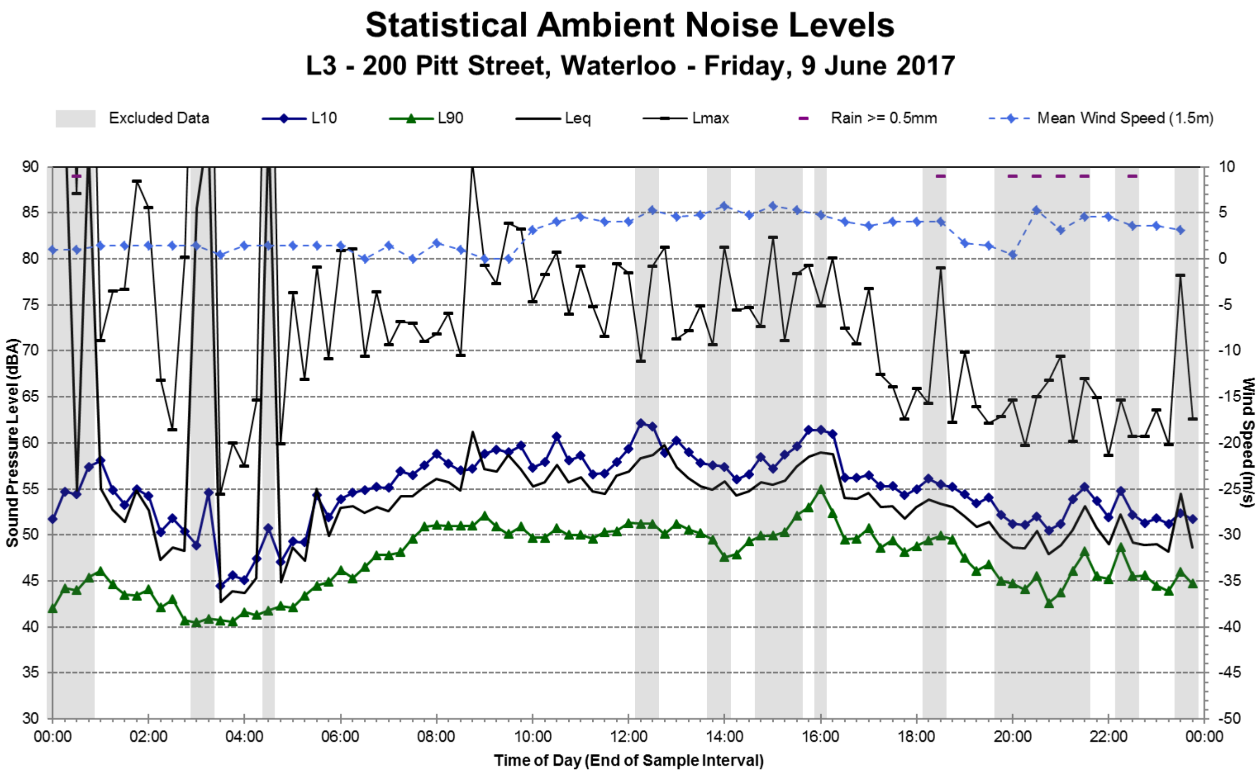
L3 - 200 Pitt Street, Waterloo - Wednesday, 7 June 2017



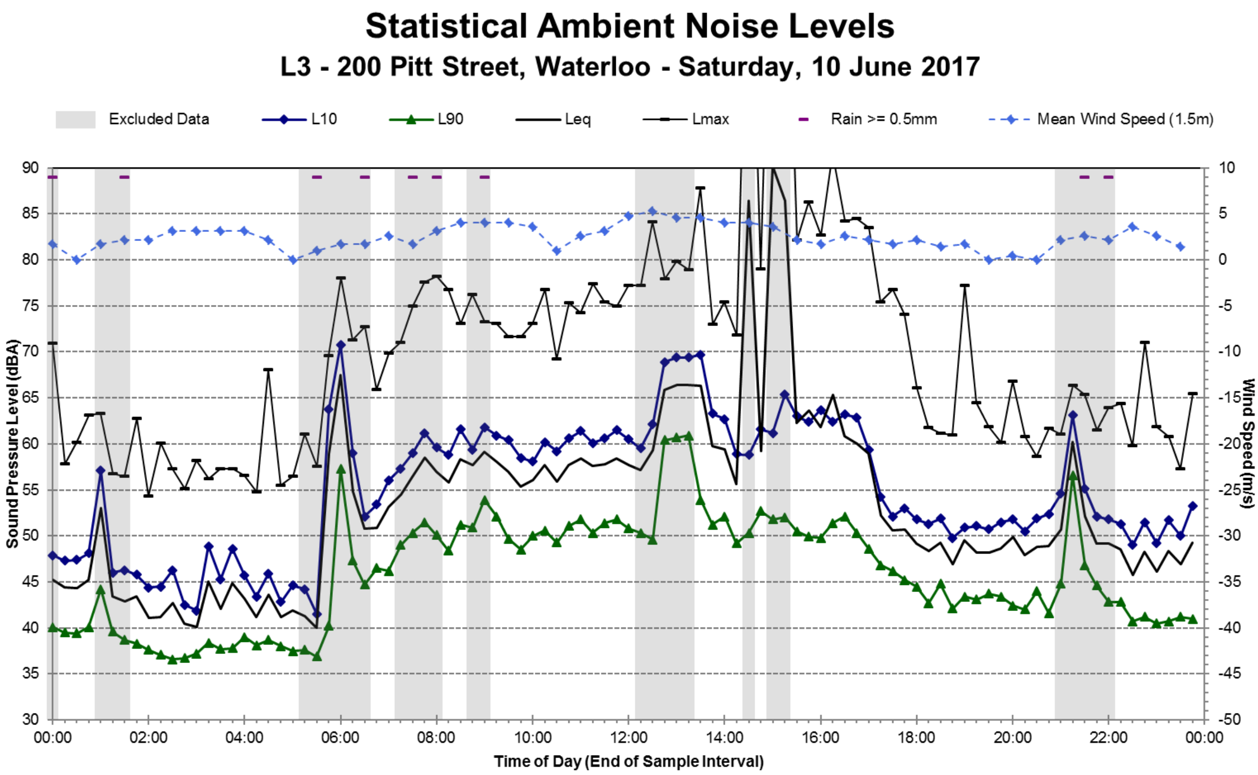
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Thursday, 8 June 2017





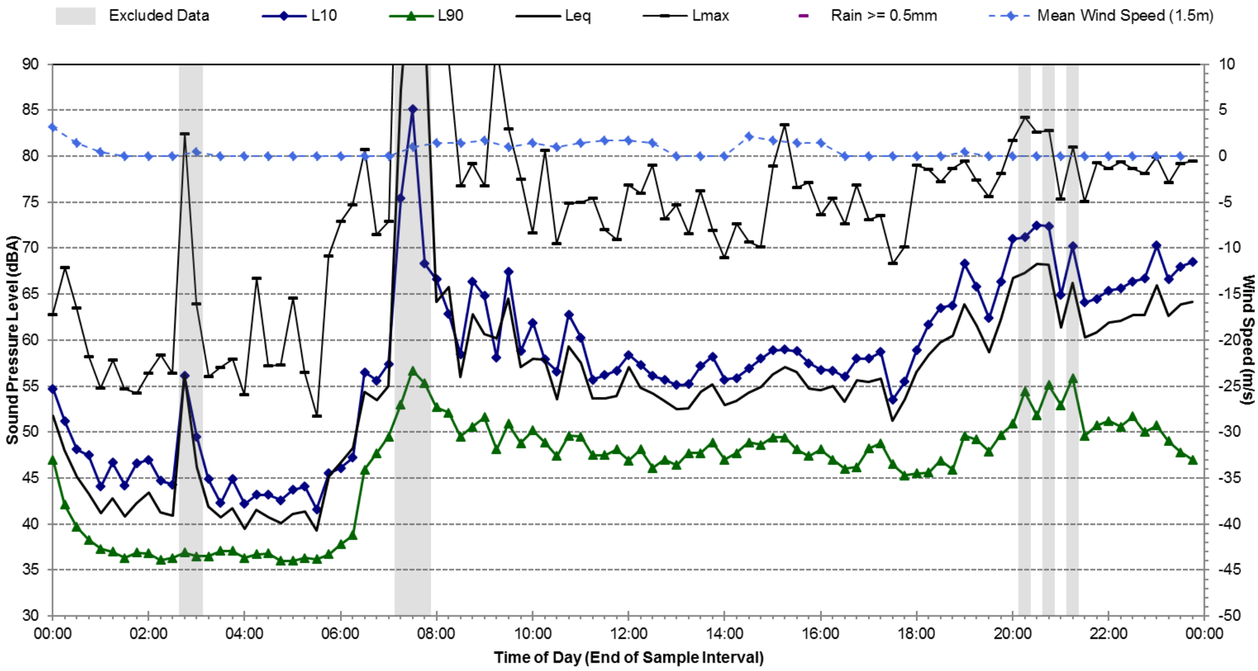
Statistical Ambient Noise Levels
L3 - 200 Pitt Street, Waterloo - Friday, 9 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
L3 - 200 Pitt Street, Waterloo - Saturday, 10 June 2017
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)

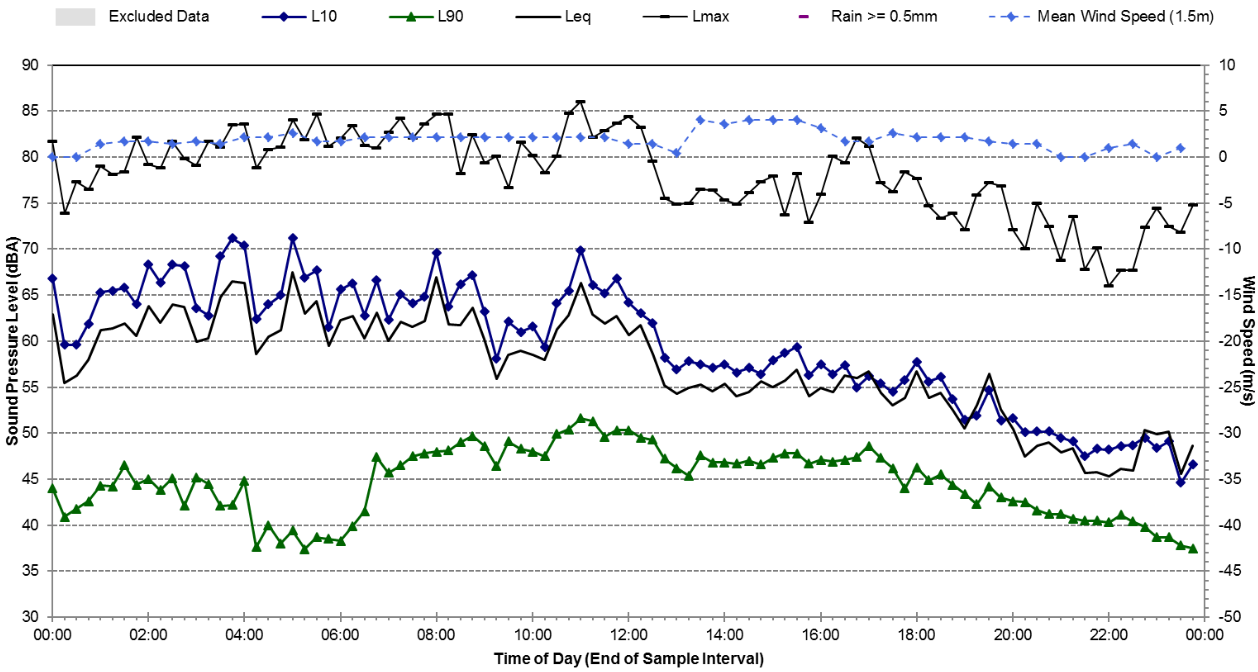
Statistical Ambient Noise Levels

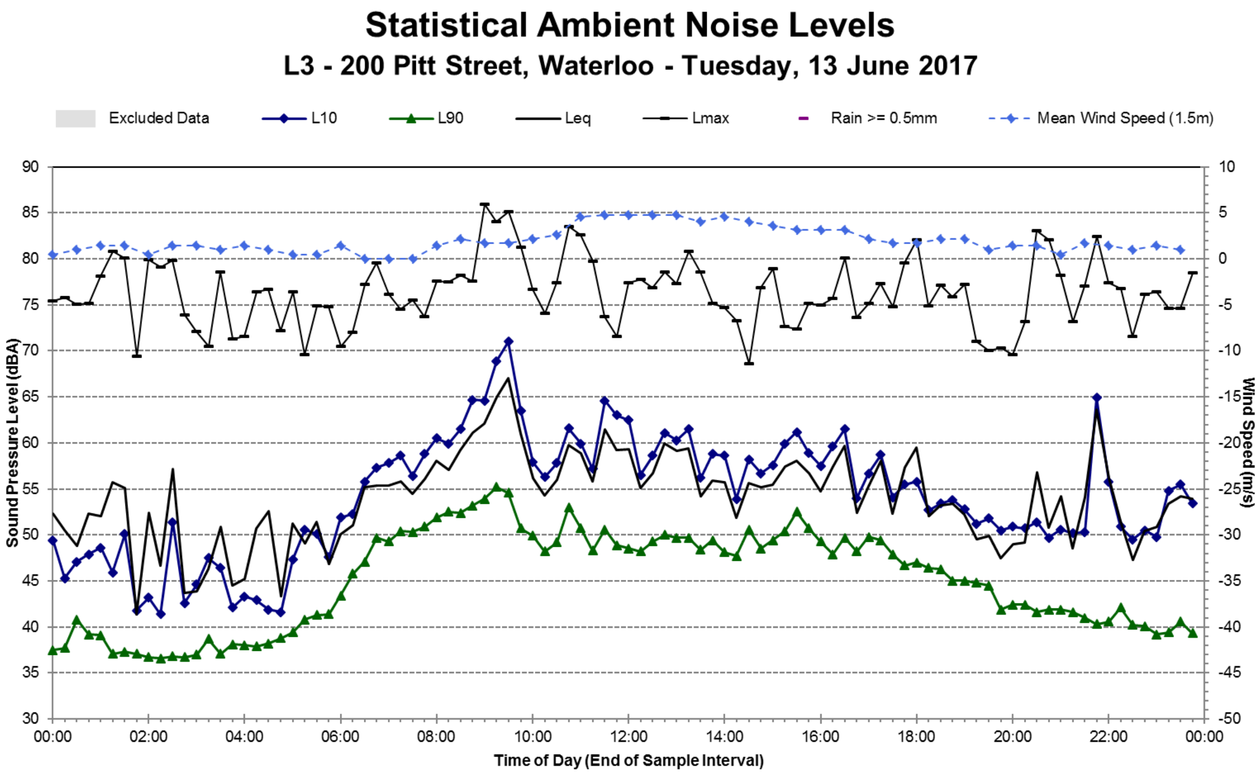
L3 - 200 Pitt Street, Waterloo - Sunday, 11 June 2017

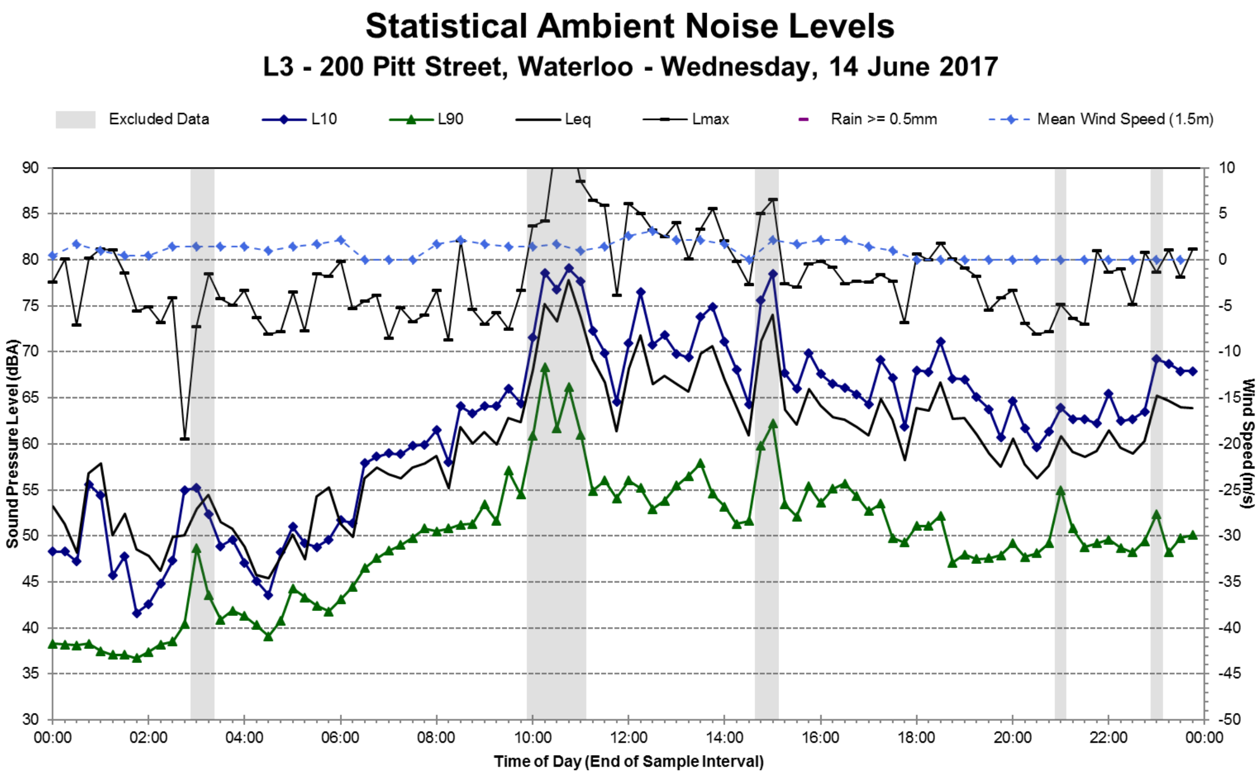


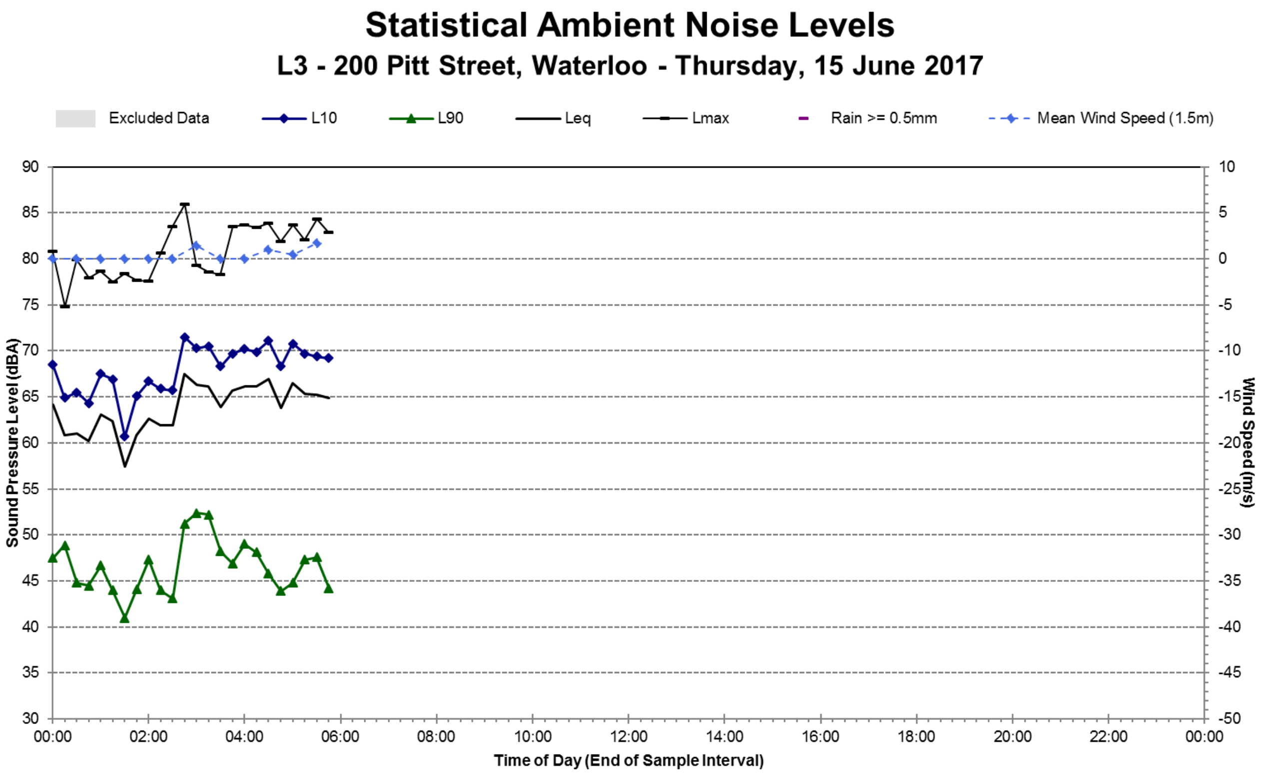
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Monday, 12 June 2017




Statistical Ambient Noise Levels
L3 - 200 Pitt Street, Waterloo - Tuesday, 13 June 2017
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
L3 - 200 Pitt Street, Waterloo - Wednesday, 14 June 2017
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
L3 - 200 Pitt Street, Waterloo - Thursday, 15 June 2017
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
10
5
0
-5
-10
-15
-20
-25
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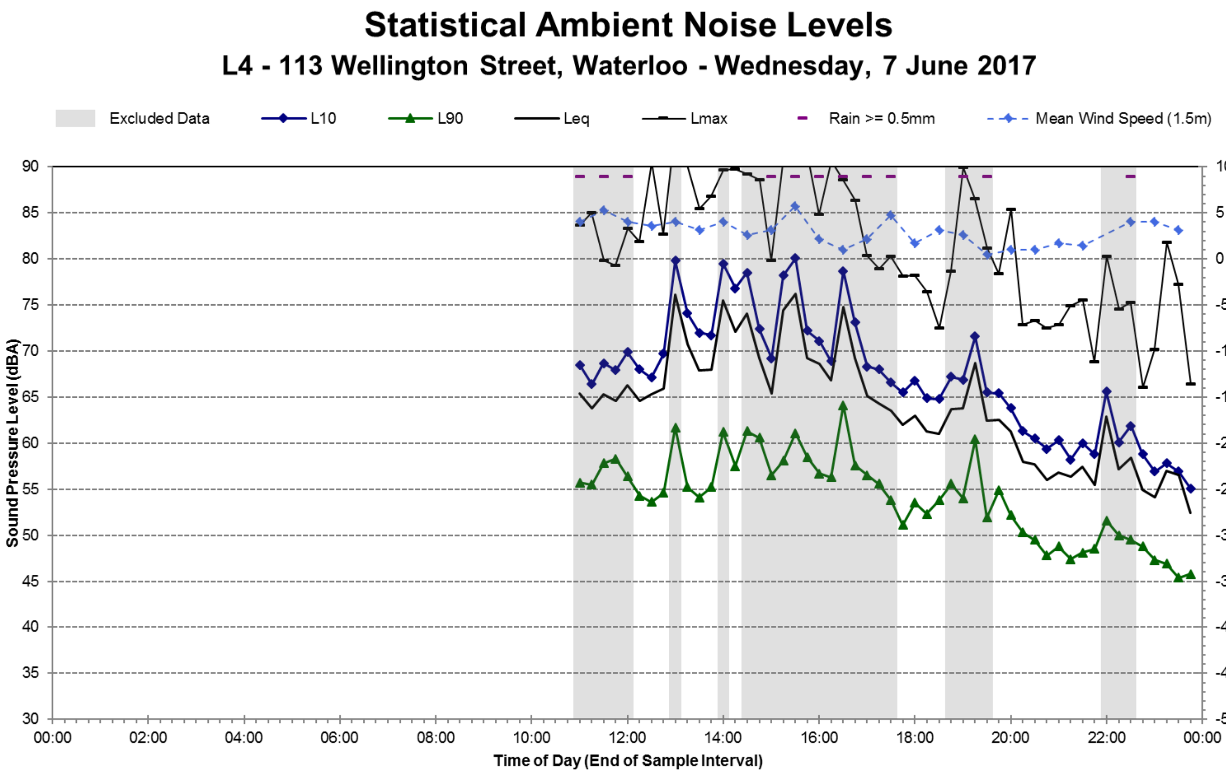
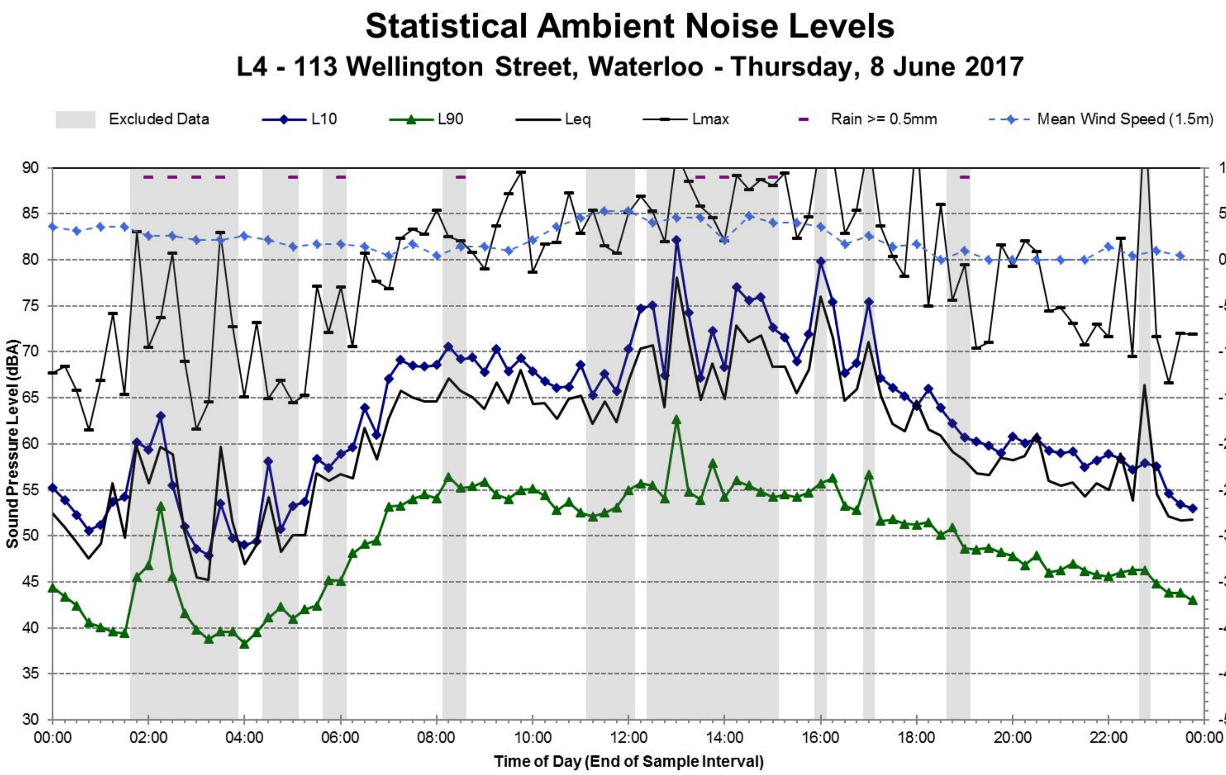
16:00
18:00
20:00
22:00
00:00



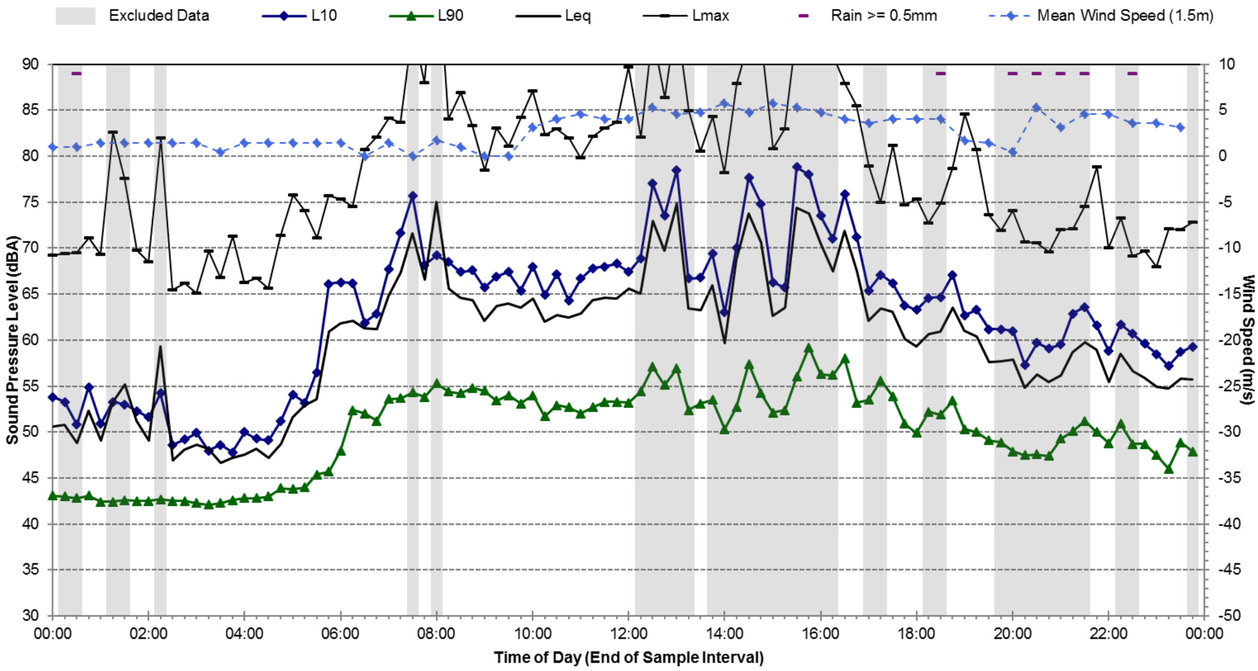
Statistical Ambient Noise Levels
L4 - 113 Wellington Street, Waterloo - Wednesday, 7 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
L4 - 113 Wellington Street, Waterloo - Thursday, 8 June 2017
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)

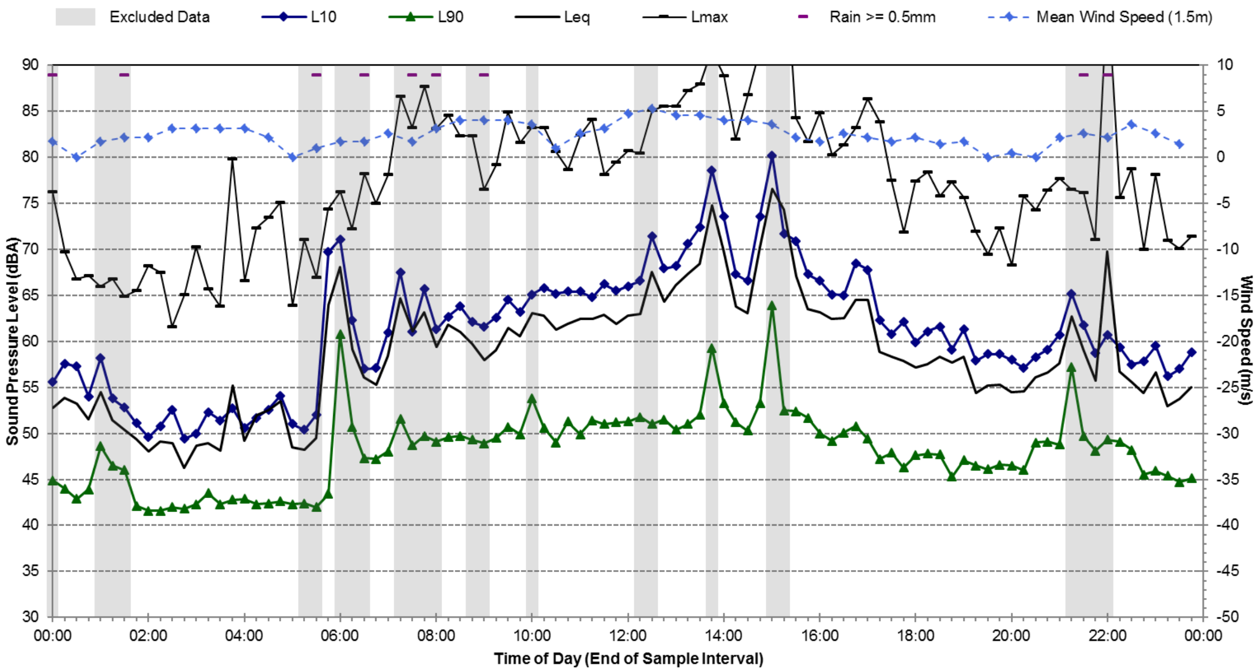
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Friday, 9 June 2017



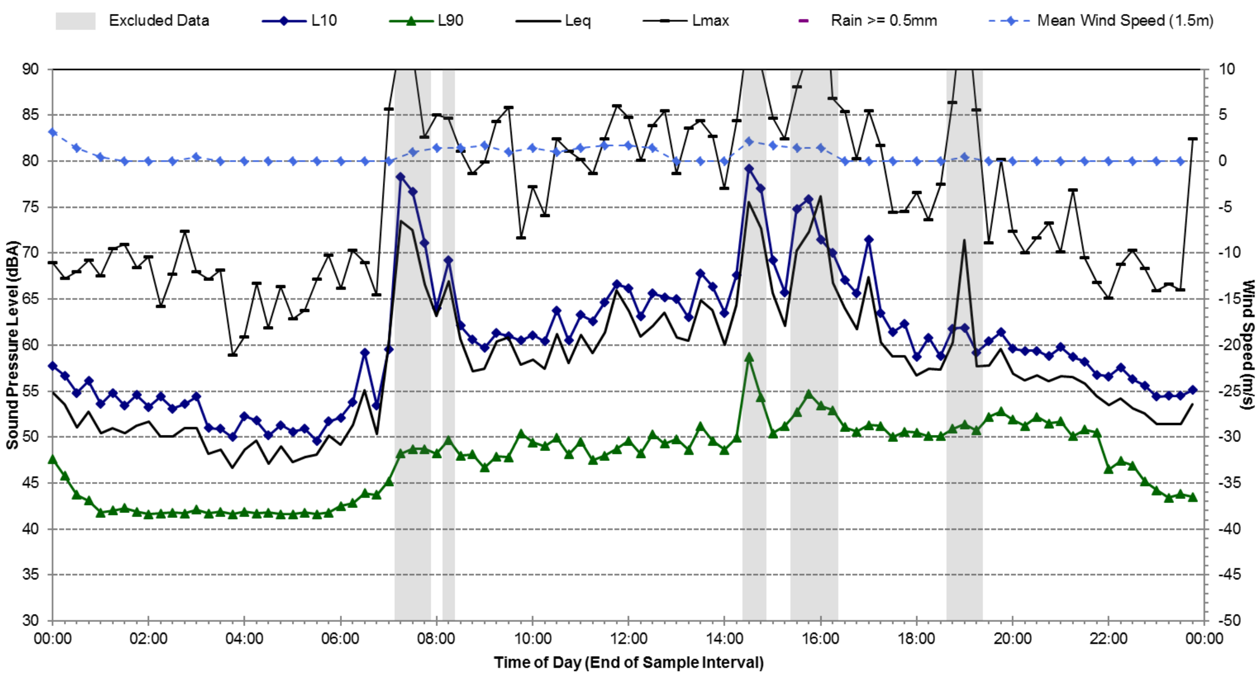
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Saturday, 10 June 2017



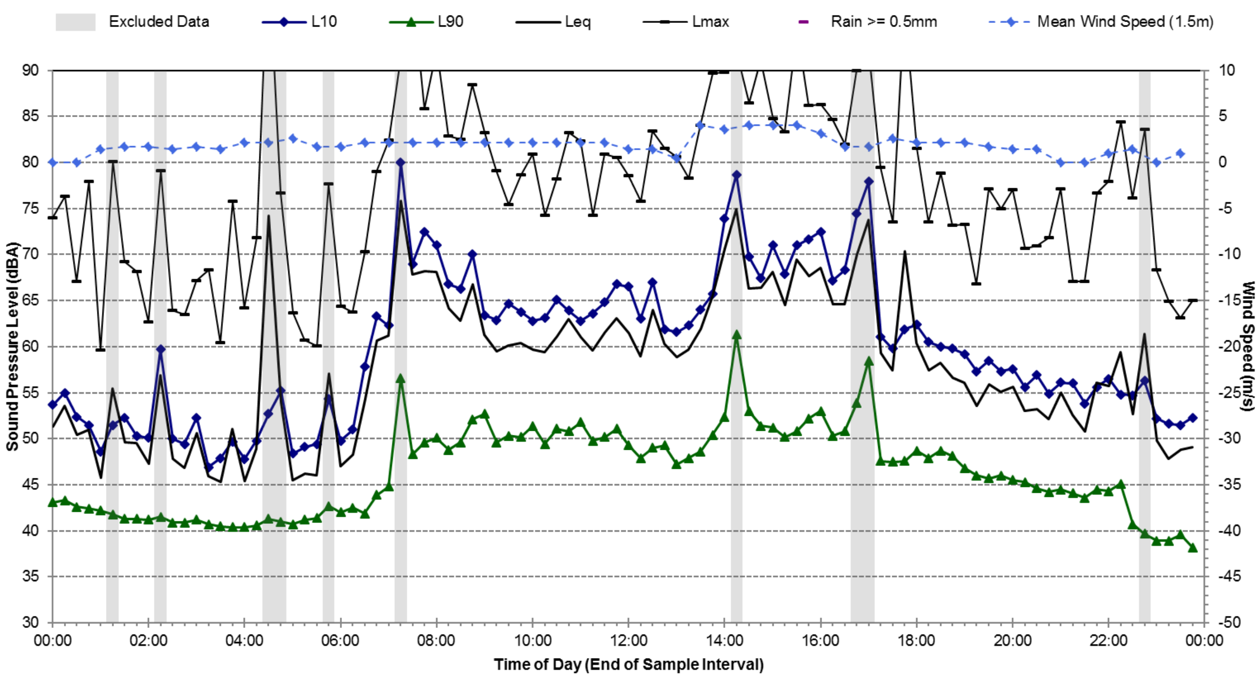
Statistical Ambient Noise Levels

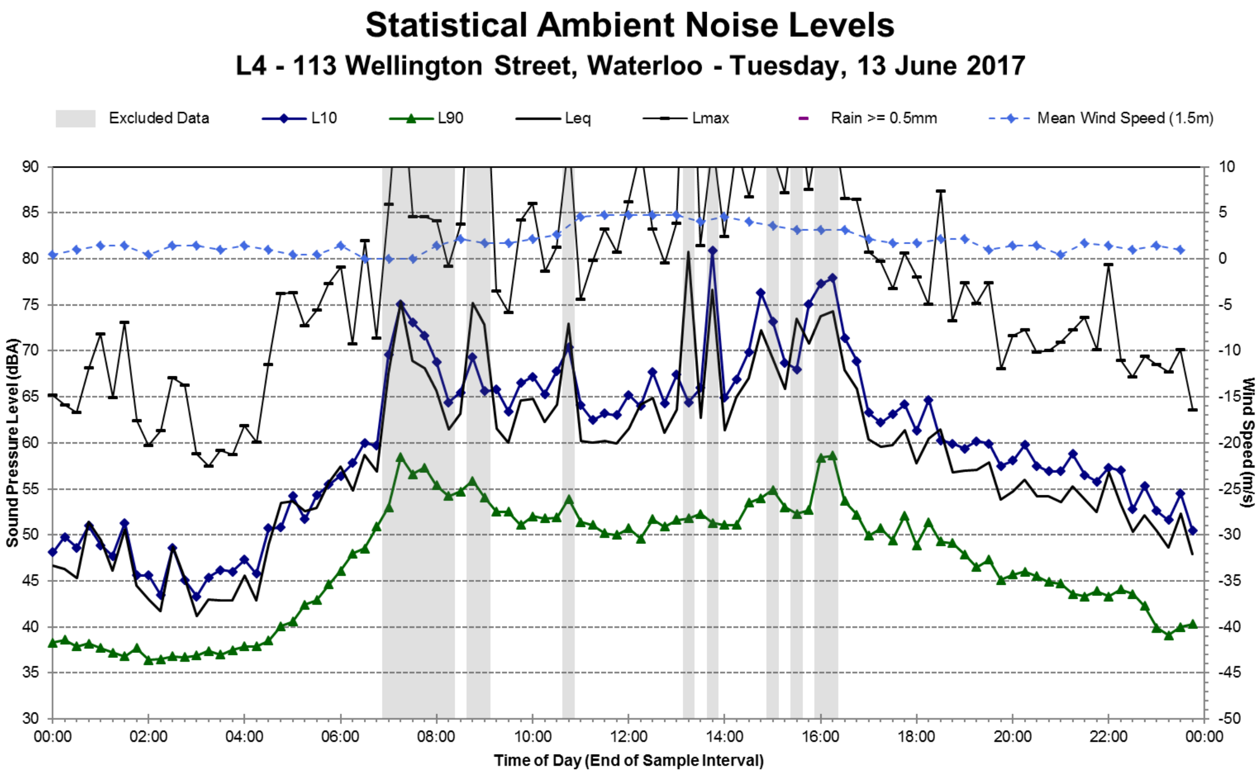
L4 - 113 Wellington Street, Waterloo - Sunday, 11 June 2017

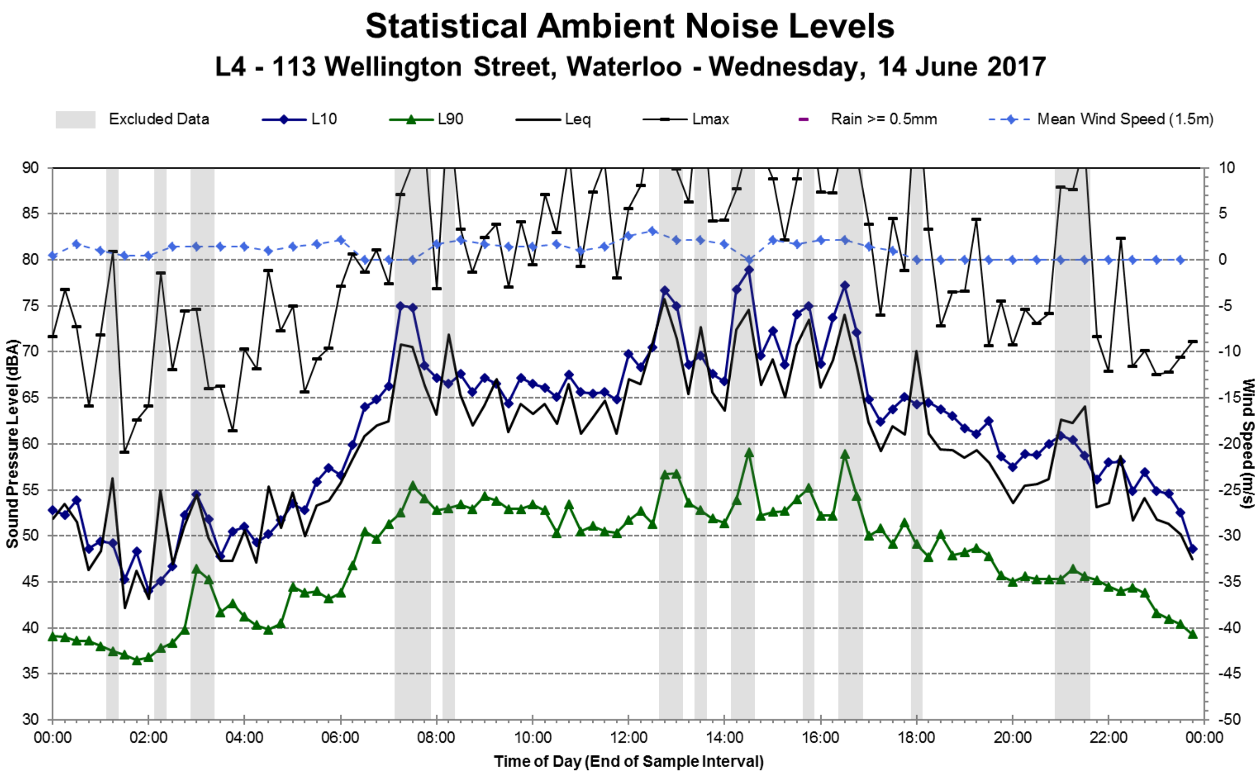


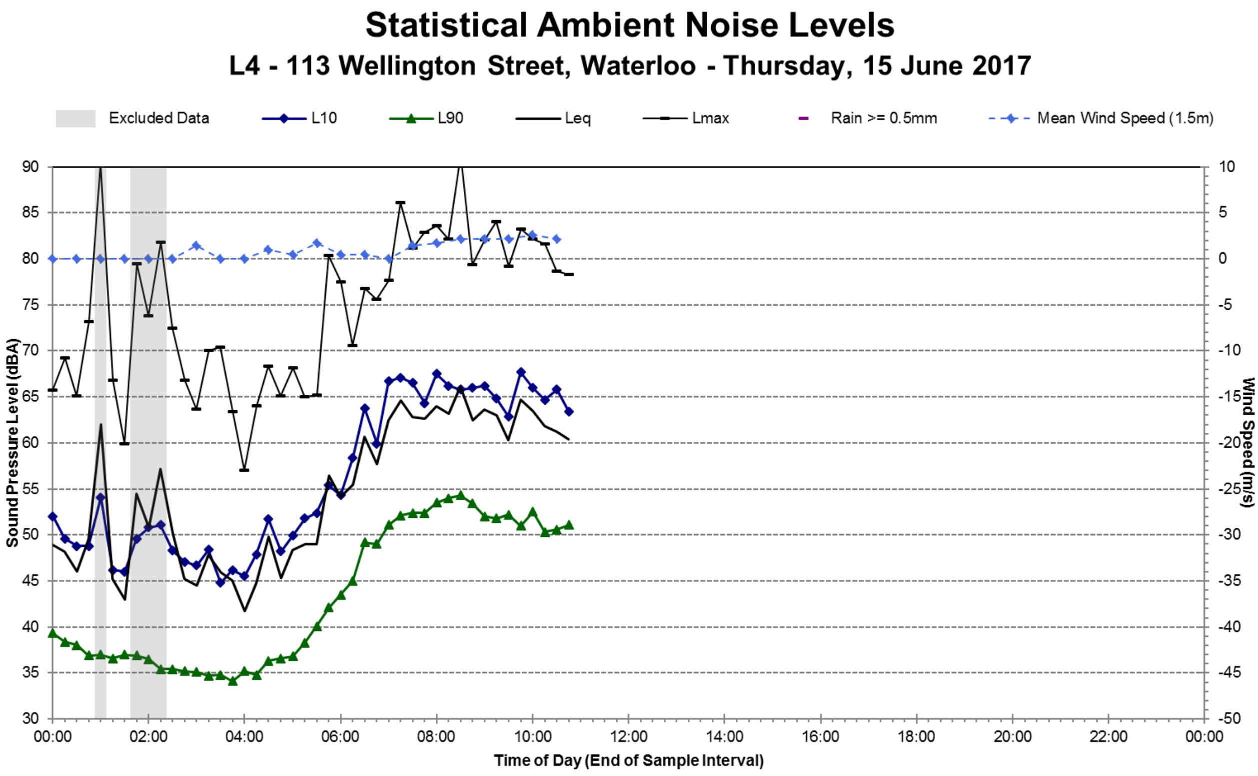
Statistical Ambient Noise Levels

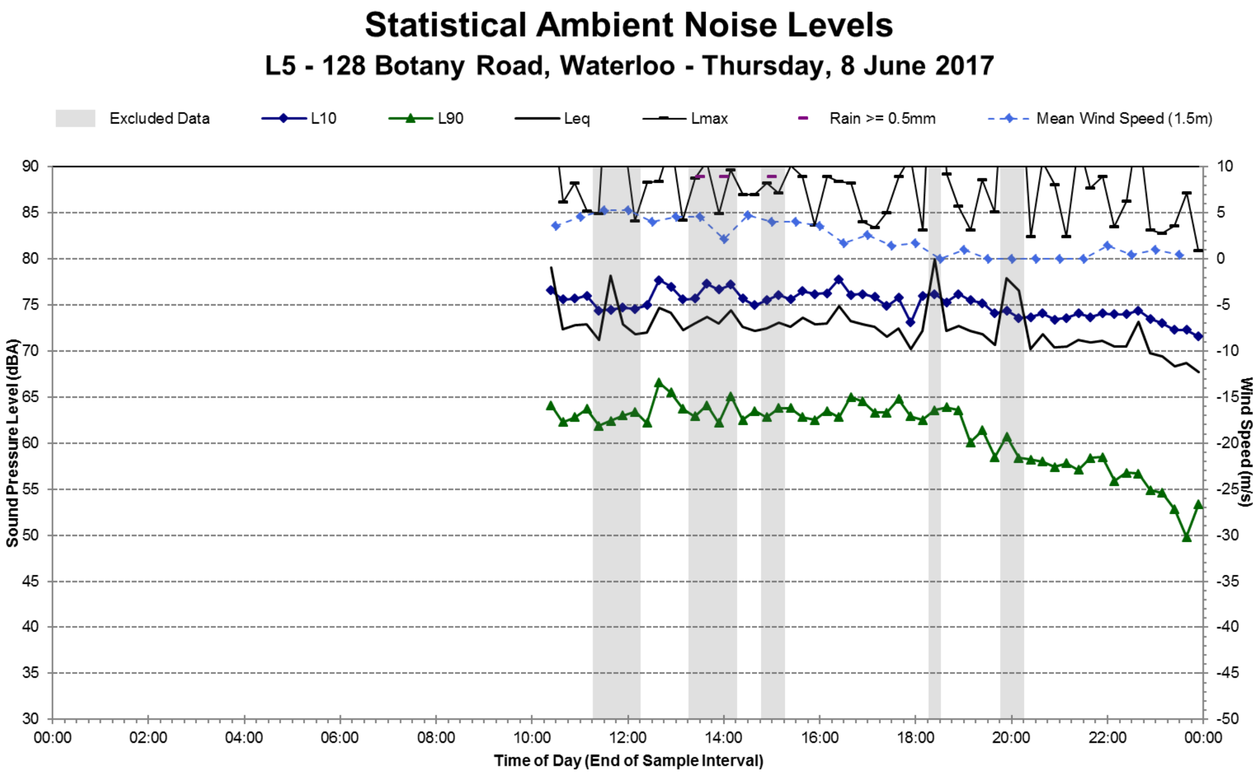
L4 - 113 Wellington Street, Waterloo - Monday, 12 June 2017

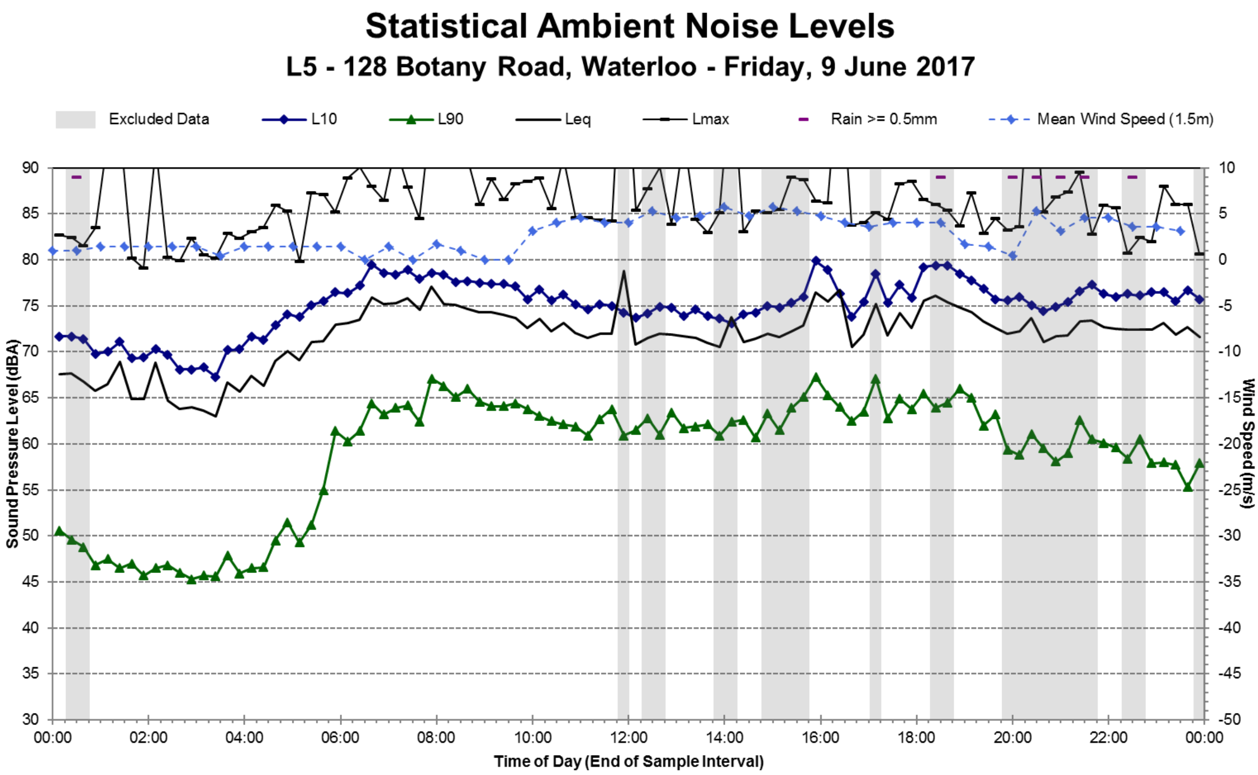


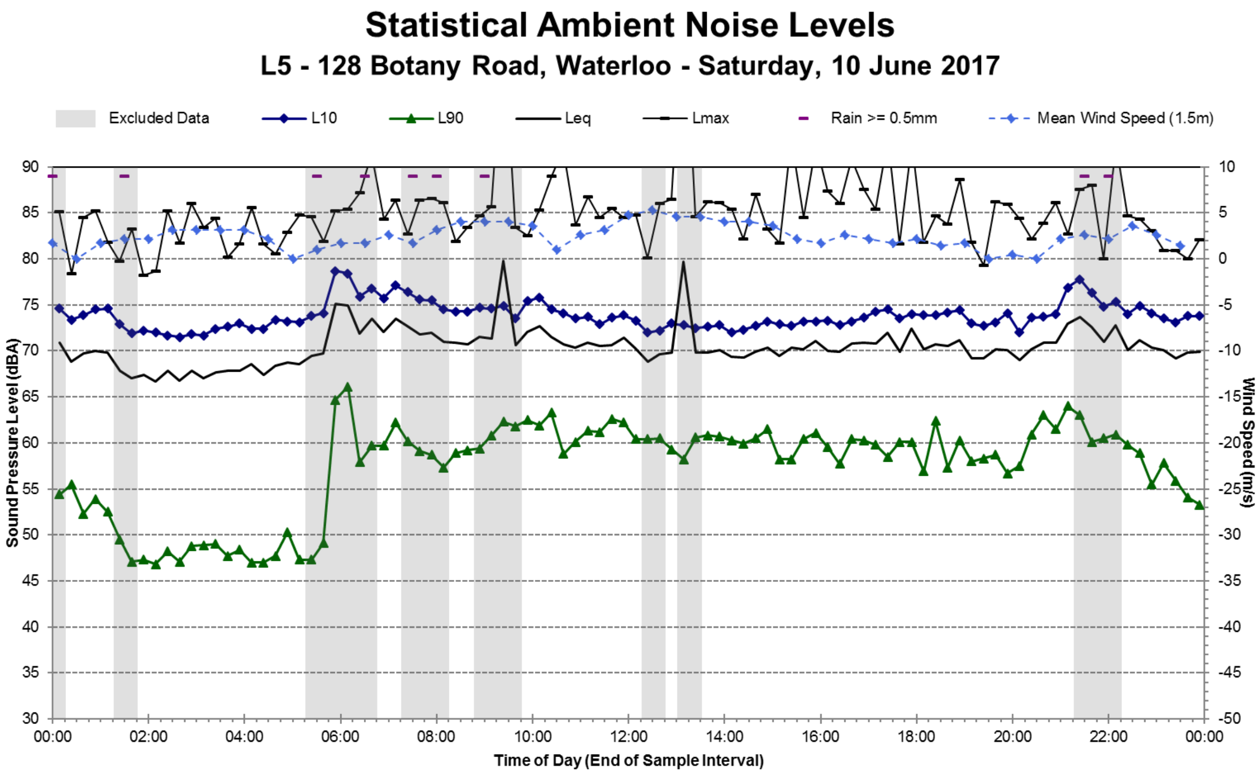

Statistical Ambient Noise Levels
L4 - 113 Wellington Street, Waterloo - Tuesday, 13 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L4 - 113 Wellington Street, Waterloo - Wednesday, 14 June 2017
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
L4 - 113 Wellington Street, Waterloo - Thursday, 15 June 2017
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
L5 - 128 Botany Road, Waterloo - Thursday, 8 June 2017
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
L5 - 128 Botany Road, Waterloo - Friday, 9 June 2017
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
L5 - 128 Botany Road, Waterloo - Saturday, 10 June 2017
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
10
5
0
-5
-10
-15
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-25
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22:00
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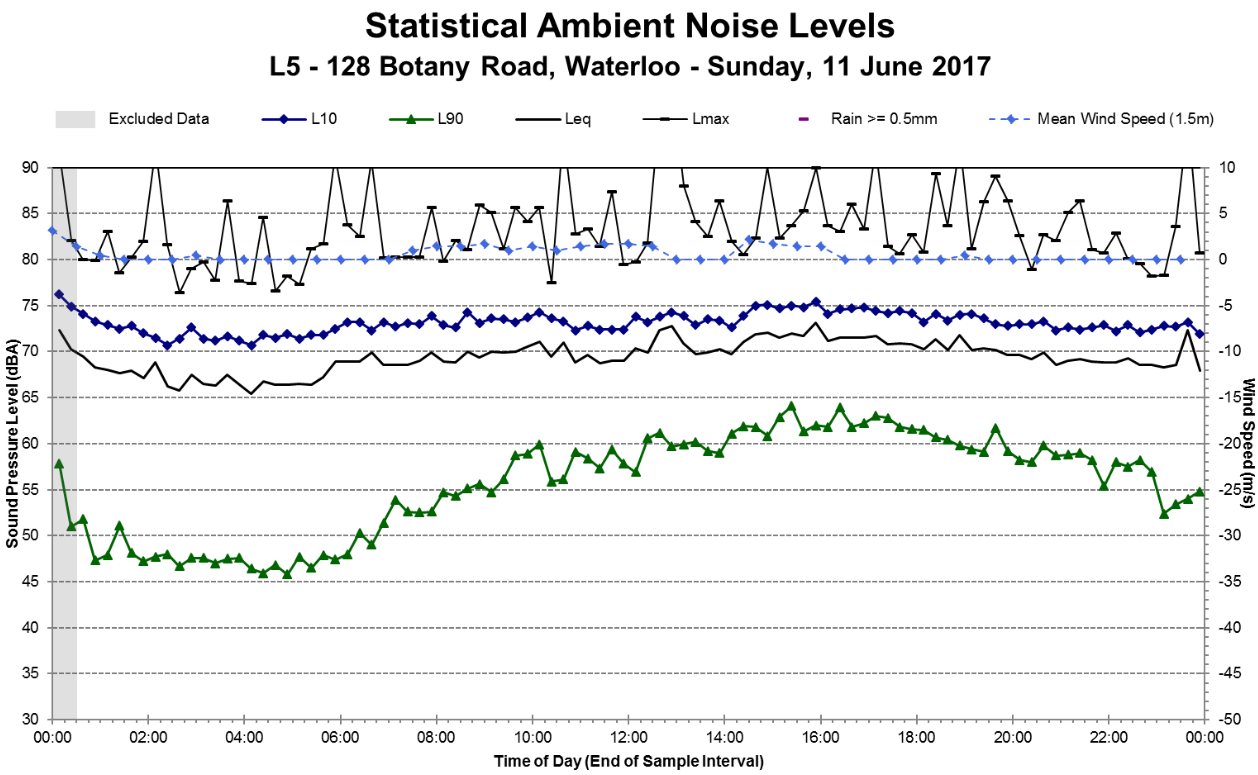
Statistical Ambient Noise Levels
L5 - 128 Botany Road, Waterloo - Sunday, 11 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
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16:00
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20:00
22:00
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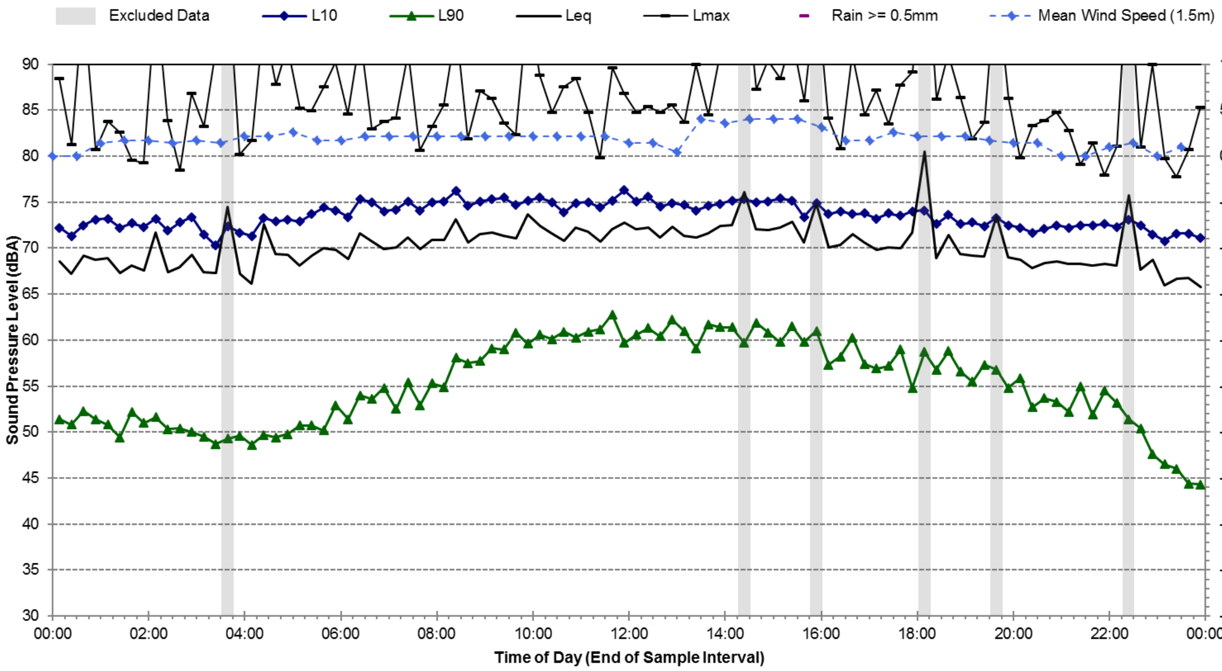
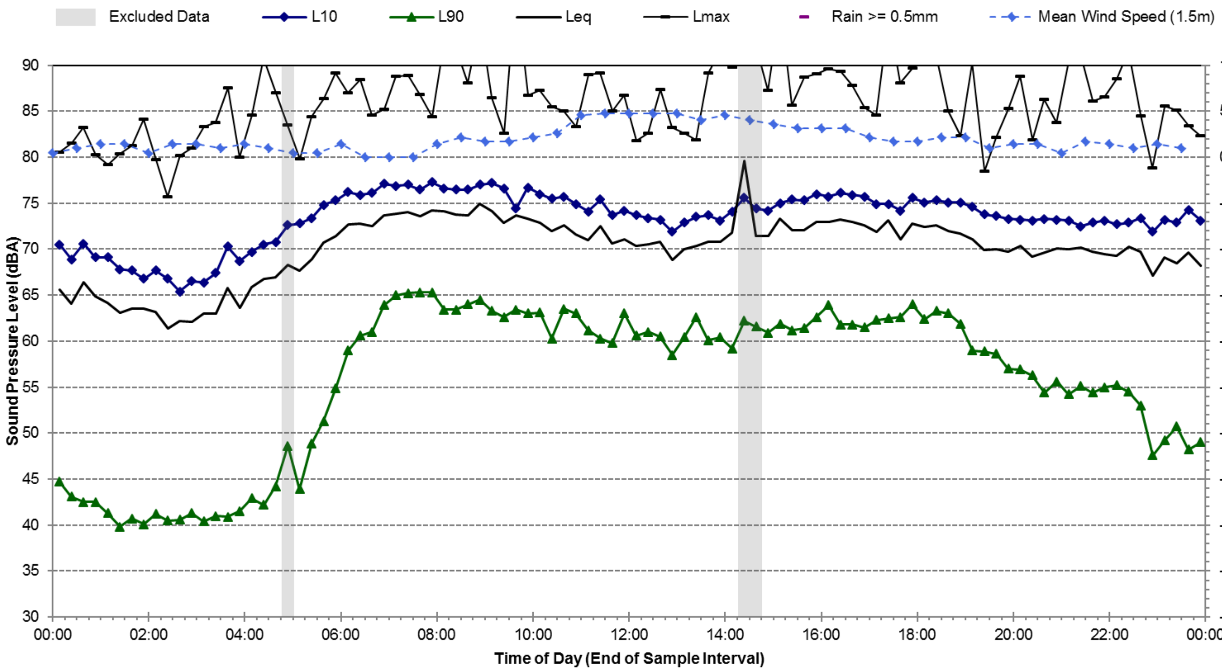
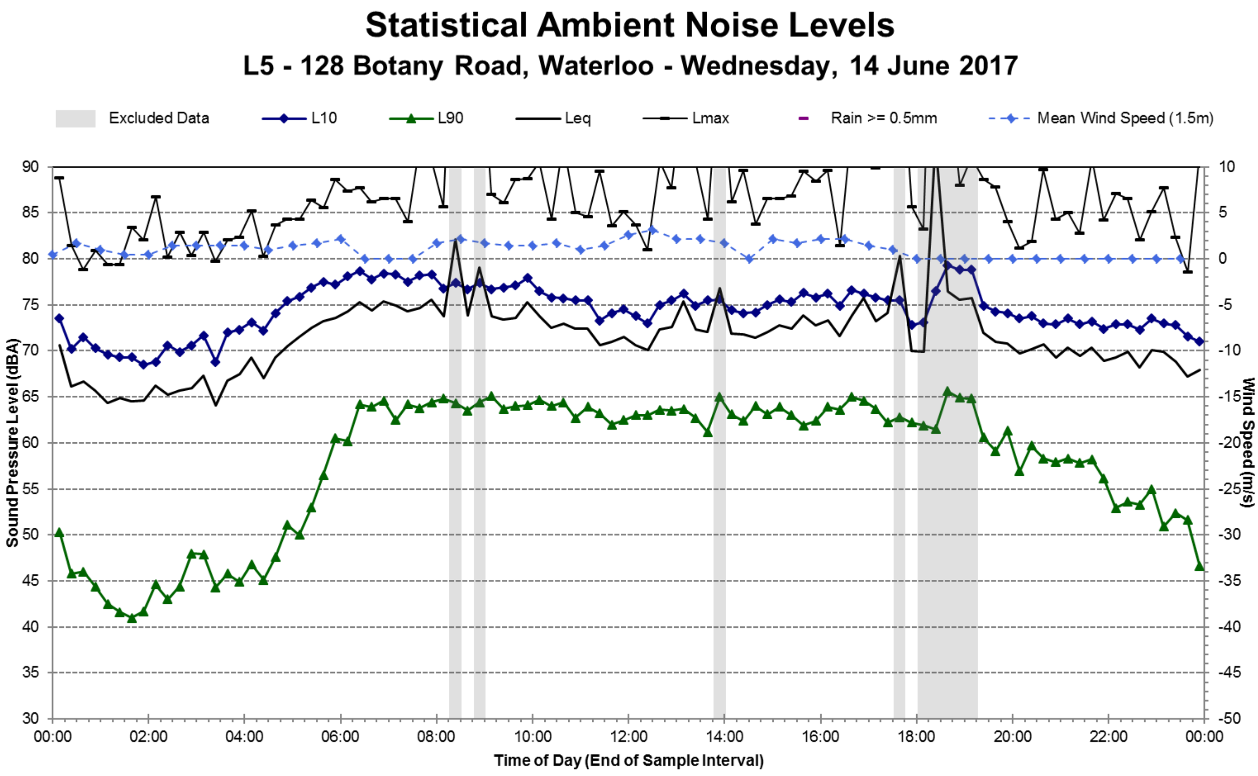
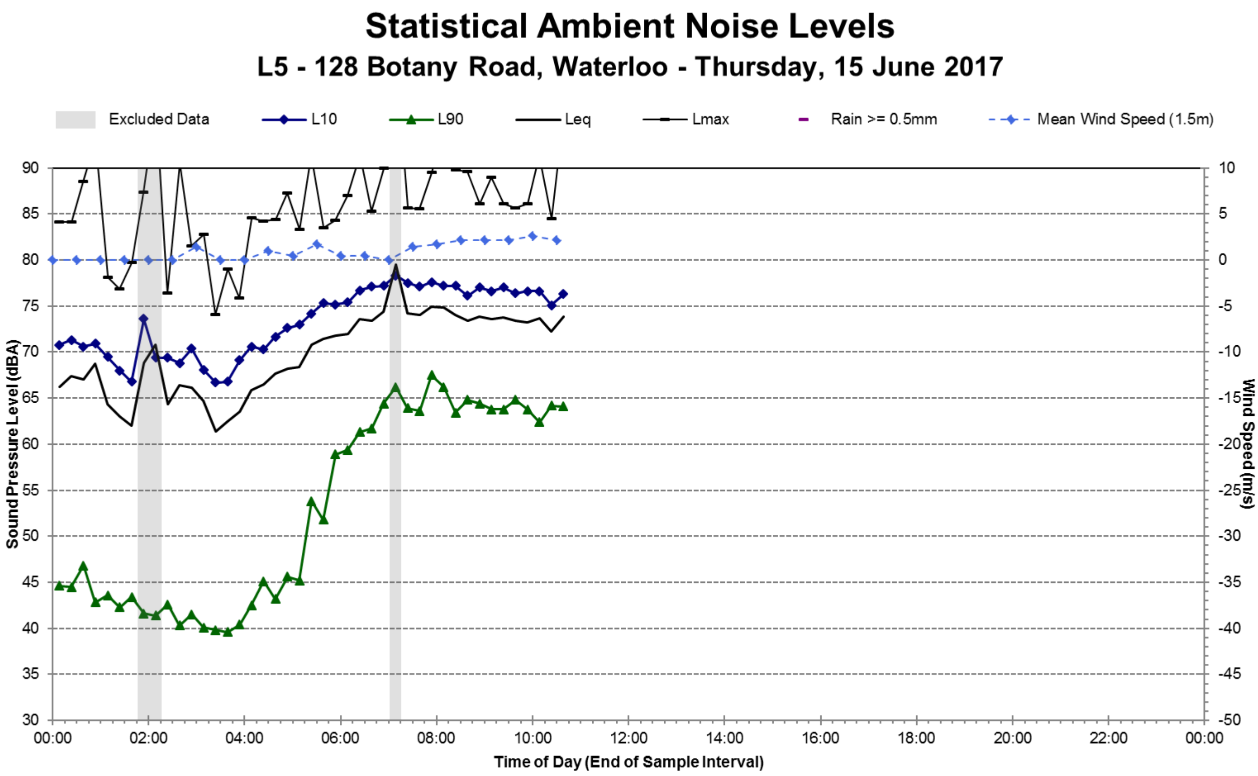
Statistical Ambient Noise Levels
L5 - 128 Botany Road, Waterloo - Monday, 12 June 2017



Statistical Ambient Noise Levels
L5 - 128 Botany Road, Waterloo - Tuesday, 13 June 2017



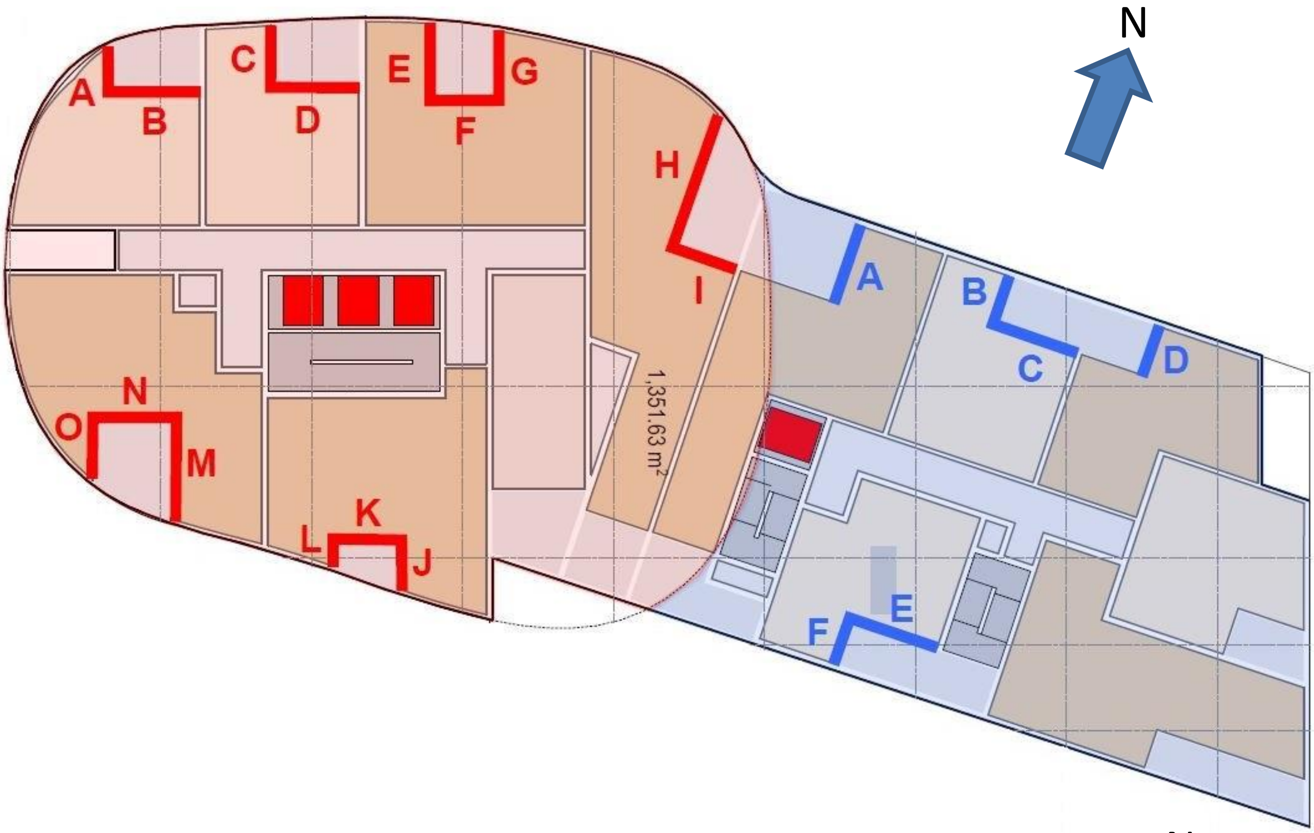

Statistical Ambient Noise Levels
L5 - 128 Botany Road, Waterloo - Wednesday, 14 June 2017
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L5 - 128 Botany Road, Waterloo - Thursday, 15 June 2017
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)

APPENDIX C

Noise Ingress Predictions

Figure 12   Facade IDs – Building 1 (B01) and Building 2 (B02)



Note 1: Building 1 (B01) shown in red and Building 2 (B02) shown in blue.

Figure 13   Facade IDs – Building 3 (B03)

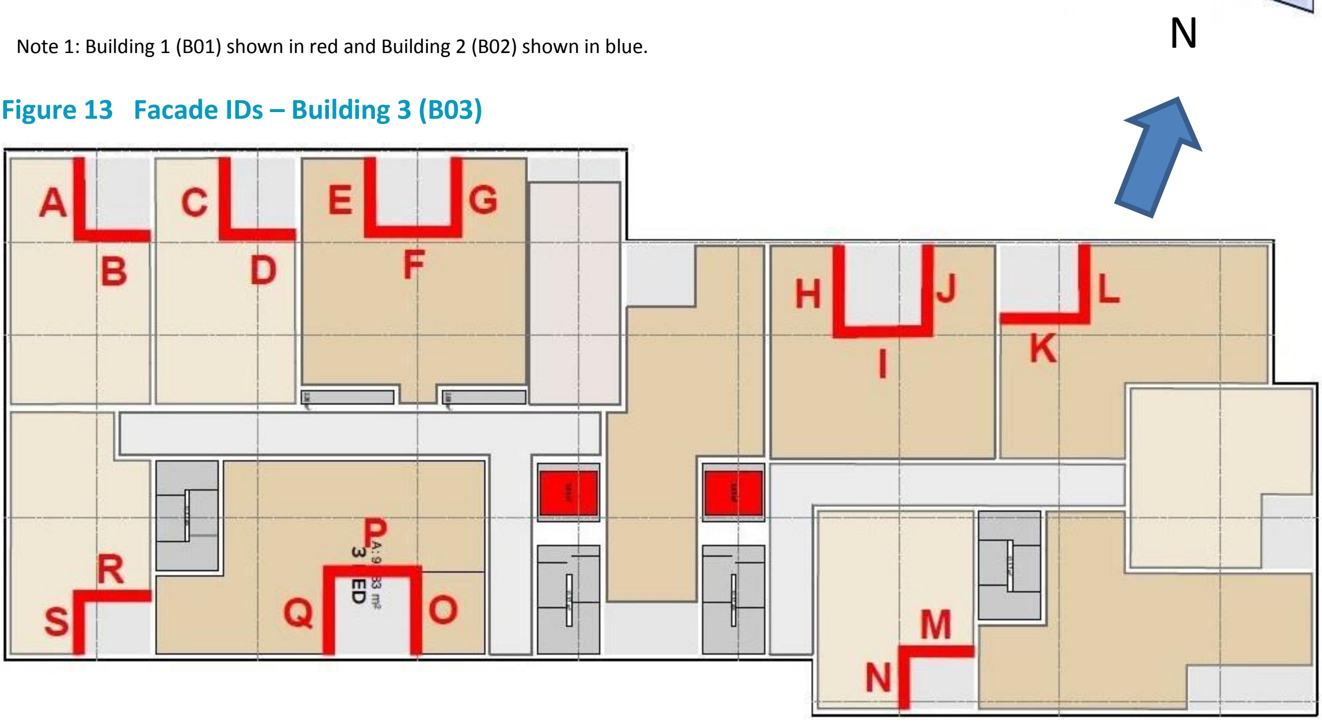


Figure 14 Facade IDs – Building 4 (B04)

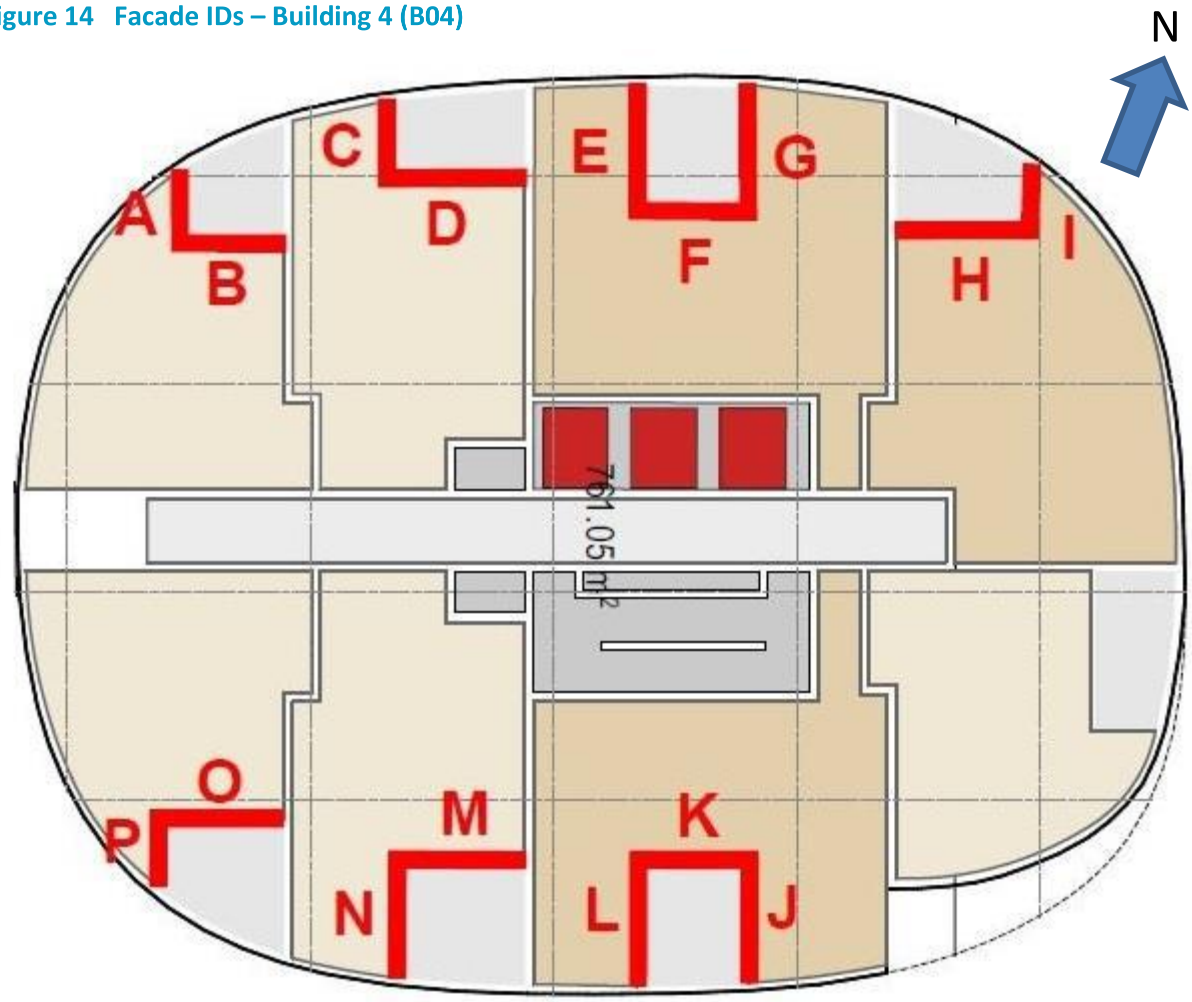
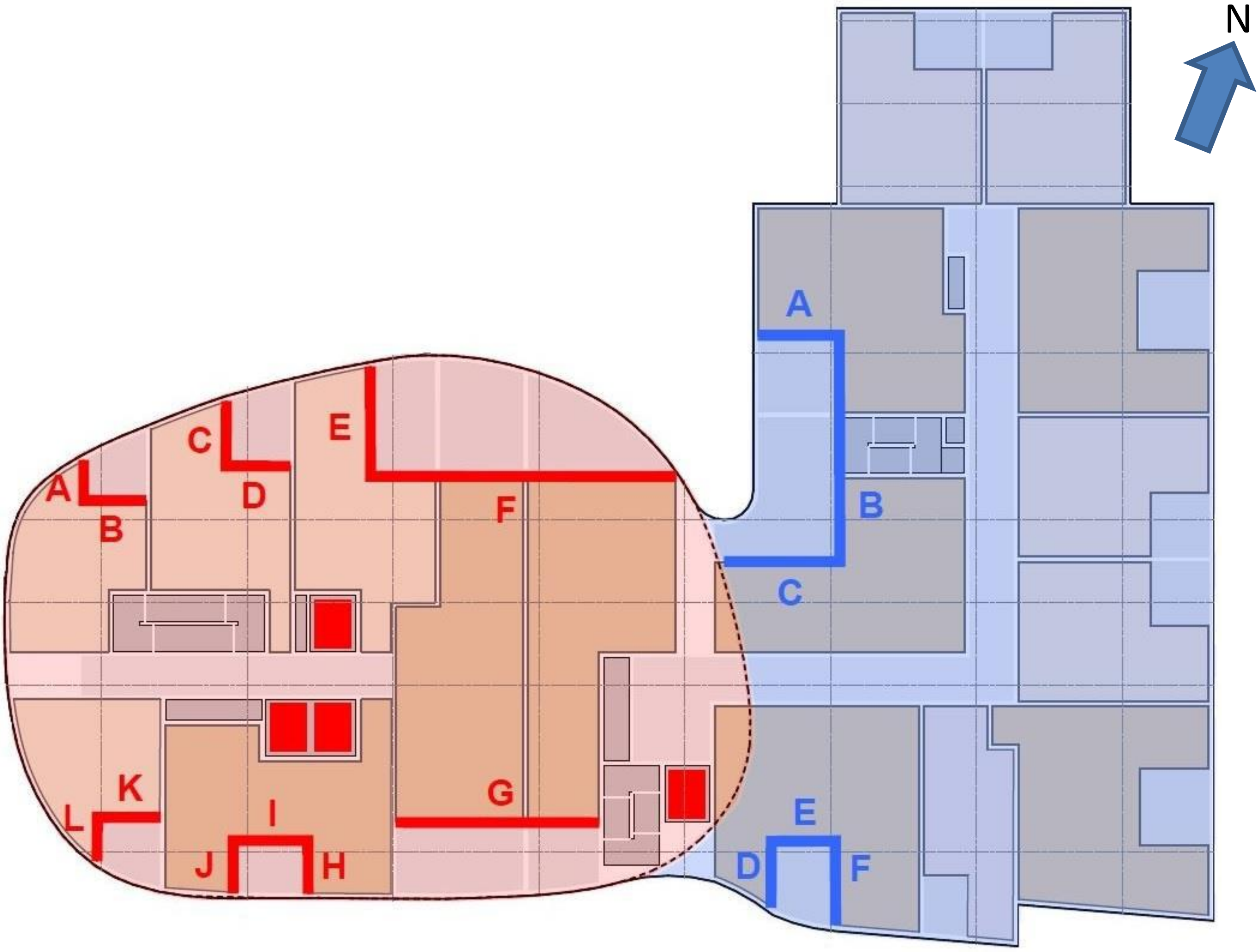


Figure 15 Facade IDs – Building 5 (B05) and Building 6 (B06)



Note 1: Building 5 (B05) shown in red and Building 6 (B06) shown in blue.

Table 17 Predicted Internal Road Traffic Noise Levels

ID	Receiver Height (m)(RL)	Building ID	Facade ID	Facade Direction	SP ID	Predicted Internal Noise Levels (dBA)			
						$L_{Aeq(15hour)}$	Day-time Compliance Achieved	$L_{Aeq(9hour)}$	Night-time Compliance Achieved
1	42	B01	A	East	B01-A-LOW	46	Yes	42	Yes
2	74	B01	A	East	B01-A-MID	45	Yes	41	Yes
3	106	B01	A	East	B01-A-HIGH	45	Yes	41	Yes
4	42	B01	B	North	B01-B-LOW	52	Yes	48	No
5	74	B01	B	North	B01-B-MID	50	Yes	46	No
6	106	B01	B	North	B01-B-HIGH	49	Yes	45	Yes
7	42	B01	C	East	B01-C-LOW	46	Yes	42	Yes
8	74	B01	C	East	B01-C-MID	44	Yes	40	Yes
9	106	B01	C	East	B01-C-HIGH	44	Yes	40	Yes

ID	Receiver	Building	Facade	Facade	SP ID	Predicted Internal Noise Levels (dBA)			
10	42	B01	D	North	B01-D-LOW	49	Yes	45	No
11	74	B01	D	North	B01-D-MID	48	Yes	44	Yes
12	106	B01	D	North	B01-D-HIGH	48	Yes	44	Yes
13	42	B01	E	East	B01-E-LOW	45	Yes	41	Yes
14	74	B01	E	East	B01-E-MID	43	Yes	39	Yes
15	106	B01	E	East	B01-E-HIGH	43	Yes	39	Yes
16	42	B01	F	North	B01-F-LOW	45	Yes	41	Yes
17	74	B01	F	North	B01-F-MID	45	Yes	41	Yes
18	106	B01	F	North	B01-F-HIGH	45	Yes	41	Yes
19	42	B01	G	West	B01-G-LOW	49	Yes	45	Yes
20	74	B01	G	West	B01-G-MID	48	Yes	44	Yes
21	106	B01	G	West	B01-G-HIGH	47	Yes	43	Yes
22	42	B01	H	East	B01-H-LOW	47	Yes	43	Yes
23	74	B01	H	East	B01-H-MID	45	Yes	41	Yes
24	106	B01	H	East	B01-H-HIGH	43	Yes	40	Yes
25	42	B01	I	North	B01-I-LOW	46	Yes	42	Yes
26	74	B01	I	North	B01-I-MID	45	Yes	41	Yes
27	106	B01	I	North	B01-I-HIGH	45	Yes	41	Yes
28	42	B01	J	West	B01-J-LOW	47	Yes	44	Yes
29	74	B01	J	West	B01-J-MID	48	Yes	44	Yes
30	106	B01	J	West	B01-J-HIGH	48	Yes	44	Yes
31	42	B01	K	South	B01-K-LOW	45	Yes	41	Yes
32	74	B01	K	South	B01-K-MID	46	Yes	43	Yes
33	106	B01	K	South	B01-K-HIGH	47	Yes	43	Yes
34	42	B01	L	East	B01-L-LOW	28	Yes	24	Yes
35	74	B01	L	East	B01-L-MID	43	Yes	39	Yes
36	106	B01	L	East	B01-L-HIGH	44	Yes	40	Yes
37	42	B01	M	West	B01-M-LOW	51	Yes	48	No
38	74	B01	M	West	B01-M-MID	50	Yes	46	No
39	106	B01	M	West	B01-M-HIGH	48	Yes	45	Yes
40	42	B01	N	South	B01-N-LOW	48	Yes	45	Yes
41	74	B01	N	South	B01-N-MID	48	Yes	44	Yes
42	106	B01	N	South	B01-N-HIGH	47	Yes	43	Yes
43	42	B01	O	East	B01-O-LOW	40	Yes	37	Yes
44	74	B01	O	East	B01-O-MID	41	Yes	38	Yes
45	106	B01	O	East	B01-O-HIGH	42	Yes	38	Yes
46	36	B02	A	West	B02-A-LOW	46	Yes	42	Yes

ID	Receiver	Building	Facade	Facade	SP ID	Predicted Internal Noise Levels (dBA)			
47	48	B02	A	West	B02-A-MID	46	Yes	42	Yes
48	60	B02	A	West	B02-A-HIGH	46	Yes	42	Yes
49	36	B02	B	East	B02-B-LOW	47	Yes	44	Yes
50	48	B02	B	East	B02-B-MID	46	Yes	43	Yes
51	60	B02	B	East	B02-B-HIGH	45	Yes	42	Yes
52	36	B02	C	North	B02-C-LOW	48	Yes	45	Yes
53	48	B02	C	North	B02-C-MID	47	Yes	44	Yes
54	60	B02	C	North	B02-C-HIGH	47	Yes	43	Yes
55	36	B02	D	West	B02-D-LOW	49	Yes	45	Yes
56	48	B02	D	West	B02-D-MID	48	Yes	44	Yes
57	60	B02	D	West	B02-D-HIGH	48	Yes	44	Yes
58	36	B02	E	South	B02-E-LOW	30	Yes	27	Yes
59	48	B02	E	South	B02-E-MID	35	Yes	31	Yes
60	60	B02	E	South	B02-E-HIGH	41	Yes	38	Yes
61	36	B02	F	East	B02-F-LOW	29	Yes	25	Yes
62	48	B02	F	East	B02-F-MID	32	Yes	28	Yes
63	60	B02	F	East	B02-F-HIGH	36	Yes	32	Yes
64	34	B03	A	East	B03-A-LOW	28	Yes	24	Yes
65	41	B03	A	East	B03-A-MID	28	Yes	24	Yes
66	47	B03	A	East	B03-A-HIGH	32	Yes	28	Yes
67	34	B03	B	North	B03-B-LOW	45	Yes	41	Yes
68	41	B03	B	North	B03-B-MID	47	Yes	43	Yes
69	47	B03	B	North	B03-B-HIGH	47	Yes	43	Yes
70	34	B03	C	East	B03-C-LOW	27	Yes	23	Yes
71	41	B03	C	East	B03-C-MID	27	Yes	23	Yes
72	47	B03	C	East	B03-C-HIGH	31	Yes	28	Yes
73	34	B03	D	North	B03-D-LOW	36	Yes	32	Yes
74	41	B03	D	North	B03-D-MID	42	Yes	39	Yes
75	47	B03	D	North	B03-D-HIGH	43	Yes	39	Yes
76	34	B03	E	East	B03-E-LOW	27	Yes	23	Yes
77	41	B03	E	East	B03-E-MID	27	Yes	23	Yes
78	47	B03	E	East	B03-E-HIGH	31	Yes	27	Yes
79	34	B03	F	North	B03-F-LOW	26	Yes	23	Yes
80	41	B03	F	North	B03-F-MID	27	Yes	23	Yes
81	47	B03	F	North	B03-F-HIGH	31	Yes	27	Yes
82	34	B03	G	West	B03-G-LOW	39	Yes	35	Yes
83	41	B03	G	West	B03-G-MID	43	Yes	39	Yes

ID	Receiver	Building	Facade	Facade	SP ID	Predicted Internal Noise Levels (dBA)			
84	47	B03	G	West	B03-G-HIGH	47	Yes	43	Yes
85	34	B03	H	East	B03-H-LOW	31	Yes	27	Yes
86	41	B03	H	East	B03-H-MID	34	Yes	30	Yes
87	47	B03	H	East	B03-H-HIGH	35	Yes	31	Yes
88	34	B03	I	North	B03-I-LOW	26	Yes	23	Yes
89	41	B03	I	North	B03-I-MID	27	Yes	23	Yes
90	47	B03	I	North	B03-I-HIGH	30	Yes	26	Yes
91	34	B03	J	West	B03-J-LOW	34	Yes	29	Yes
92	41	B03	J	West	B03-J-MID	37	Yes	32	Yes
93	47	B03	J	West	B03-J-HIGH	39	Yes	34	Yes
94	34	B03	K	North	B03-K-LOW	25	Yes	22	Yes
95	41	B03	K	North	B03-K-MID	27	Yes	23	Yes
96	47	B03	K	North	B03-K-HIGH	30	Yes	26	Yes
97	34	B03	L	East	B03-L-LOW	33	Yes	29	Yes
98	41	B03	L	East	B03-L-MID	36	Yes	32	Yes
99	47	B03	L	East	B03-L-HIGH	38	Yes	34	Yes
100	34	B03	M	South	B03-M-LOW	34	Yes	30	Yes
101	41	B03	M	South	B03-M-MID	34	Yes	31	Yes
102	47	B03	M	South	B03-M-HIGH	35	Yes	31	Yes
103	34	B03	N	East	B03-N-LOW	39	Yes	35	Yes
104	41	B03	N	East	B03-N-MID	38	Yes	35	Yes
105	47	B03	N	East	B03-N-HIGH	39	Yes	35	Yes
106	34	B03	O	West	B03-O-LOW	38	Yes	35	Yes
107	41	B03	O	West	B03-O-MID	46	Yes	43	Yes
108	47	B03	O	West	B03-O-HIGH	48	Yes	44	Yes
109	34	B03	P	South	B03-P-LOW	34	Yes	31	Yes
110	41	B03	P	South	B03-P-MID	42	Yes	38	Yes
111	47	B03	P	South	B03-P-HIGH	42	Yes	38	Yes
112	34	B03	Q	East	B03-Q-LOW	32	Yes	28	Yes
113	41	B03	Q	East	B03-Q-MID	34	Yes	30	Yes
114	47	B03	Q	East	B03-Q-HIGH	35	Yes	31	Yes
115	34	B03	R	South	B03-R-LOW	48	Yes	44	Yes
116	41	B03	R	South	B03-R-MID	49	Yes	45	Yes
117	47	B03	R	South	B03-R-HIGH	48	Yes	45	Yes
118	34	B03	S	East	B03-S-LOW	44	Yes	40	Yes
119	41	B03	S	East	B03-S-MID	44	Yes	40	Yes
120	47	B03	S	East	B03-S-HIGH	44	Yes	41	Yes

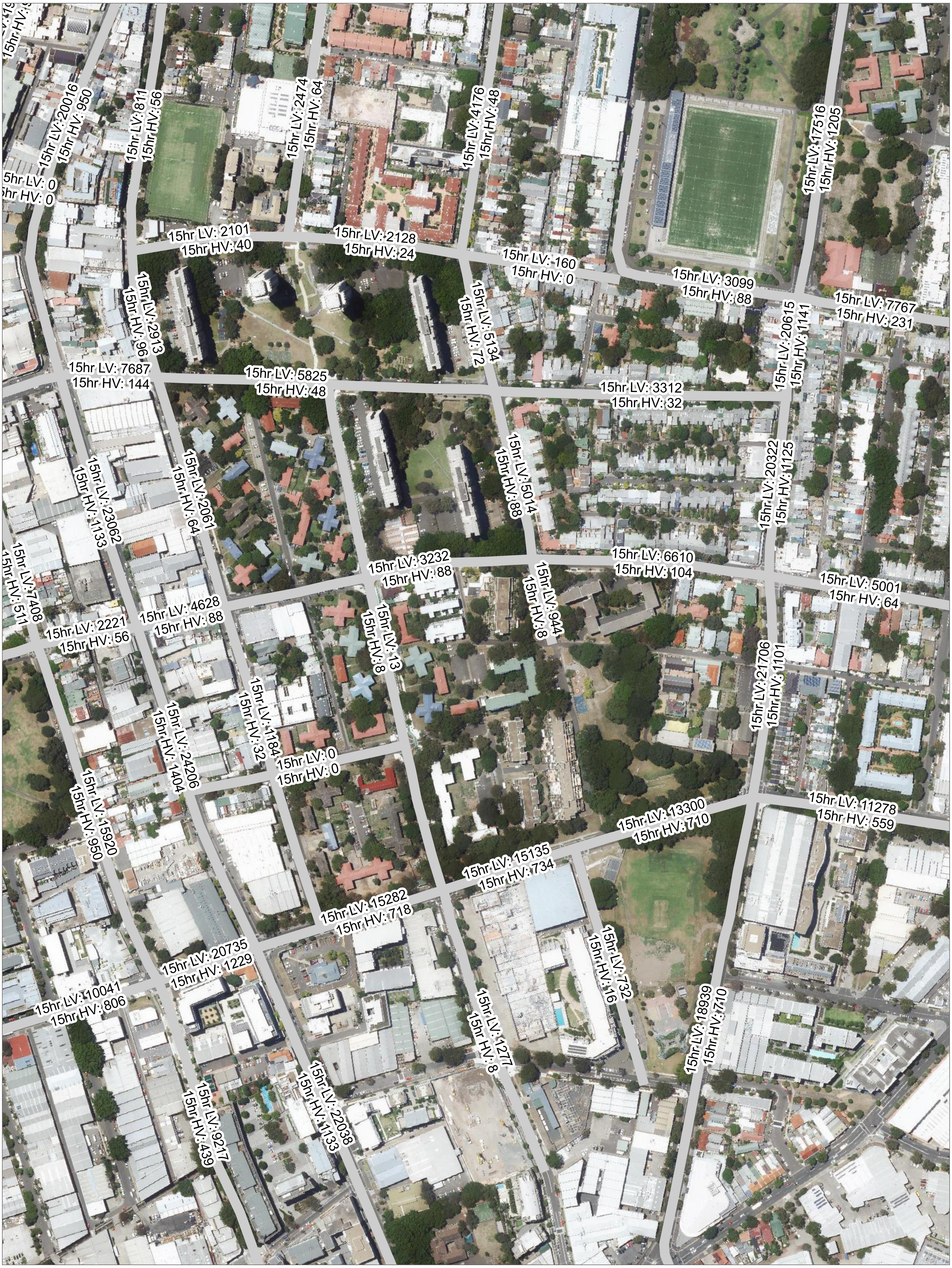
ID	Receiver	Building	Facade	Facade	SP ID	Predicted Internal Noise Levels (dBA)			
121	38	B04	A	East	B04-A-LOW	27	Yes	23	Yes
122	64	B04	A	East	B04-A-MID	32	Yes	28	Yes
123	91	B04	A	East	B04-A-HIGH	37	Yes	33	Yes
124	38	B04	B	North	B04-B-LOW	46	Yes	43	Yes
125	64	B04	B	North	B04-B-MID	47	Yes	43	Yes
126	91	B04	B	North	B04-B-HIGH	48	Yes	44	Yes
127	38	B04	C	East	B04-C-HIGH	48	Yes	44	Yes
128	38	B04	D	North	B04-C-MID	33	Yes	29	Yes
129	64	B04	C	East	B04-C-LOW	31	Yes	27	Yes
130	91	B04	C	East	B04-C-HIGH	38	Yes	34	Yes
131	91	B04	D	North	B04-C-LOW	40	Yes	36	Yes
132	64	B04	D	North	B04-D-MID	46	Yes	42	Yes
133	38	B04	E	East	B04-E-LOW	29	Yes	25	Yes
134	64	B04	E	East	B04-E-MID	31	Yes	27	Yes
135	91	B04	E	East	B04-E-HIGH	39	Yes	35	Yes
136	38	B04	F	North	B04-F-LOW	26	Yes	22	Yes
137	64	B04	F	North	B04-F-MID	34	Yes	29	Yes
138	91	B04	F	North	B04-F-HIGH	43	Yes	39	Yes
139	38	B04	G	West	B04-G-LOW	36	Yes	32	Yes
140	64	B04	G	West	B04-G-MID	44	Yes	40	Yes
141	91	B04	G	West	B04-G-HIGH	47	Yes	42	Yes
142	38	B04	H	North	B04-H-LOW	29	Yes	25	Yes
143	64	B04	H	North	B04-H-MID	34	Yes	30	Yes
144	91	B04	H	North	B04-H-HIGH	43	Yes	39	Yes
145	38	B04	I	West	B04-I-LOW	31	Yes	27	Yes
146	64	B04	I	West	B04-I-MID	42	Yes	37	Yes
147	91	B04	I	West	B04-I-HIGH	45	Yes	41	Yes
148	38	B04	J	West	B04-J-LOW	47	Yes	43	Yes
149	64	B04	J	West	B04-J-MID	46	Yes	43	Yes
150	91	B04	J	West	B04-J-HIGH	45	Yes	42	Yes
151	38	B04	K	South	B04-K-LOW	29	Yes	25	Yes
152	64	B04	K	South	B04-K-MID	37	Yes	34	Yes
153	91	B04	K	South	B04-K-HIGH	37	Yes	34	Yes
154	38	B04	L	East	B04-L-LOW	27	Yes	23	Yes
155	64	B04	L	East	B04-L-MID	31	Yes	28	Yes
156	91	B04	L	East	B04-L-HIGH	36	Yes	32	Yes
157	38	B04	M	South	B04-M-LOW	44	Yes	40	Yes

ID	Receiver	Building	Facade	Facade	SP ID	Predicted Internal Noise Levels (dBA)			
158	64	B04	M	South	B04-M-MID	44	Yes	40	Yes
159	91	B04	M	South	B04-M-HIGH	43	Yes	40	Yes
160	38	B04	N	East	B04-N-LOW	27	Yes	23	Yes
161	64	B04	N	East	B04-N-MID	31	Yes	28	Yes
162	91	B04	N	East	B04-N-HIGH	36	Yes	33	Yes
163	38	B04	O	South	B04-O-LOW	49	Yes	45	Yes
164	64	B04	O	South	B04-O-MID	48	Yes	44	Yes
165	91	B04	O	South	B04-O-HIGH	46	Yes	43	Yes
166	38	B04	P	East	B04-P-LOW	38	Yes	34	Yes
167	64	B04	P	East	B04-P-MID	39	Yes	36	Yes
168	91	B04	P	East	B04-P-HIGH	39	Yes	36	Yes
169	36	B05	A	East	B05-A-LOW	40	Yes	36	Yes
170	60	B05	A	East	B05-A-MID	40	Yes	36	Yes
171	85	B05	A	East	B05-A-HIGH	40	Yes	37	Yes
172	36	B05	B	North	B05-B-LOW	50	Yes	46	No
173	60	B05	B	North	B05-B-MID	49	Yes	45	Yes
174	85	B05	B	North	B05-B-HIGH	48	Yes	44	Yes
175	36	B05	C	East	B05-C-LOW	30	Yes	27	Yes
176	60	B05	C	East	B05-C-MID	32	Yes	28	Yes
177	85	B05	C	East	B05-C-HIGH	34	Yes	31	Yes
178	36	B05	D	North	B05-D-LOW	46	Yes	43	Yes
179	60	B05	D	North	B05-D-MID	46	Yes	43	Yes
180	85	B05	D	North	B05-D-HIGH	46	Yes	42	Yes
181	36	B05	E	East	B05-E-LOW	30	Yes	26	Yes
182	60	B05	E	East	B05-E-MID	33	Yes	29	Yes
183	85	B05	E	East	B05-E-HIGH	36	Yes	32	Yes
184	36	B05	F	North	B05-F-LOW	44	Yes	41	Yes
185	60	B05	F	North	B05-F-MID	47	Yes	43	Yes
186	85	B05	F	North	B05-F-HIGH	47	Yes	43	Yes
187	36	B05	G	South	B05-G-LOW	49	Yes	45	Yes
188	60	B05	G	South	B05-G-MID	50	Yes	47	No
189	85	B05	G	South	B05-G-HIGH	49	Yes	46	No
190	36	B05	H	West	B05-H-LOW	52	Yes	48	No
191	60	B05	H	West	B05-H-MID	51	Yes	47	No
192	85	B05	H	West	B05-H-HIGH	49	Yes	46	No
193	36	B05	I	South	B05-I-LOW	50	Yes	46	No
194	60	B05	I	South	B05-I-MID	49	Yes	46	No

ID	Receiver	Building	Facade	Facade	SP ID	Predicted Internal Noise Levels (dBA)			
195	85	B05	I	South	B05-I-HIGH	48	Yes	45	Yes
196	36	B05	J	East	B05-J-LOW	46	Yes	42	Yes
197	60	B05	J	East	B05-J-MID	45	Yes	42	Yes
198	85	B05	J	East	B05-J-HIGH	45	Yes	42	Yes
199	36	B05	K	South	B05-K-LOW	51	Yes	47	No
200	60	B05	K	South	B05-K-MID	50	Yes	46	No
201	85	B05	K	South	B05-K-HIGH	49	Yes	45	No
202	36	B05	L	East	B05-L-LOW	46	Yes	43	Yes
203	60	B05	L	East	B05-L-MID	46	Yes	43	Yes
204	85	B05	L	East	B05-L-HIGH	46	Yes	42	Yes
205	42	B06	A	South	B06-A-LOW	30	Yes	26	Yes
206	49	B06	A	South	B06-A-MID	33	Yes	30	Yes
207	56	B06	A	South	B06-A-HIGH	37	Yes	33	Yes
208	42	B06	B	West	B06-B-LOW	45	Yes	41	Yes
209	49	B06	B	West	B06-B-MID	46	Yes	42	Yes
210	56	B06	B	West	B06-B-HIGH	46	Yes	43	Yes
211	42	B06	C	North	B06-C-LOW	44	Yes	40	Yes
212	49	B06	C	North	B06-C-MID	44	Yes	41	Yes
213	56	B06	C	North	B06-C-HIGH	45	Yes	41	Yes
214	42	B06	D	East	B06-D-LOW	40	Yes	36	Yes
215	49	B06	D	East	B06-D-MID	43	Yes	39	Yes
216	56	B06	D	East	B06-D-HIGH	43	Yes	40	Yes
217	42	B06	E	South	B06-E-LOW	43	Yes	39	Yes
218	49	B06	E	South	B06-E-MID	45	Yes	42	Yes
219	56	B06	E	South	B06-E-HIGH	46	Yes	42	Yes
220	42	B06	F	West	B06-F-LOW	46	Yes	43	Yes
221	49	B06	F	West	B06-F-MID	48	Yes	45	Yes
222	56	B06	F	West	B06-F-HIGH	49	Yes	45	Yes

APPENDIX D

Existing Traffic Volumes



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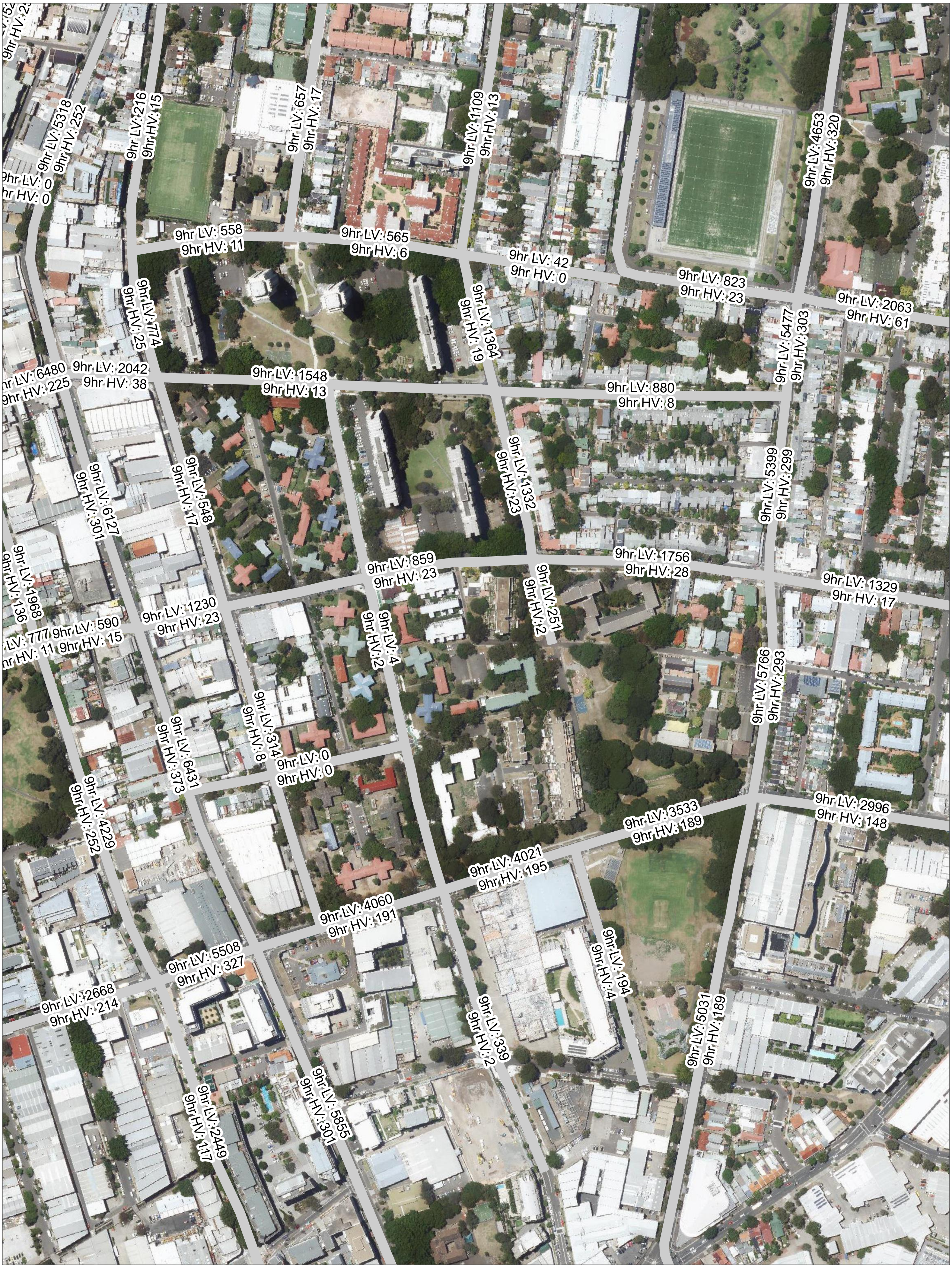
Project No.:	610.14863
Date:	28/02/2016
Drawn by:	MA
Scale:	1:4,500
Sheet Size:	@ A4
Projection:	GDA 1994 MGA Zone 56

0 40 80 120 m

UrbanGrowth NSW

Waterloo Precinct SSP

Daytime (7am to 10pm) traffic volumes



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Date:	28/02/2016
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Scale:	1:4,500
Sheet Size:	@ A4
Projection:	GDA 1994 MGA Zone 56

0 40 80 120 m

UrbanGrowth NSW

Waterloo Precinct SSP

Night-time (10pm to 7am) traffic volumes

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