AECOM Imagine it. Delivered.

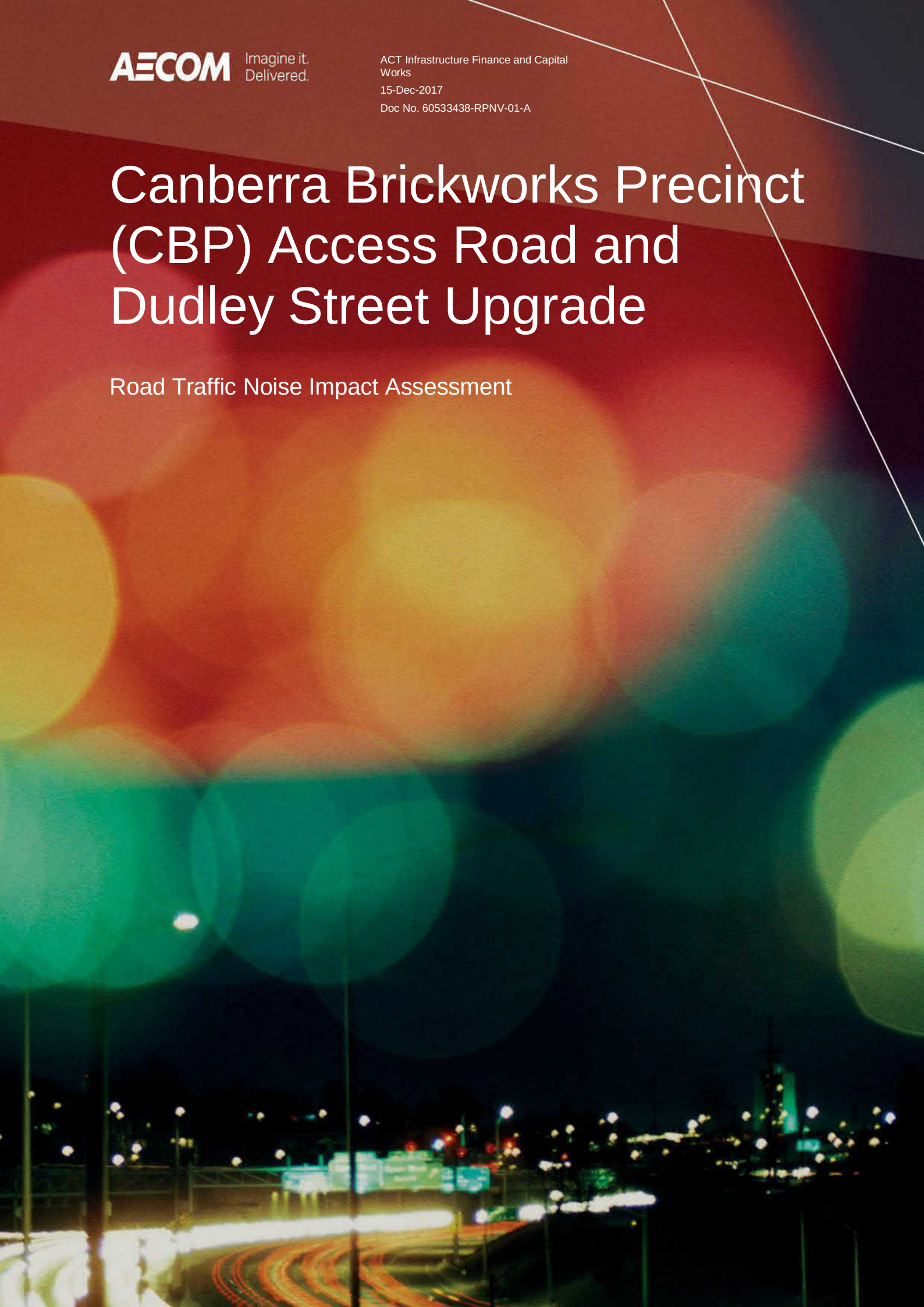
ACT Infrastructure Finance and Capital Works

15-Dec-2017

Doc No. 60533438-RPNV-01-A

Canberra Brickworks Precinct (CBP) Access Road and Dudley Street Upgrade

Road Traffic Noise Impact Assessment



Canberra Brickworks Precinct (CBP) Access Road and Dudley Street Upgrade

Road Traffic Noise Impact Assessment

Client: ACT Infrastructure Finance and Capital Works

ABN: 66 676 633 401

Prepared by

AECOM Australia Pty Ltd
Level 2, 60 Marcus Clarke Street, Canberra ACT 2600, Australia
T +61 2 6201 3000 F +61 2 6201 3099 www.aecom.com
ABN 20 093 846 925

15-Dec-2017

Job No.: 60533438

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document	Canberra Brickworks Precinct (CBP) Access Road and Dudley Street Upgrade
Ref	60533438
Date	15-Dec-2017
Prepared by	Jack Robinson/Michael Allan
Reviewed by	Gayle Greer

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	15-Dec-2017	Rev.01	Richard Farmer Principal Environmental Scientist	

Table of Contents

List of Tables

List of Figures

1.0 Introduction

ACT Infrastructure Finance and Capital Works has engaged AECOM Australia Pty Ltd (AECOM) to prepare a Road Traffic Noise Impact Assessment for the proposed upgrade of Dudley Street and new Access Road which would service the proposed Canberra Brickworks Precinct.

Dudley Street provides a link from north western Canberra to the suburbs of Yarralumla and Deakin. It connects Cotter Road to the roundabout intersection of Novar Street / Adelaide Avenue off Ramp / Kent Street. Previous traffic studies have identified concerns with the function of Dudley Street and found that it was operating at capacity under existing traffic conditions, particularly in the morning peak.

Upgrades are required to allow Dudley Street to operate safely and to meet the design requirements for a 'major collector road'. Dudley Street is currently only six metres wide and does not have a sealed shoulder to cater for traffic incidents or breakdowns. Modifications to the width of the road and provision of an off road shared path are required. The upgraded road is proposed to carry over 9,000 vehicles per day as a result of future growth in Molonglo and Deakin.

Access is also required off Dudley Street to enable the development of the Canberra Brickworks Precinct, a proposed development area which would provide for approximately 380 residential dwellings and will revitalise this historical heritage area of Yarralumla. The Canberra Brickworks Precinct is currently only accessible via one local access road, Denman Street / Kintore Crescent, which is not suitable to support the additional traffic the development will generate. A new access is required to connect the Canberra Brickworks Precinct directly to Dudley Street reducing the traffic impact of the development on residential streets within Yarralumla. A second estate access off Dudley Street to support the Canberra Brickworks Precinct was also a predevelopment requirement from Transport Canberra and City Services (TCCS) Directorate.

For the purposes of this assessment the Access Road and Dudley Street Upgrade will be referred to as the Project. The development of the Canberra Brickworks Precinct is not part of this Project and is a separate development proposal (by the DOMA Group).

A feasibility design, concept design and preliminary sketch plan design have been developed for the Project which have identified improvements for Dudley Street and proposed an alignment for the new Access Road, including a new roundabout intersection from Dudley Street.

A detailed assessment of the impact of road traffic noise on sensitive receivers has been undertaken, including those located on Denman Street, Kintore Crescent and Novar Street.

The road noise assessment has been conducted using the criteria in the ACT's Noise Management Guidelines (Draft, March 1996). While the guidelines have been superseded by various Codes under the Territory Plan, the criteria are still applied to major road projects as a matter of planning practice.

This report provides a summary of the findings of the road traffic noise impact assessment in support of the Development Application for the Project.

1.1 Scope

The scope of this report is:

- Attended and unattended noise measurements undertaken to determine existing road traffic noise levels
- Identification of sensitive receivers potentially affected by road traffic noise from the proposed upgrade
- Establishment of operational road traffic noise criteria
- Methodology to assess operational road noise
- Predictions of road traffic noise levels on Dudley Street and discussion on mitigation options where necessary.

A glossary of acoustic terminology can be found in Appendix A.

2.0 Existing noise environment

2.1 Site location

The Project is located within the central Australian Capital Territory (ACT) suburb of Yarralumla, approximately three kilometres from the Canberra Central Business District (CBD). The Project is situated within an area of public open space to the south of the main residential areas of Yarralumla. Other residential areas in the vicinity of the Project include the surrounding suburbs of Curtin and Deakin to the south east and south west. The Royal Canberra Golf Club and Government House (the official residence of the Governor-General of Australia) are located to the north and north east.

Directly to the south of the Project is Cotter Road and the major southern infrastructure corridor of Yarra Glen/Adelaide Avenue which connects the southern ACT suburbs to the Canberra CBD. The location of the Project in its regional context with adjacent roads is shown in Figure 1.

Dudley Street provides a link from north western Canberra to the suburbs of Yarralumla (via Novar Street) and Deakin, Hughes and Garran (via Kent Street). It connects Cotter Road to the roundabout intersection of Novar Street / Adelaide Avenue off ramp / Kent Street.

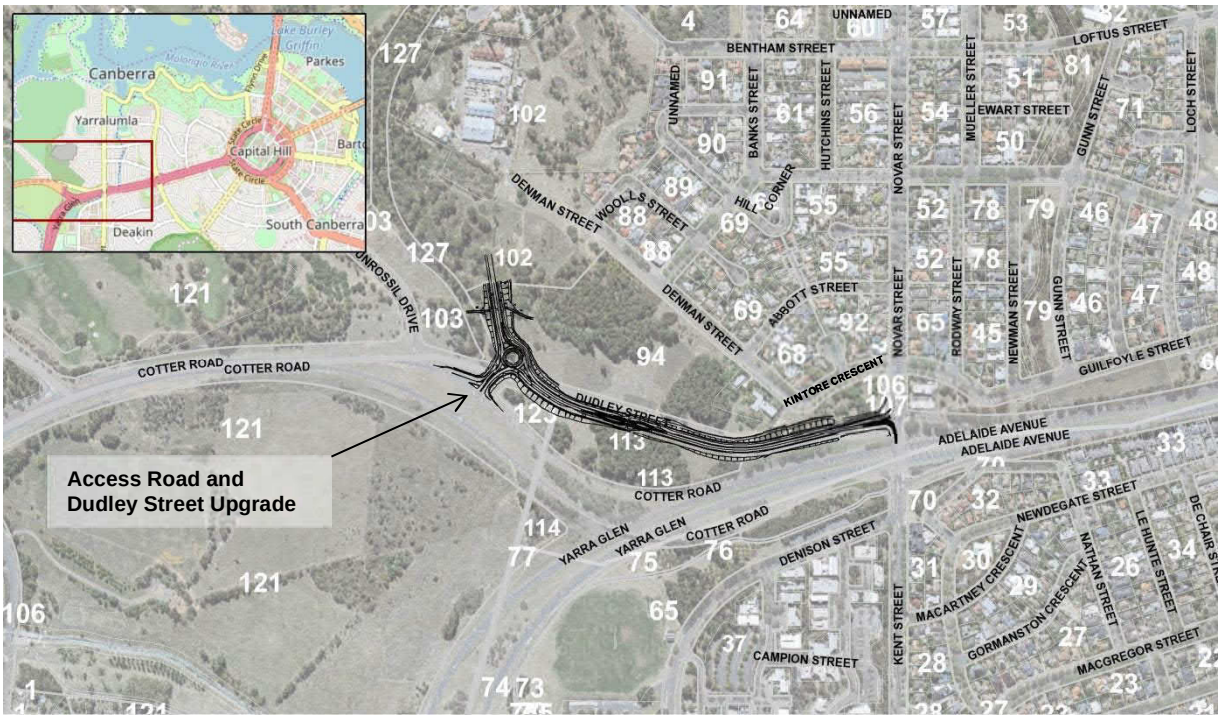


Figure 1 Regional context of the Project

2.2 Overview

Generally the existing noise environment throughout the Project area is dominated by road traffic noise from Tourist Drive 5 (Adelaide Avenue and Yarra Glen) and Dudley Avenue to a lesser degree. There is also some noise contribution from more infrequent traffic along Denman Street. The existing noise environment at each individual noise sensitive receiver area is generally dependent on the proximity to nearby roads.

2.3 Receivers

The Project area is located within the southern extents of Yarralumla to the north of Deakin and consists largely of urban open space with the existing Dudley Street travelling from east to west. The closest residential receivers are located to the north of the Project on Denman Street and Kintore Crescent (around 60 metres from the Project at the nearest location) and to the east on Novar Street (around 40 metres from the Project). The Yarralumla Uniting Church is located between Dudley Street

and Denman Street. It is noted that generally the residential receivers face towards the Project area and have the benefit of having private outdoor spaces in their backyards.

Road traffic noise from Dudley Street and the infrastructure corridor of Adelaide Avenue / Yarra Glen (which is located to the south of the Project) are the dominant noise sources in the Project area. There is also some noise contribution from more infrequent traffic along Denman Street. The existing noise environment at each individual noise receiver is generally dependent on the proximity to nearby roads.

In the wider vicinity of the Project are the residential receivers to the south in the suburb of Deakin, however the noise environment for these receivers is predominately controlled by traffic volumes on Adelaide Avenue / Yarra Glen.

2.4 Ambient noise monitoring

2.4.1 Unattended measurements

Road traffic noise monitoring was undertaken at three locations throughout the Project area to determine existing road traffic noise levels from the surrounding road network. Noise logging was undertaken over a period of nine days from 16 to 25 June, 2017.

A noise logger measures noise levels over the sample period and then determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for one per cent, 10% and 90% of the sample period respectively. The L_{A1} is indicative of typical maximum noise levels. The L_{A90} is taken as the background noise level. The L_{Aeq} is the energy averaged noise level over a defined period. The $L_{A10(18hour)}$ is the noise level exceeded 10% of the time between 6 am and 12 am. This is the road traffic noise index used in the ACT.

Provided below in Table 1 is a summary of the measured noise levels. Noise logging locations are provided in Appendix B. Charts are provided in Appendix C illustrating the logged noise levels over the measurement period.

Table 1 Road traffic noise logging results

Logger ID	Measurement location	dB(A)
NL01	Parkland between Dudley Street and Denman Street, Yarralumla	55
NL02	12 Denman Street, Yarralumla	49
NL03	Yarralumla Uniting Church, Yarralumla	60

3.0 Assessment criteria

3.1 Operational noise criteria

The operational road traffic noise assessment criteria for road development were established within the ACT's Noise Management Guidelines (Draft, March 1996). The criteria apply at building facades and within private open spaces. This Project involves the upgrade and minor realignment of an existing carriageway. As such the Project has been assessed as the upgrade of an existing road.

The applicable criteria for the affected sensitive receivers adjacent to a new road carriageway are provided below in Table 2.

Table 2 Maximum traffic noise levels resulting from upgraded roads in existing areas, expressed as $L_{A10(18hour)}$ dB(A) (From the ACT's *Noise Management Guidelines (Draft)*, March 1996, Table 3.3)

Existing traffic noise level at adjacent buildings[1]	Maximum traffic noise level at adjacent buildings after road works completed
> 63	Equal to existing road
58 - 63	63
< 58	Not more than 5 dB(A) above existing level

Notes: 1 - This noise level incorporates façade reflection.

The *Noise Management Guidelines (Draft), 1996* recognises backyards, courtyards and similar areas as private open spaces for which an additional criterion of a maximum of 58 dB(A) $L_{10, 18 hour}$, measured one metre inside the nearest boundary, must be met. These criteria are applicable to the following three scenarios:

- new development on existing road (in which case any acoustic requirements are the responsibility of the lessee)
- development of new road in new areas
- development of new road in existing areas

While the criteria is not strictly relevant for the redevelopment of an existing road, private open space will be assessed within the rear yard of each affected residence.

4.0 Road traffic noise assessment

4.1 Noise modelling methodology

The sections below outline the methodology used for modelling road traffic noise.

4.1.1 Road traffic noise modelling methodology

Road traffic noise levels were calculated using SoundPLAN software, which implements the Calculation of Road Traffic Noise (CoRTN) algorithm. The UK Department of Transport devised the CoRTN algorithm and with suitable corrections, this method has been shown to give accurate predictions of road traffic noise under Australian conditions.

The modelling parameters which are included in the model are detailed in Table 3.

Table 3 Modelling noise parameters

Parameter	Comment
Traffic volumes and mix	The number of vehicles using the road and the percentage of heavy vehicles. A higher percentage of heavy vehicles would increase the road traffic noise levels. Surveys of existing road traffic volumes have been undertaken by Trans Traffic Survey and incorporated into the existing noise model. Future traffic volumes have been predicted by AECOM traffic engineers and incorporated in the Year 2029 noise model.
Traffic speeds	An increase in speed generally causes an increase in road traffic noise. Traffic speeds have been based on posted road speeds for existing roads and proposed speeds for roads throughout the Project area (both 60km/h for Dudley Street).
Traffic noise source heights	The noise modelling has incorporated a single source height 0.5 m above the ground (in accordance with the CoRTN algorithm).
Roadway gradient	Road traffic noise levels vary dependent on the gradient of the roadway compared with a flat roadway. CoRTN calculates this variation, however it does not take into account noise from heavy vehicle engine braking.
Road surface	Road surfaces would determine the level of road / tyre interfacial noise created. Dense graded asphalt (DGA) is accepted as the standard road surface with other road surfaces such as stone mastic asphalt (SMA) and open graded asphalt (OGA) being considered as 'low noise' surfaces. Horizontally tyned concrete road surfaces generate more road / tyre interfacial noise than DGA. Longitudinally tyned concrete road surfaces have recently been accepted as similar performance to DGA. The following corrections were applied to the road traffic noise model to account for the proposed road surfaces: · Dense Graded Asphalt 0 dB(A) Road surface corrections have been applied based on guidance provided in the NSW Road and Maritime Services' Environmental Noise Management Manual (ENMM).
Ground absorption	Road traffic noise levels reduce with increasing distance from the noise source along the ground. The noise calibration model verified that a ground absorption factor of 0.75 was appropriate for this Project.

Parameter	Comment
Terrain	Natural topographical features such as hills and valleys can shield sensitive receivers from road traffic noise. These effects are taken account of in the model which incorporates 1 metre terrain contours.
Buildings	The height of receiver buildings in the study area affects the road traffic noise exposure. It can also affect the amount of acoustic shielding provided to other nearby buildings. The heights of all buildings within the study area were determined through a ground-truthing exercise and included in the road traffic noise model.
Noise barriers	No existing noise barriers were identified within the Project area.
Facade	A correction of 2.5 dB(A) was added to all road traffic noise levels to take account of façade reflection effects. Noise levels have been calculated and assessed at each façade of each sensitive receiver location. Only the most affected façade for each receiver is presented in this report.
Road network	All existing and proposed major roads were included in the noise model. For this Project noise levels are generally controlled by Tourist Drive 5 and Dudley Street.
Standard corrections	The ARRB correction of -1.7dB(A) is used throughout all of Australia to account for Australian conditions. This correction has been incorporated in this Project also. [1]

4.1.2 Traffic flows

Trans Traffic Survey was commissioned to undertake vehicle tube counts over the noise logging period. The AECOM traffic modelling team used this data and turning counts to predict the Year 2029 vehicle movements with the Project.

The traffic flows which were included in the model are detailed in Table 4.

Table 4 Traffic flows for the years 2017 and 2029

Section	Existing - Year 2017		Design - Year 2029	
	Total vehicles (Veh/18hrs)	Heavy vehicles %	Total vehicles (Veh/18hrs)	Heavy Vehicles %
Dudley Street	7,885	4.3	9,791	4.3
Cotter Road	17,937	4.5	21,656	4.5
Adelaide Avenue	27,097	4.8	31,974	4.8

4.1.3 Year 2017 Noise Model Validation

Road traffic noise emission was calculated using the Calculation of Road Traffic Noise (CoRTN) algorithm contained within the SoundPLAN 7.4 software road traffic module. Point receivers were modelled 1.5 metres above the ground at the same locations as measurements were taken. The results of the validation of the noise model are presented below in Table 5.

[1] Saunders et al (1983) An evaluation of the UK DoE traffic noise prediction method, Australian Road Research Board, Research Report No. 122.

Table 5 Noise model validation

Noise Logger	Location	Measured $L_{Aeq(18hr)}$, dB(A)	Predicted $L_{Aeq(18hr)}$, dB(A)	Difference
NL01	Parkland, Dudley Street, Yarralumla	55.3	55.2	-0.1
NL02	12 Denman Street, Yarralumla	49.3	49.9	+0.6
NL03	Yarralumla Uniting Church, Yarralumla	60.0	60.2	+0.2

The results presented in Table 5 indicate that the noise model is generally over predicting up to 0.6 dB. The CoRTN algorithm is considered to have an accuracy of ±2 dB(A). While the noise model is slightly over–predicting (resulting in a marginally conservative model), it is well within the acknowledged tolerance of the algorithm. As such the model is considered appropriate for the assessment of this Project.

4.2 Noise modelling results

Provided below in Table 6 is a summary of the existing and future predicted noise levels for 39 representative sensitive receivers at the most affected façade of each building. Noise contours are also provided in Appendix D.

Table 6 Predicted road traffic noise levels at representative sensitive receivers

Location[1]	$L_{A10(18hour)}$ noise level, dB(A)				Exceeds
	2017	2029	Increase	Criteria	
3/16 Woolls Street, Yarralumla	49	50	1.2	54	No
4/16 Woolls Street, Yarralumla	48	49	1.2	53	No
2/16 Woolls Street, Yarralumla	50	51	1.1	55	No
16 Woolls Street, Yarralumla	50	51	1.1	55	No
9 Woolls Street, Yarralumla	47	48	1.1	52	No
11 Woolls Street, Yarralumla	48	49	1.2	53	No
5 Woolls Street, Yarralumla	46	47	1.2	51	No
3 Woolls Street, Yarralumla	45	47	1.1	50	No
1 Woolls Street, Yarralumla	48	49	1.1	53	No
9 Maxwell Street, Yarralumla	48	49	1.1	53	No
11 Maxwell Street, Yarralumla	48	49	1.0	53	No
4 Blakely Row, Yarralumla	46	48	1.2	51	No
6 Blakely Row, Yarralumla	47	48	1.1	52	No
8 Blakely Row, Yarralumla	50	51	1.2	55	No
8 Blakely Row, Yarralumla	47	48	1.2	52	No
20 Abbott Street, Yarralumla	49	51	1.3	54	No
22 Abbott Street, Yarralumla	49	50	1.4	54	No
5 Fraser Place, Yarralumla	56	56	0.9	61	No
3 Fraser Place, Yarralumla	58	59	0.8	63	No

Location[1]	$L_{A10(18hour)}$ noise level, dB(A)				Exceeds
	2017	2029	Increase	Criteria	
Yarralumla Uniting Church	64	65	1.1	64	**Yes**
3 Denman Street, Yarralumla	58	59	1.0	63	No
2 Denman Street, Yarralumla	61	62	0.7	63	No
4 Denman Street, Yarralumla	54	55	0.1	59	No
6 Denman Street, Yarralumla	55	55	0.9	60	No
19 Abbott Street, Yarralumla	56	57	1.0	61	No
17 Abbott Street, Yarralumla	54	55	1.3	59	No
24 Abbott Street, Yarralumla	53	54	1.1	58	No
12 Denman Street, Yarralumla	53	54	1.0	58	No
14 Denman Street, Yarralumla	52	53	1.0	57	No
16 Denman Street, Yarralumla	52	53	0.9	57	No
18 Denman Street, Yarralumla	52	53	0.9	57	No
20 Denman Street, Yarralumla	52	53	0.8	57	No
22 Denman Street, Yarralumla	50	51	1.1	55	No
12 Maxwell Street, Yarralumla	51	52	0.9	56	No
24 Denman Street, Yarralumla	49	50	1.1	54	No
26 Denman Street, Yarralumla	51	52	0.9	56	No
28 Denman Street, Yarralumla	49	50	1.1	54	No
30 Denman Street, Yarralumla	50	51	1.1	55	No
7 Woolls Street, Yarralumla	46	47	1.2	51	No

Notes: 1 – Results are presented for noise sensitive receivers in Yarralumla only. This is due to the fact that road traffic noise impacting noise sensitive receivers in Deakin is controlled by traffic travelling on Tourist Drive 5.

A single exceedance has been identified at Yarralumla Uniting Church. This receiver is predicted to increase by 1.1 dB in the future (a combination of both background traffic growth and the Project), resulting in a 1 dB exceedance of the applicable criteria.

Where exceedances of the applicable criteria are identified feasible and reasonable noise mitigation measures should be considered. The consideration of feasible and reasonable noise mitigation measures is undertaken on a case by case basis. The purpose of this approach is to ensure that the proposed mitigation measures are commensurate with the significance of the exceedance and the potential impact the exceedance would have.

The predicted design noise levels indicate that in 2029 the Yarralumla Uniting Church would experience noise levels of up to $L_{A10(18hour)}$ 65 dB(A), an increase and exceedance of 1.1 dB. A change in noise levels of up to 2 dB is typically considered indiscernible, resulting in what is considered to be a minor non-compliance.

Reviewing the noise logger charts, the maximum one hour noise levels which contributes to the predicted exceedance are during the afternoon peak between 4 pm and 6 pm on weekdays. While the church may be in use at these times, it does not coincide with the main service time (Sunday 9:30 am) and the standard office hours (Wednesday 12 pm to 3 pm). Based on the noise logging results, noise levels during Sunday service are expected to be 5 dB lower than those presented in Table 6 and hence compliant with the applicable noise criterion.

Therefore although a noise exceedance at the Yarralumla Uniting Church has been predicted, the impact would be minimal and further noise mitigation is not required. During the main hours of use the noise levels will comply with the applicable noise criterion.

4.2.1 Private open spaces

Noise contours showing noise levels in private open spaces are provided in Appendix D. The noise contours highlight that compliance with the private open space criteria would be achieved at all locations, except 1 Fraser Place, Yarralumla. Noise levels at this location already exceed the private open space, and are predicted to increase by less than 1 dB. As such consideration of noise mitigation is not considered reasonable.

5.0 Conclusion

AECOM has been commissioned by ACT Infrastructure Finance and Capital Works to prepare a Road Traffic Noise Impact Assessment for the proposed upgrade of Dudley Street and new Access Road which would service the proposed Canberra Brickworks Precinct.

A detailed assessment of the impact of road traffic noise on 39 representative sensitive receivers has been undertaken to support the Development Application process. The road noise assessment has been conducted using the criteria in the ACT's Noise Management Guidelines (Draft, March 1996). While the guidelines have been superseded by various Codes under the Territory Plan, the criteria are still applied to major road projects as a matter of planning practice.

A combination of unattended and attended noise logging has been undertaken at three locations throughout the Project area to define the existing noise environment. Concurrent traffic counts were also undertaken. Using these measured traffic volumes and noise levels, an existing road traffic noise model was built and validated. The purpose of the validation was to determine that road traffic noise throughout the Project area is accurately being predicted by the model. The validation model was found to slightly over predict the traffic noise impact by less than 1 dB. This accuracy is well within the algorithm's acknowledged accuracy and provides a slightly conservative assessment.

A detailed road traffic noise model of the design year (2017) was then developed, and noise assessed at the most affected sensitive receivers throughout the Project area. A single sensitive receiver was found to be exceeding the applicable noise criteria, Yarralumla Uniting Church. It has been found that the exceedance is driven by times that the church is typically not in use. During the main service and office hours, the predicted noise levels are likely to be as much as 5 dB lower and compliant with the applicable criterion. Noise mitigation is therefore not considered reasonable and has not been recommended for this receiver.

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing
	30dB(A) A quiet country park
	40dB(A) Whisper in a library
	50dB(A) Open office space
	70dB(A) Inside a car on a freeway
	80dB(A) Outboard motor
	90dB(A) Heavy truck pass-by
	100dB(A) Jackhammer/Subway train
	110 dB(A) Rock Concert
	115dB(A) Limit of sound permitted in industry
	120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level L_{eq}	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L10.

L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L90.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L90 sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The $L_{10,18hr}$ sound level is used to quantify traffic noise in the ACT.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 "Acoustics – Glossary of terms and related symbols".

Appendix B

Site plan and noise logging locations

AECOM

Legend

Design alignment

Noise loggers

Dudley Street Upgrade

Noise logger locations

Source:

0 50 100 200 m

NOV 2017

60533438

Fig. **1**

Appendix C

Noise logging charts

Logger 1 - Canberra Central Park - 16/06/17 - 25/06/17

Logger Setup

Logger Type: Rion NL52

Serial No : 164395

Address: Canberra Central Park , Yarralumla

Location: Park

Facade / Free Field: Free Field

Environment: Environment dominated from road traffic on Dudley street 45dB. Most traffic consisting of cars and vans. very still day, no wildlife noise to be heard. Distant noise from freeway further away barely audible

Logger Setup Photo

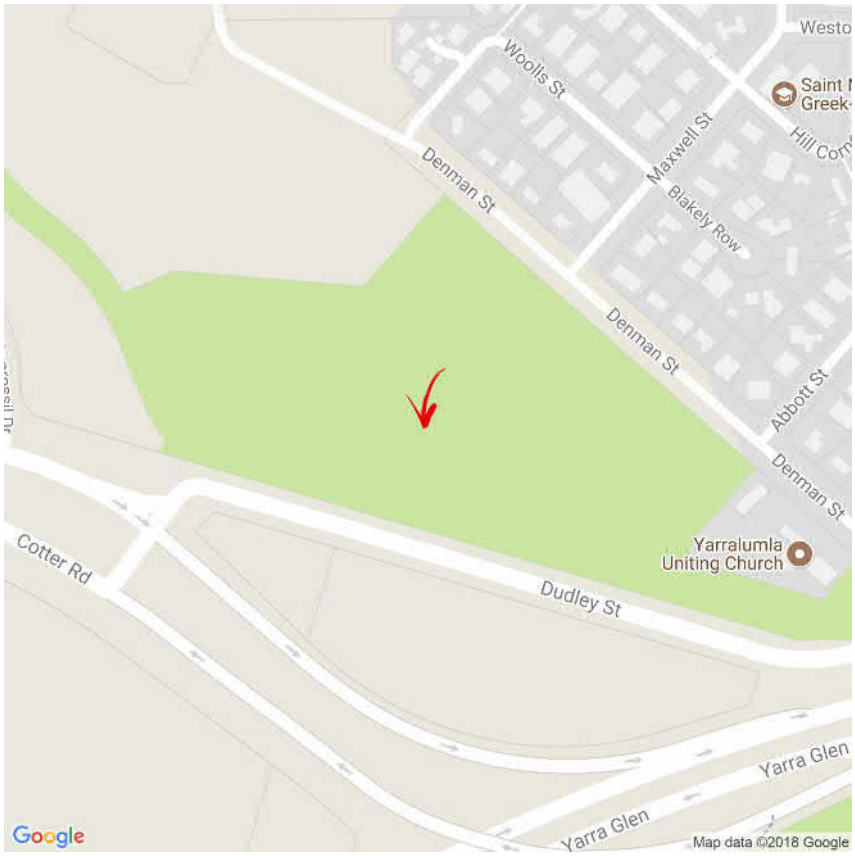
INP Noise Level, dB(A)

	Log Average	RBL
Day	54	45
Evening	54	48
Night	47	32

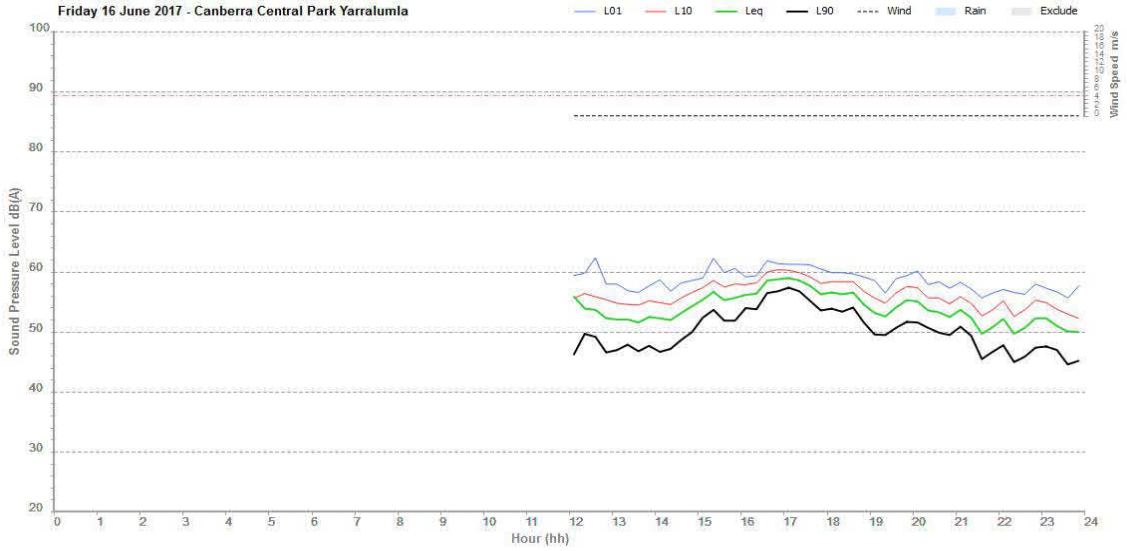
RNP Noise Level, dB(A)

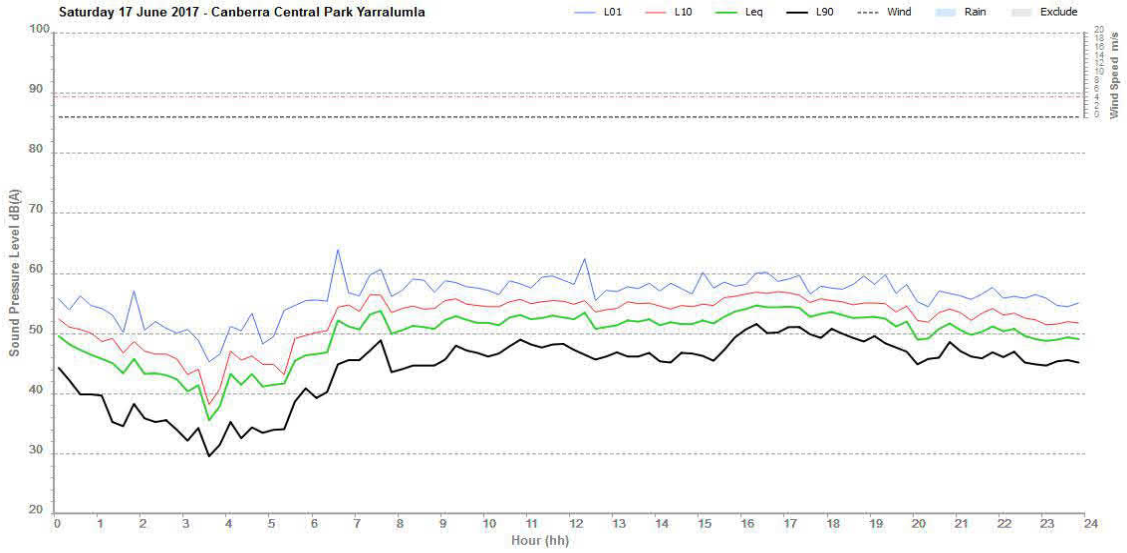
	$L_{Aeq(1hr)}$	$L_{Aeq(period)}$
Day (7am - 10 pm)	-	-
Night (10pm - 7am)	-	-

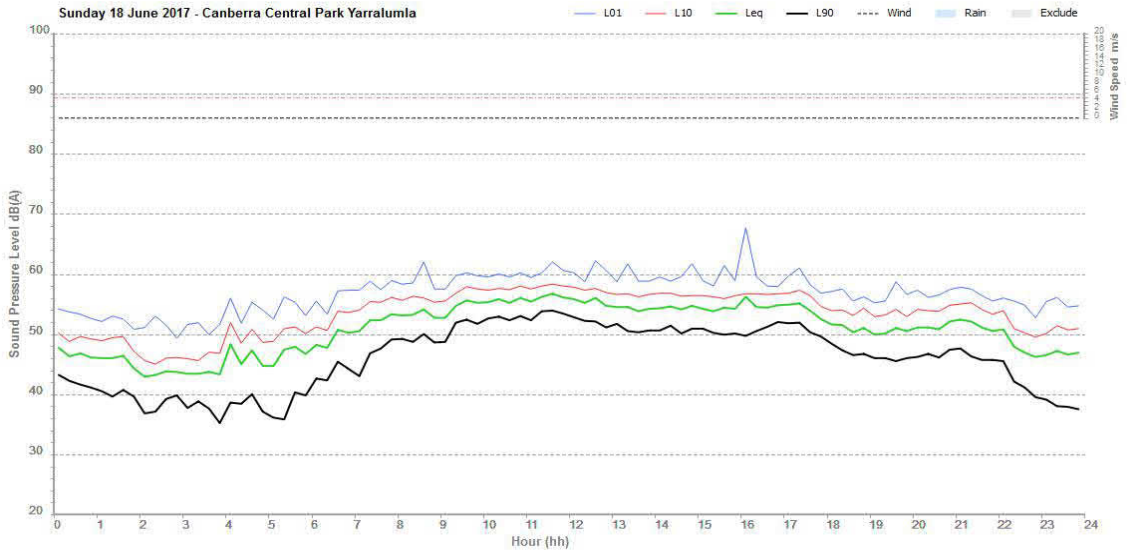
Logger Location Map



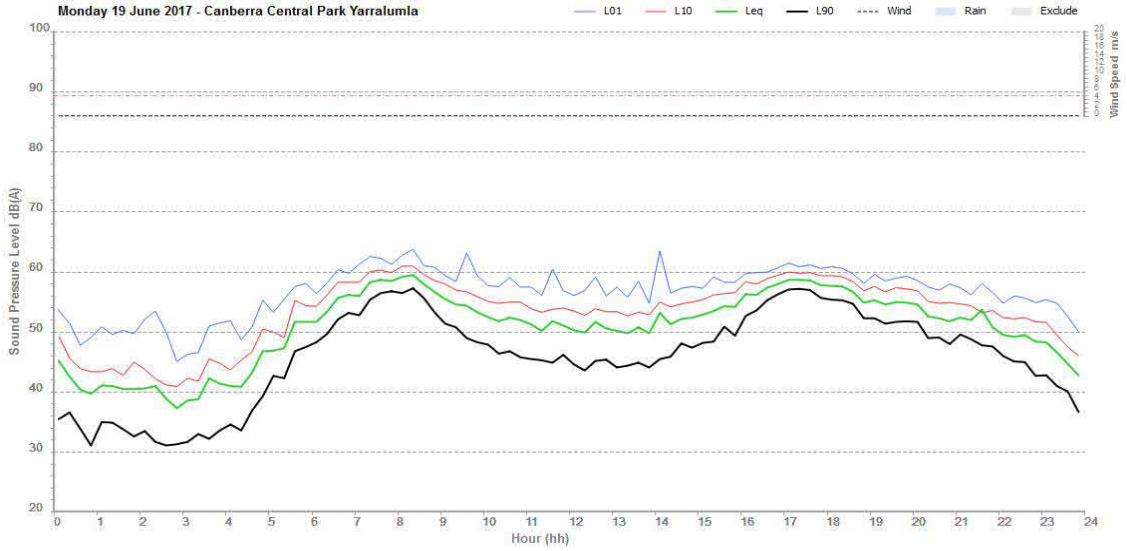
Logger Graphs

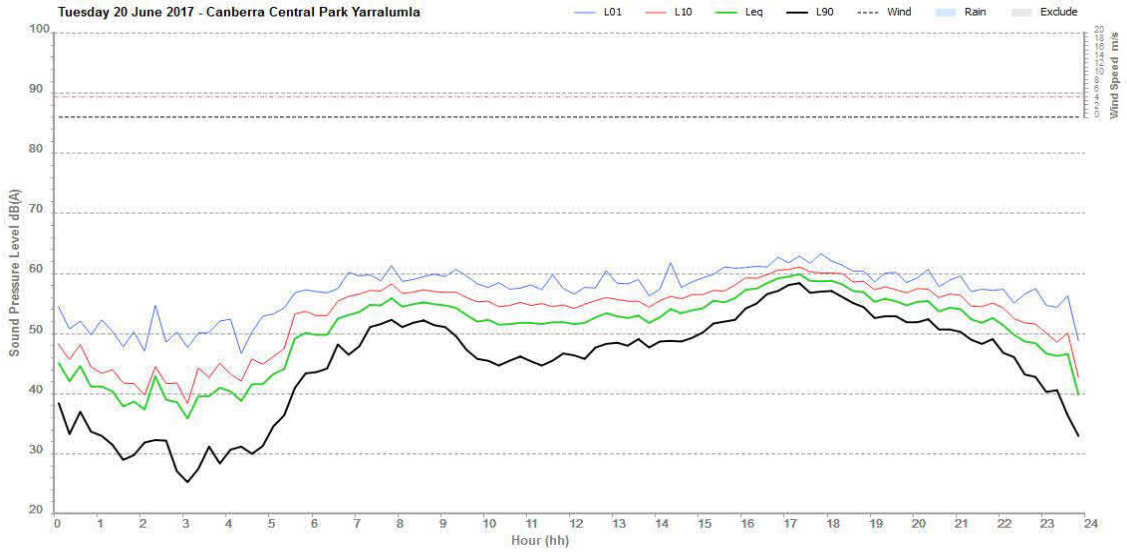


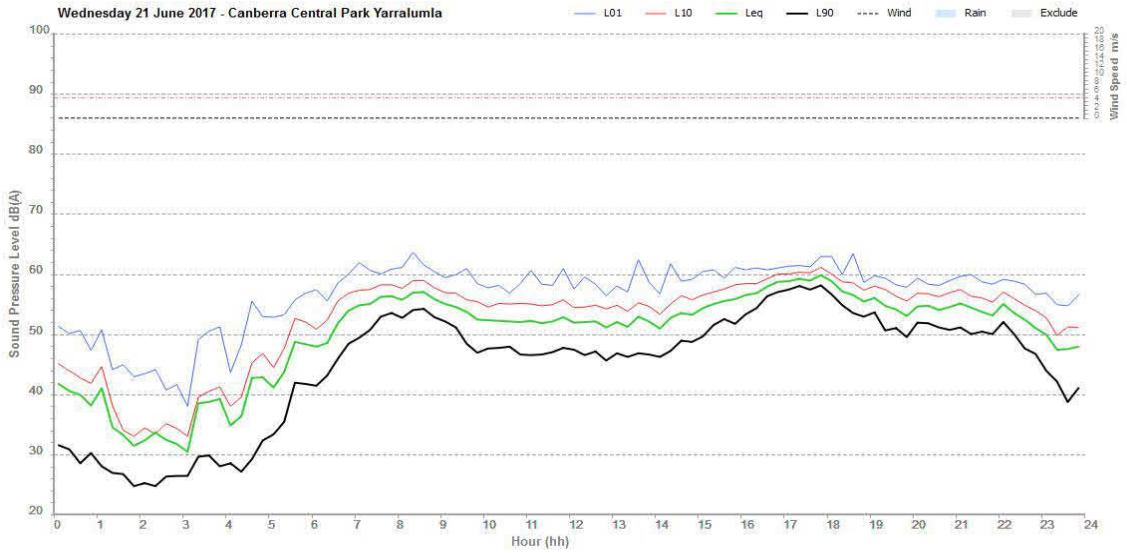




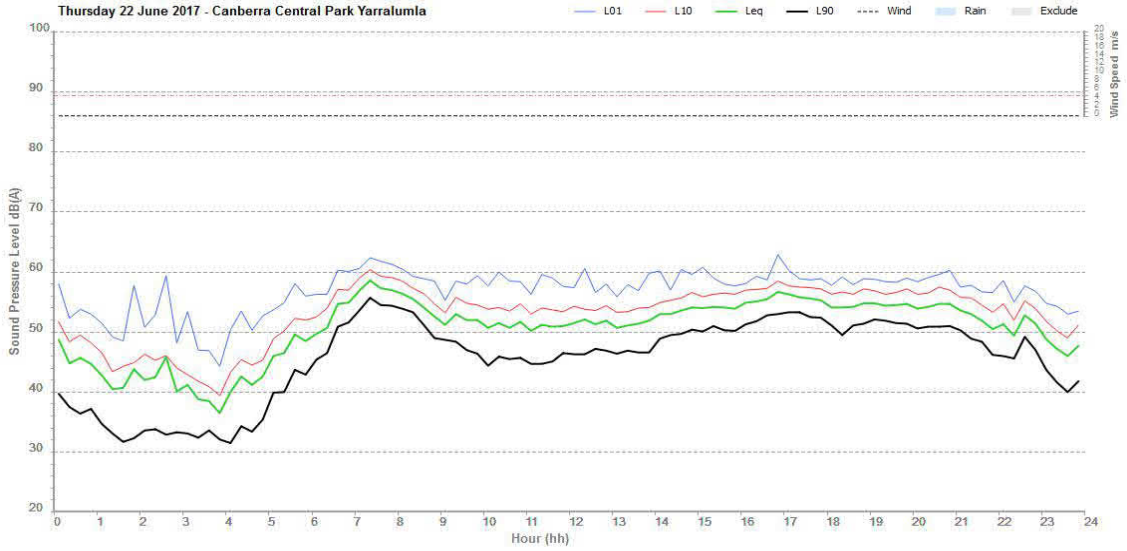
Logger Graphs

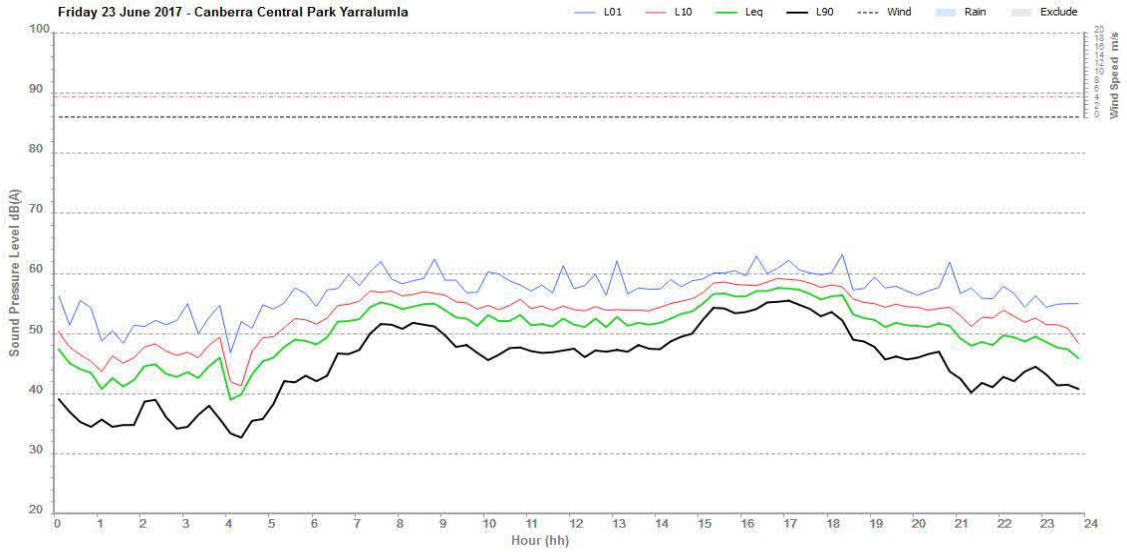


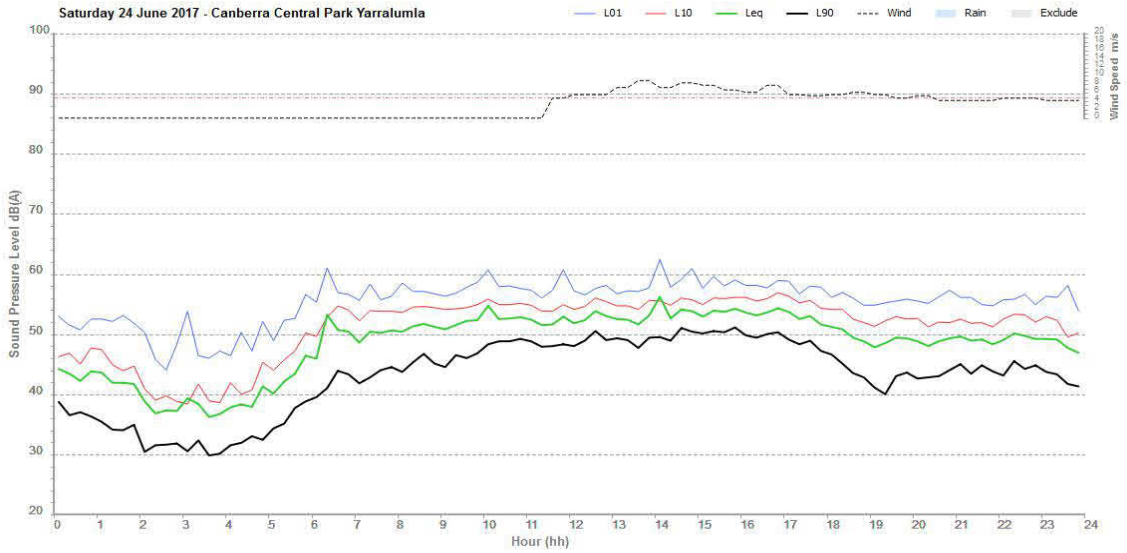




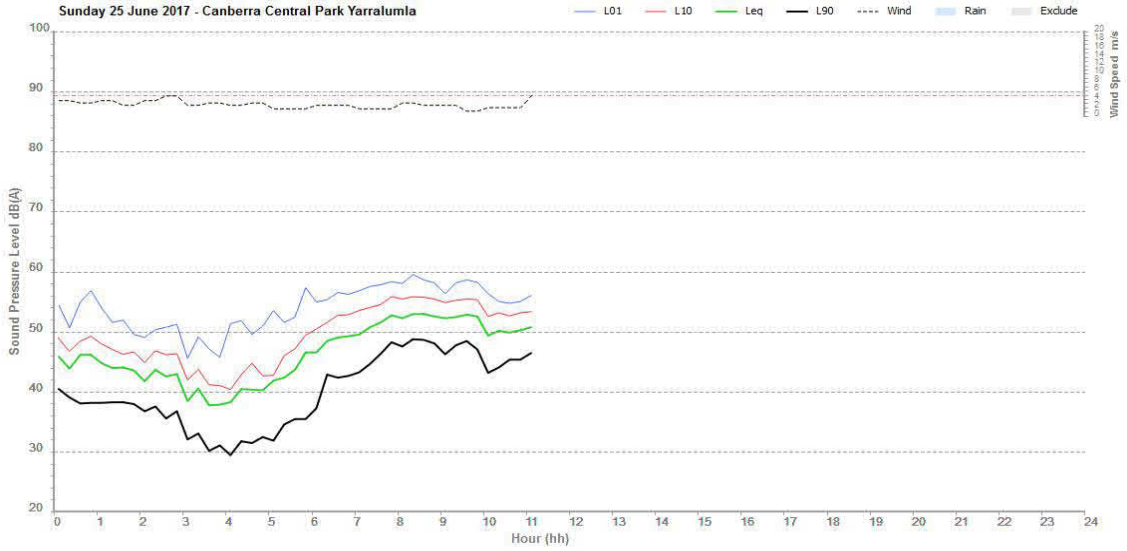
Logger Graphs







Logger Graphs



Logger 2 - 12 Denman Street - 16/06/17 - 25/06/17

Logger Setup

Logger Type: Rion NL52

Serial No : 1043455

Address: 12 Denman Street , Yarralumla

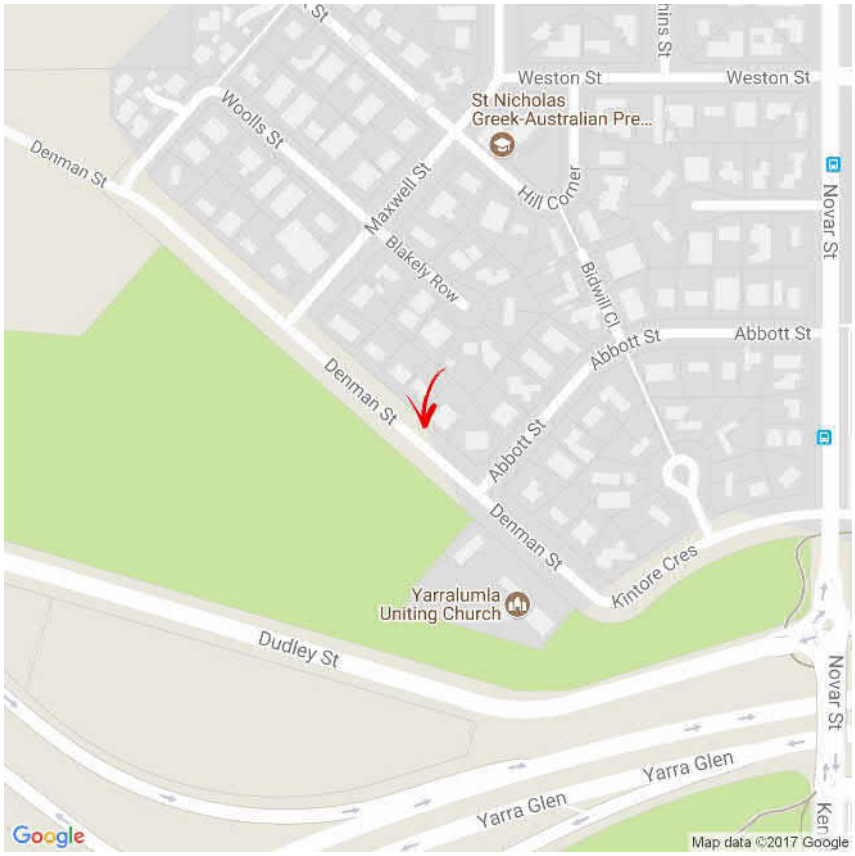
Location: Front of House

Facade / Free Field: Free Field

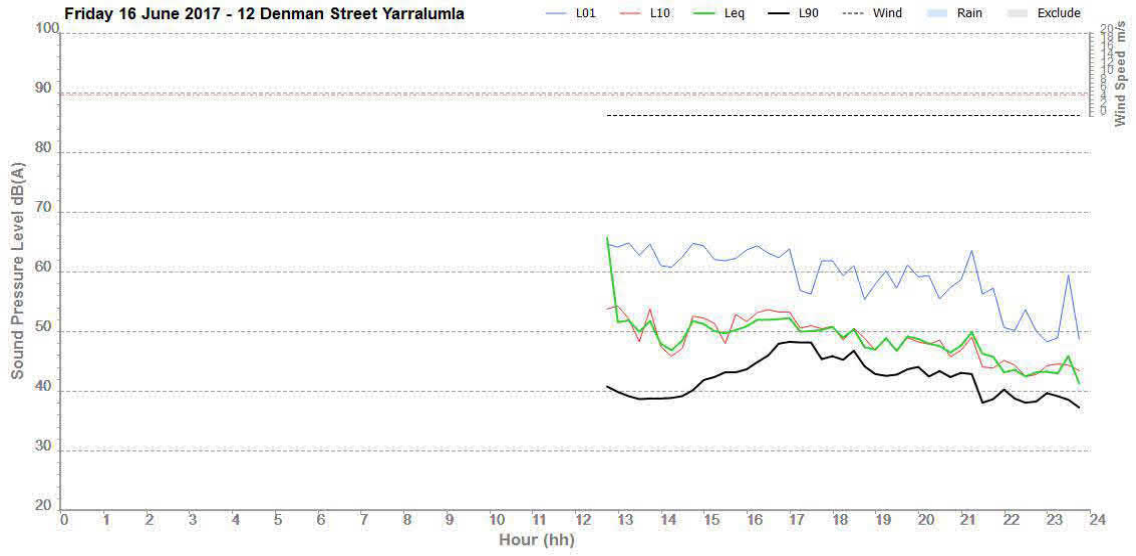
Environment: Very faint noise from Dudley street. Adelaide Avenue noise inaudible. Occasional car pass by on Denman Road. Birds chirping in trees in adjacent woodland, dog barking behind houses on Denman street.

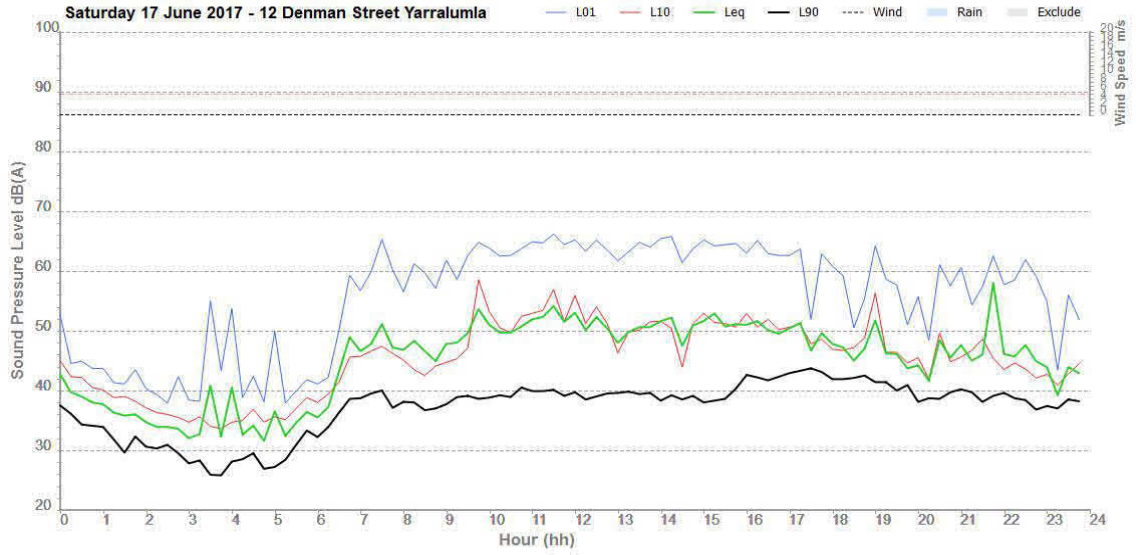
Logger Setup Photo

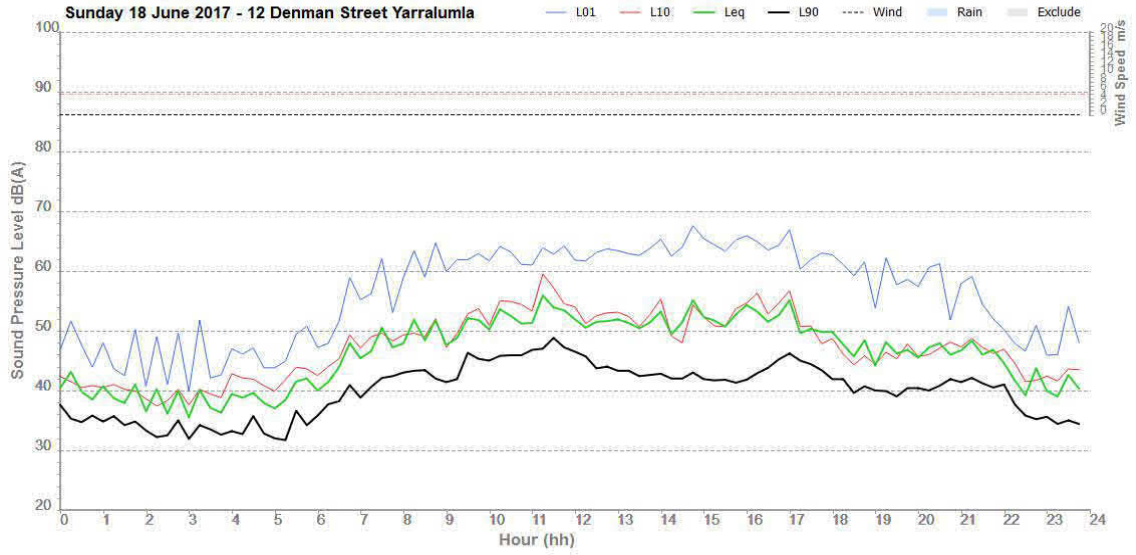
Logger Location Map



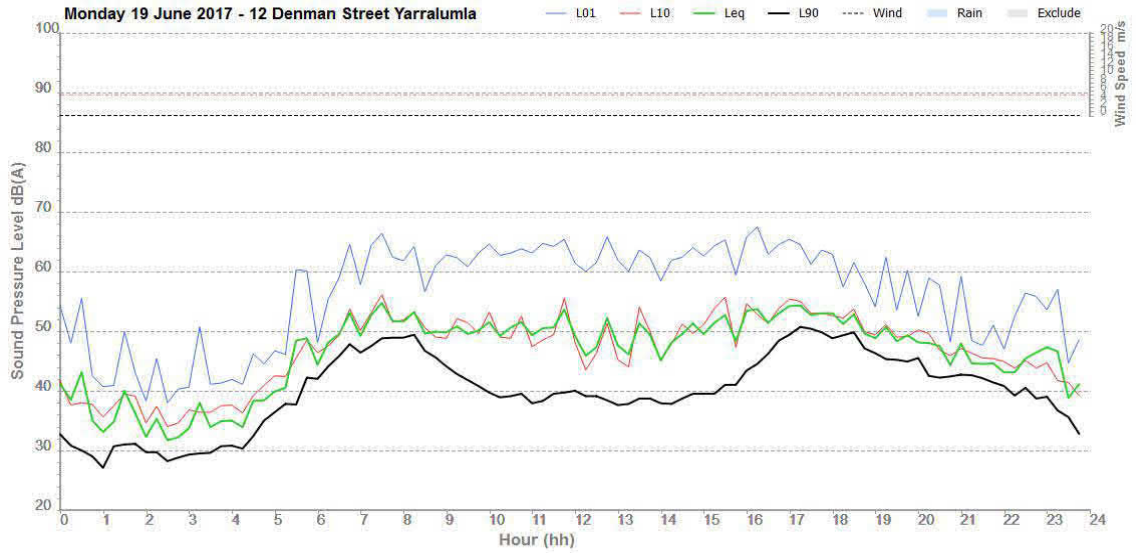
Logger Graphs

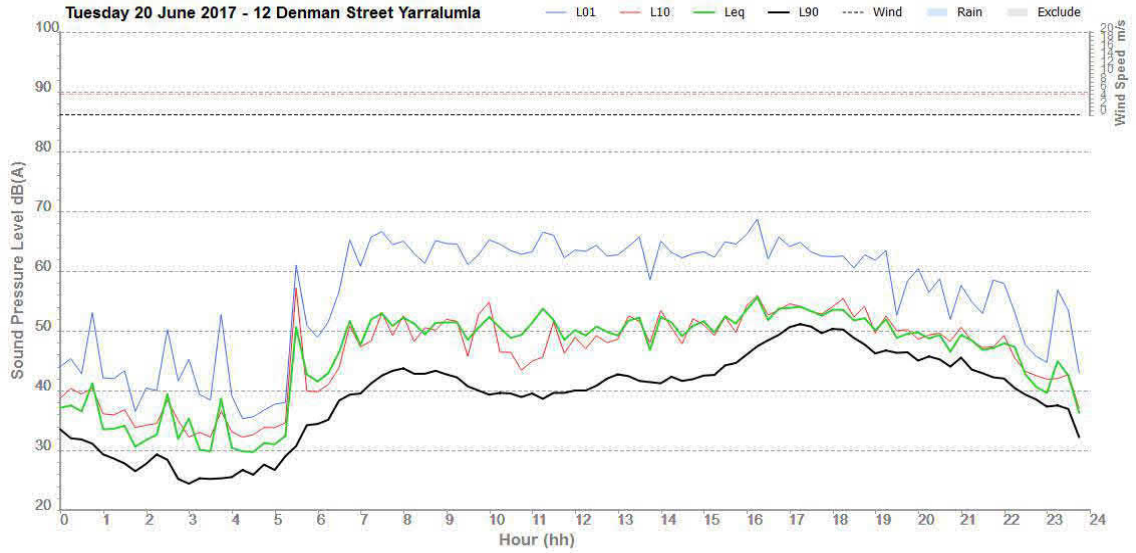


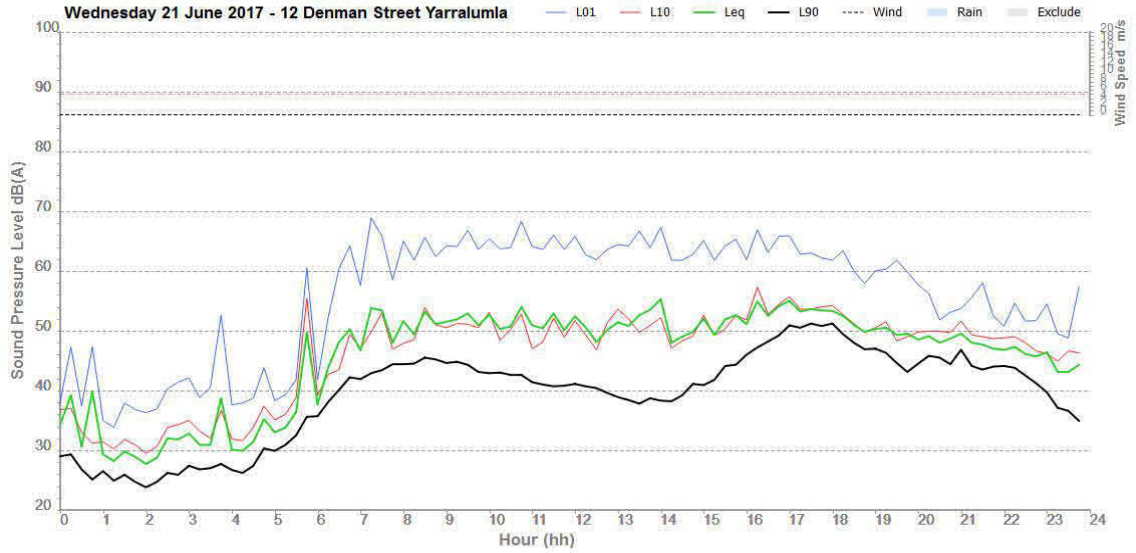




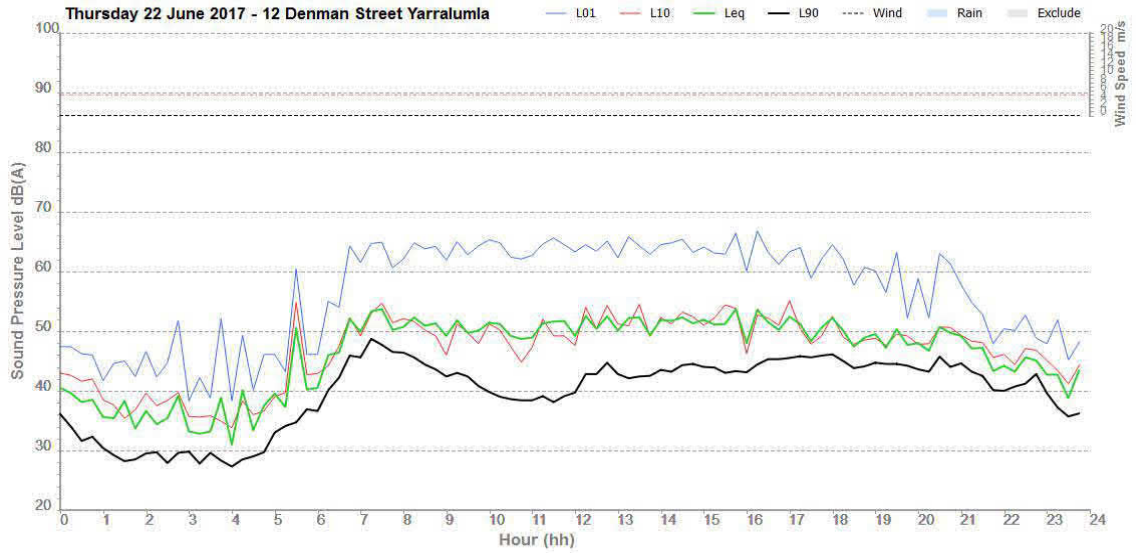
Logger Graphs

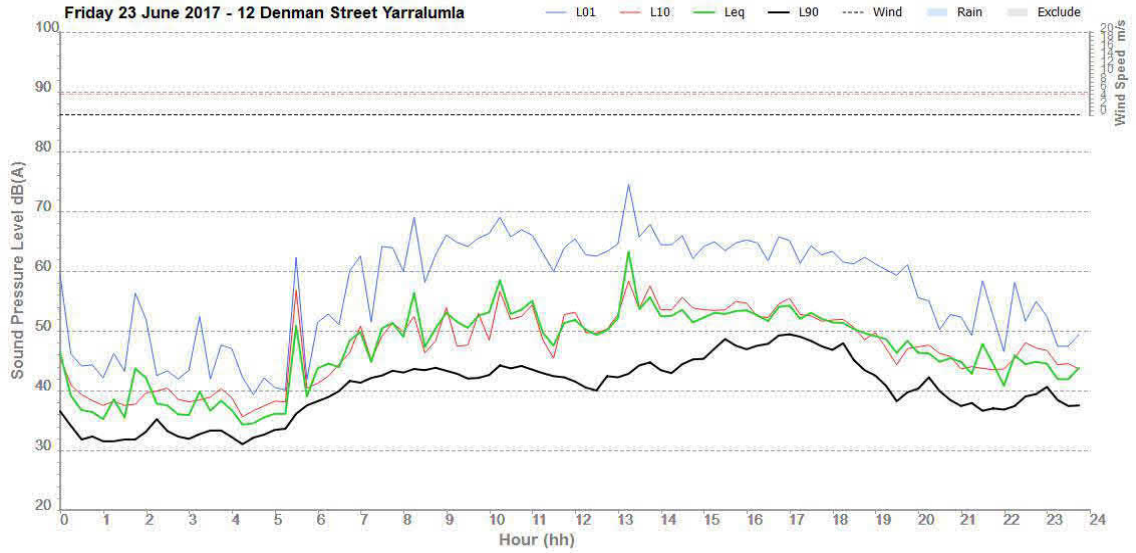


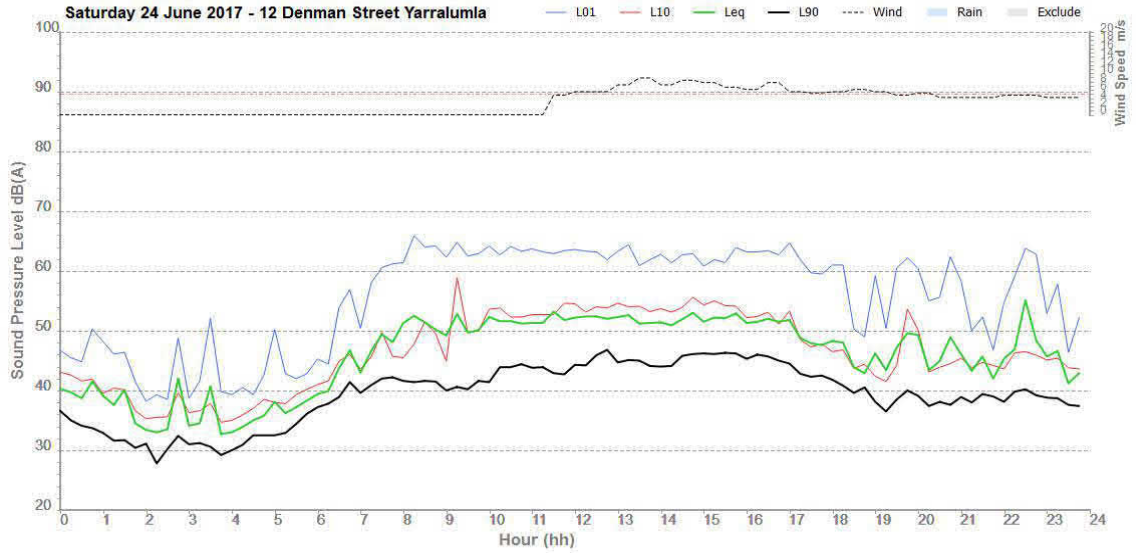




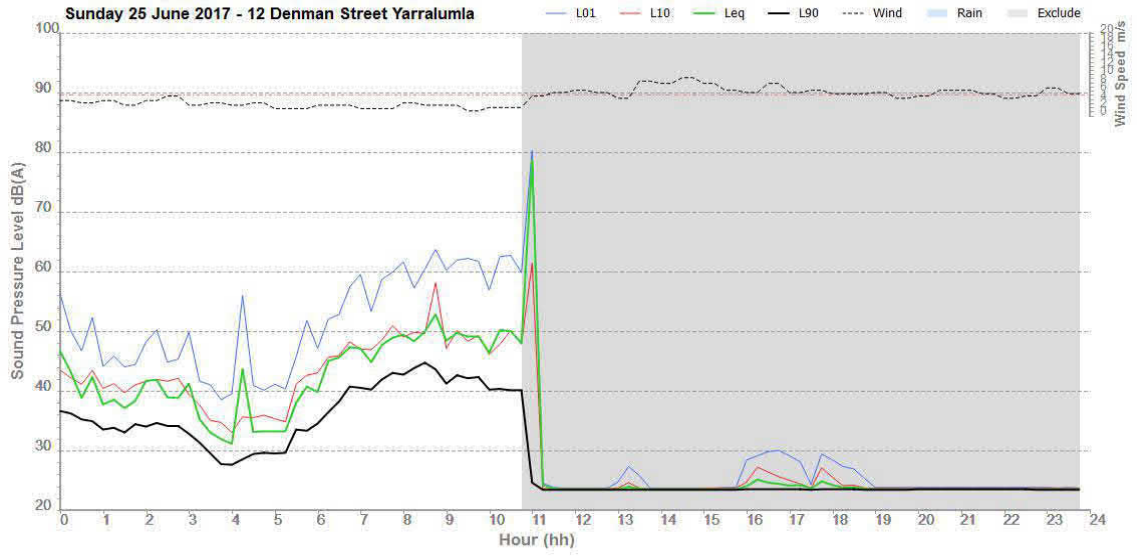
Logger Graphs







Logger Graphs



Logger 3 - Yarralumla Uniting Church - 16/06/17 - 25/06/17

Logger Setup

Logger Type: Rion NL52

Serial No : 553966

Address: Tourist Drive 2 Curtin , ACT

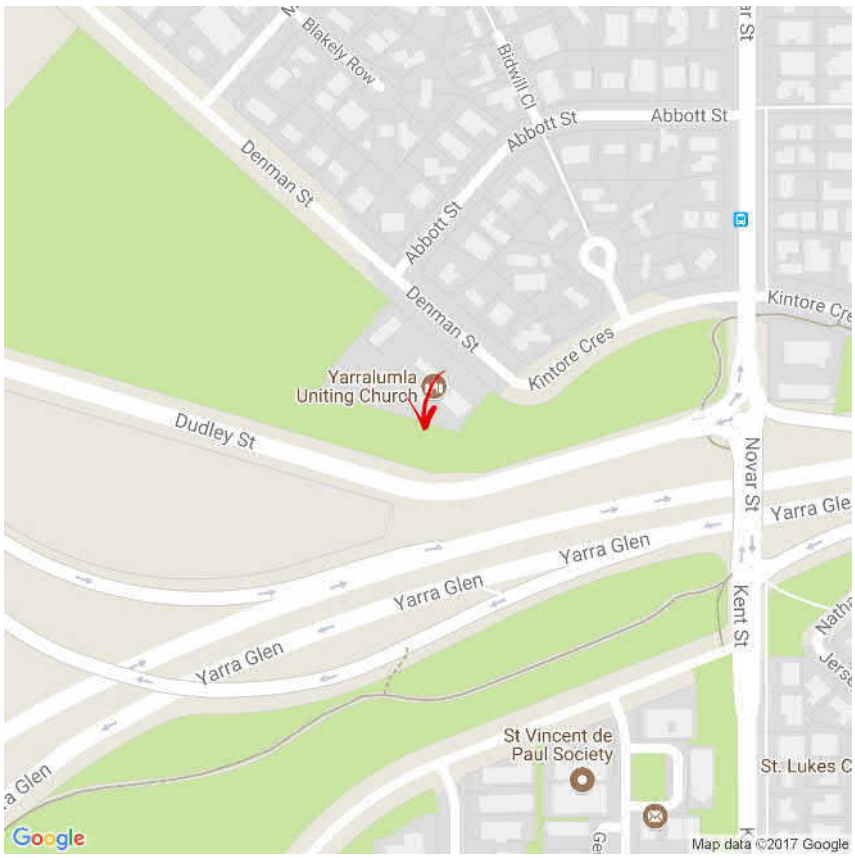
Location: Sign in front of church

Facade / Free Field: Free Field

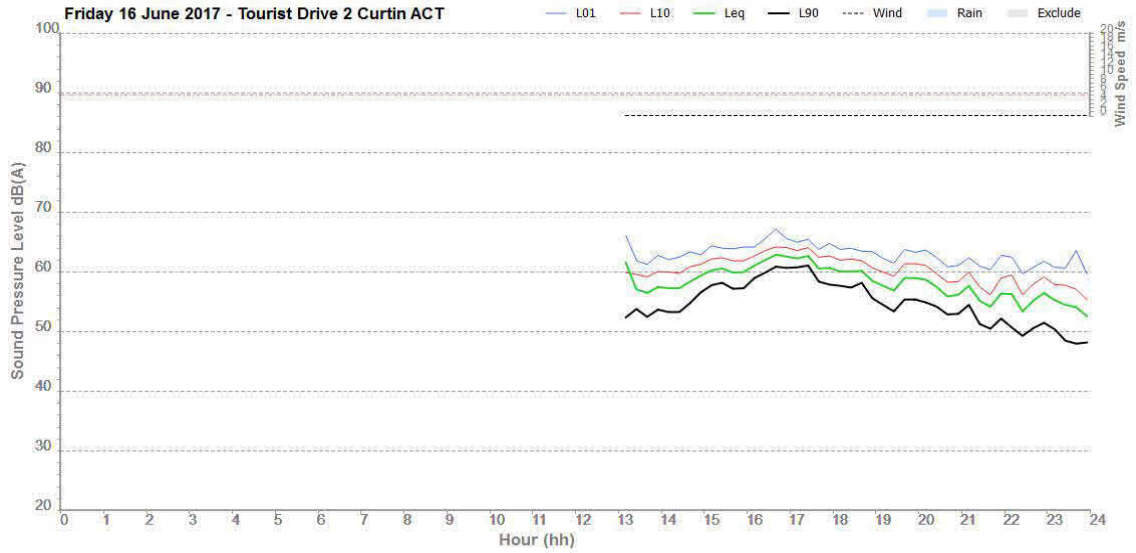
Environment: Noise environment dominated by dudley street traffic. Distant but audible noise from highway can also be heard. No wildlife noise

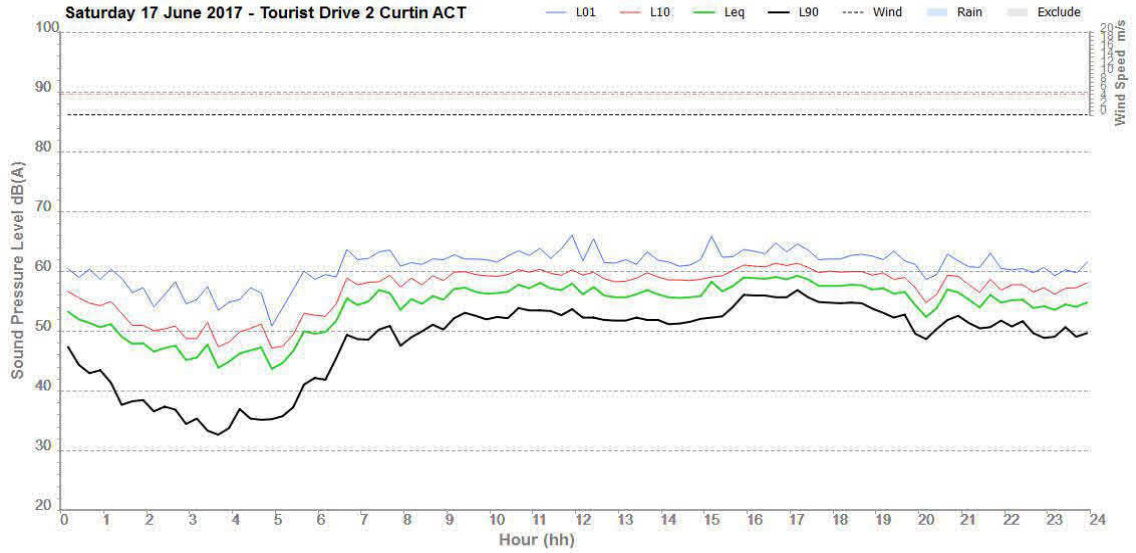
Logger Setup Photo

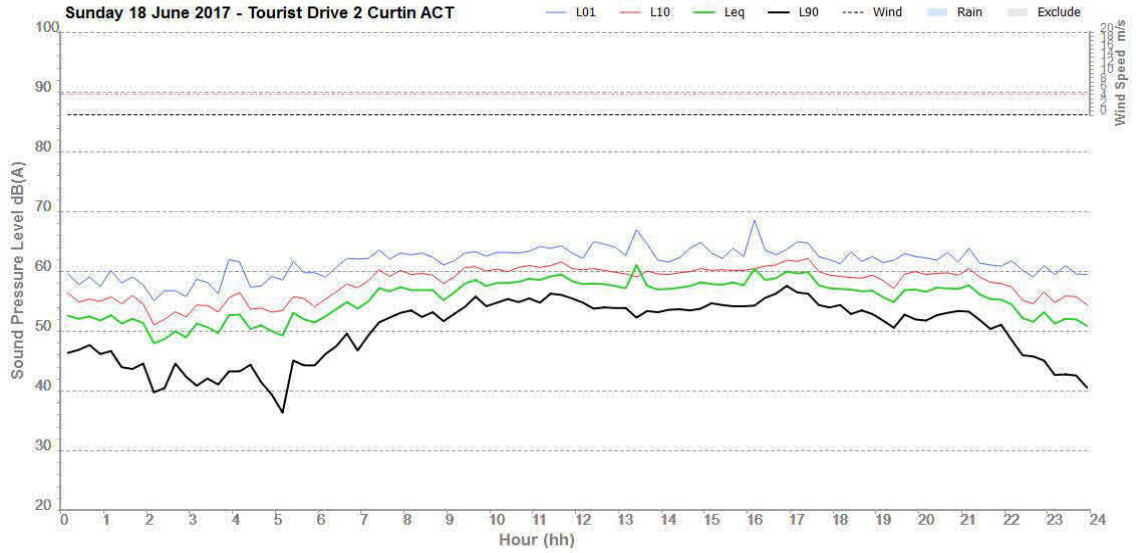
Logger Location Map



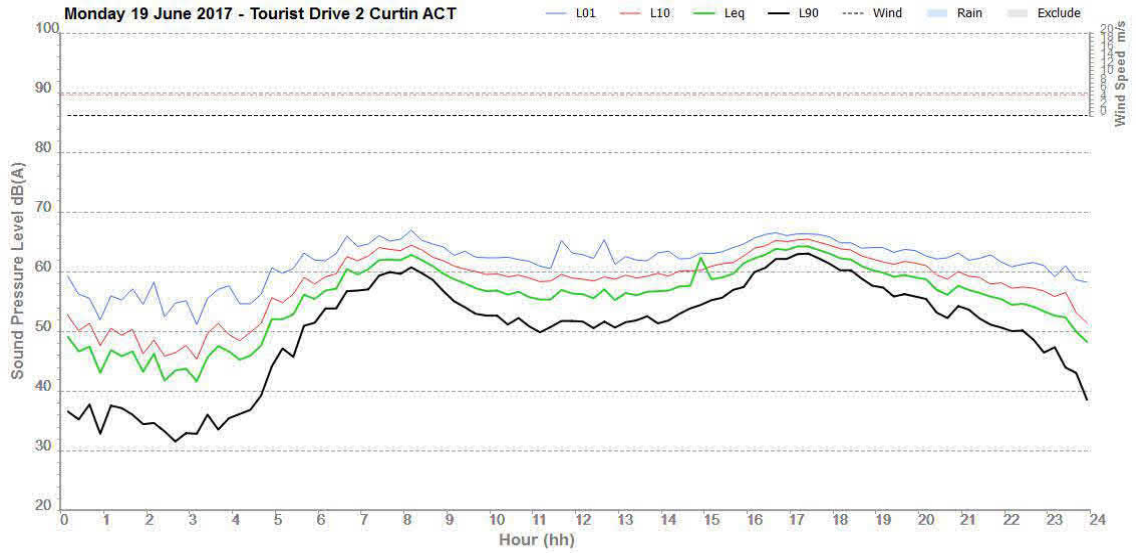
Logger Graphs

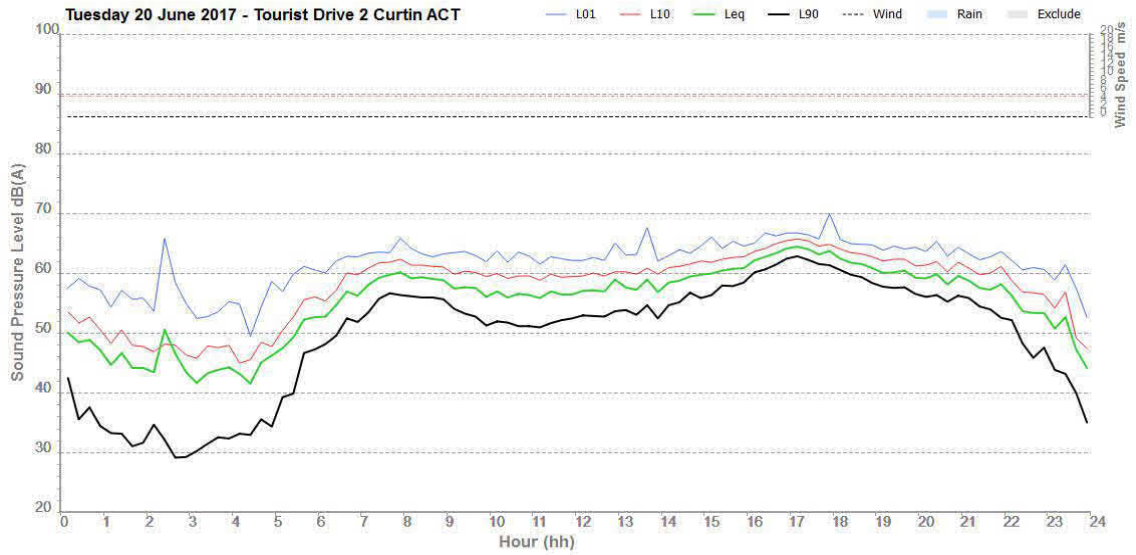


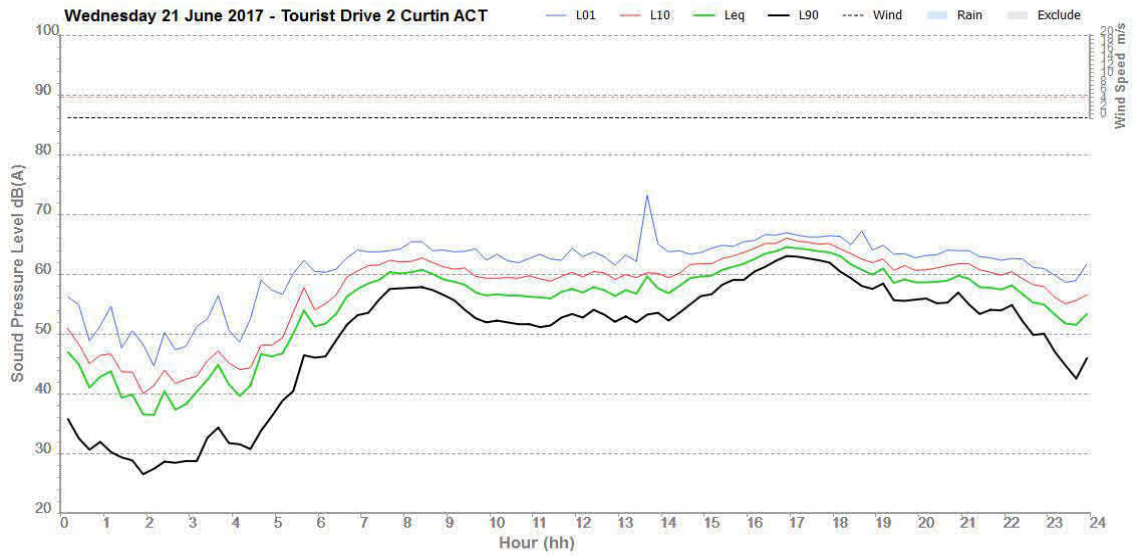




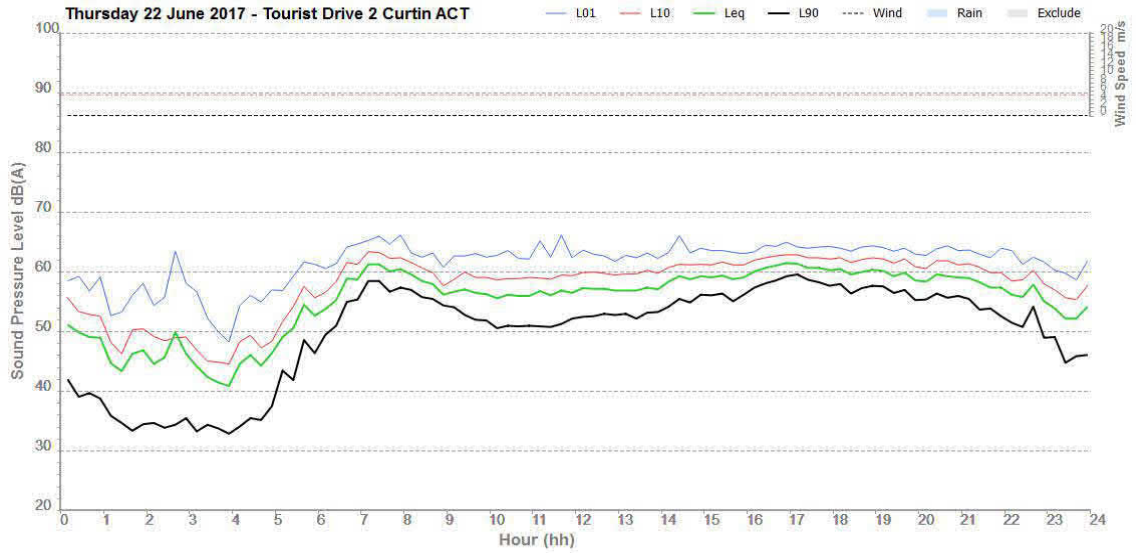
Logger Graphs

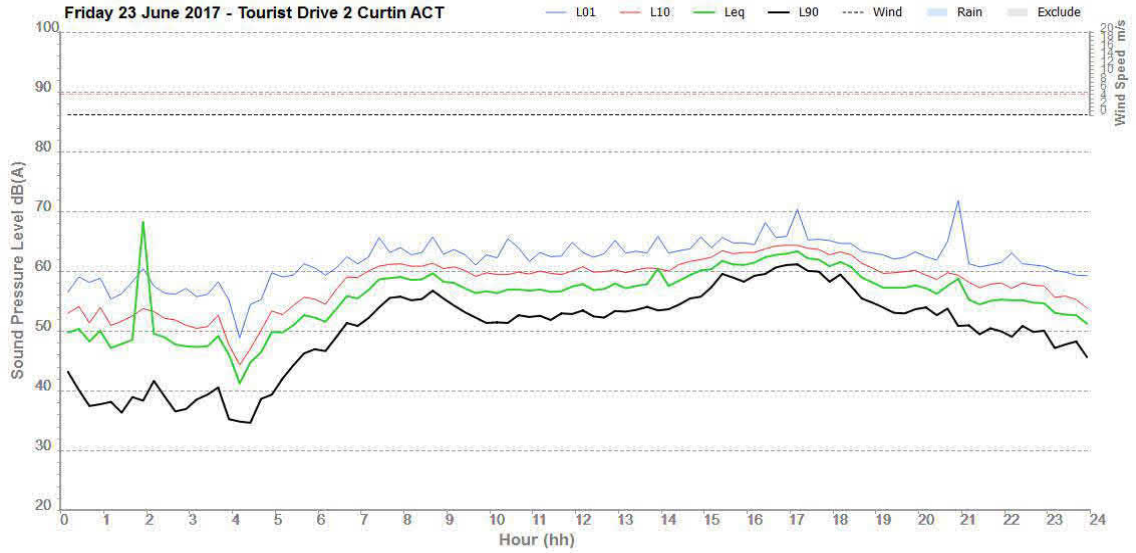


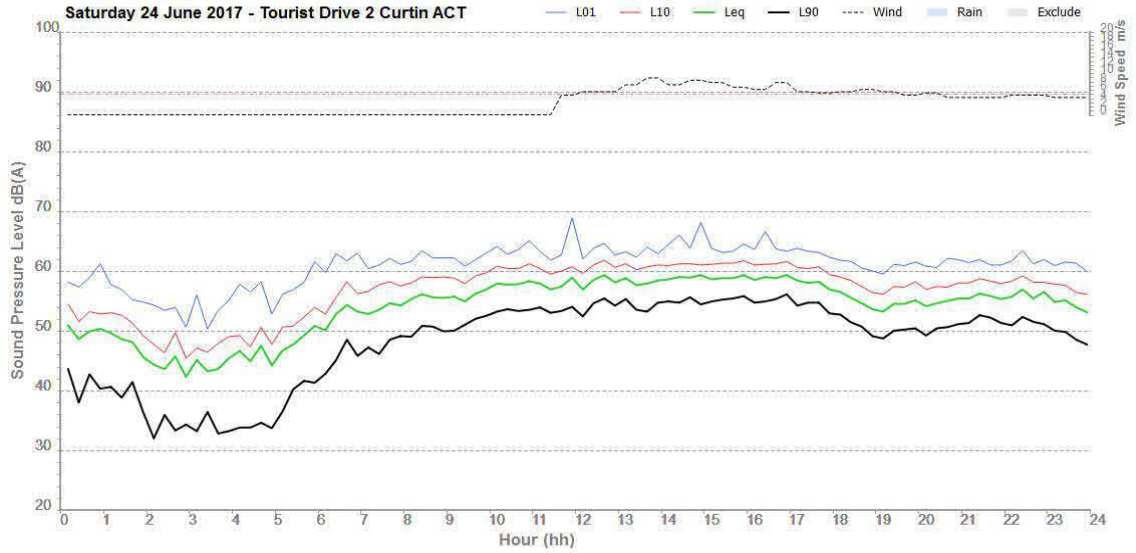




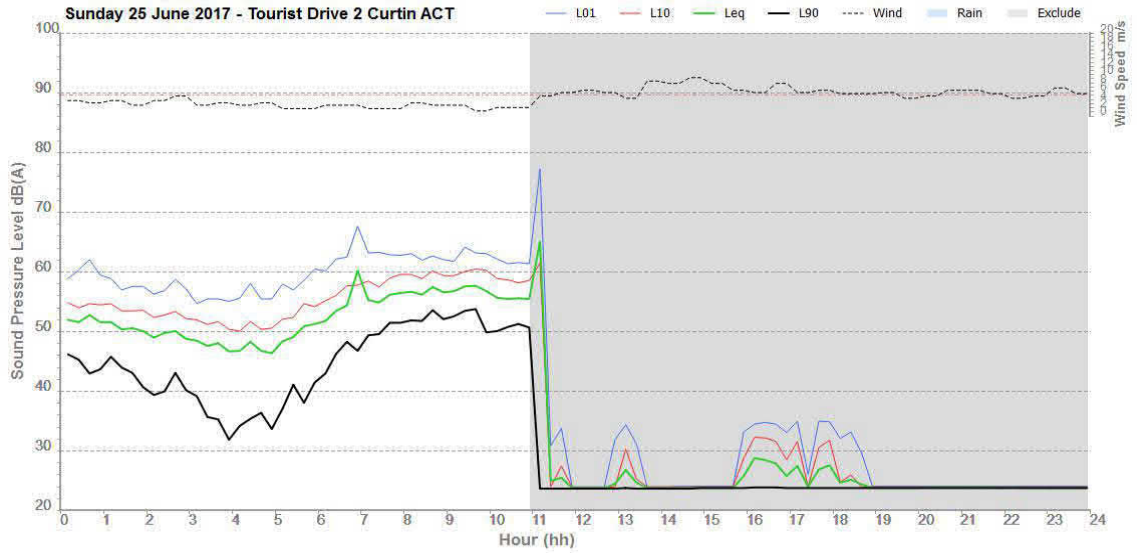
Logger Graphs







Logger Graphs



Appendix D

Noise contour maps

$L_{A10(18hour)}$ noise levels, dBA

58 - Open space criteria (no facade correction)

63 - Sensitive receiver criteria (facade correction included

Design alignment

Dudley Street Upgrade

Year 2017 - Existing Noise Level

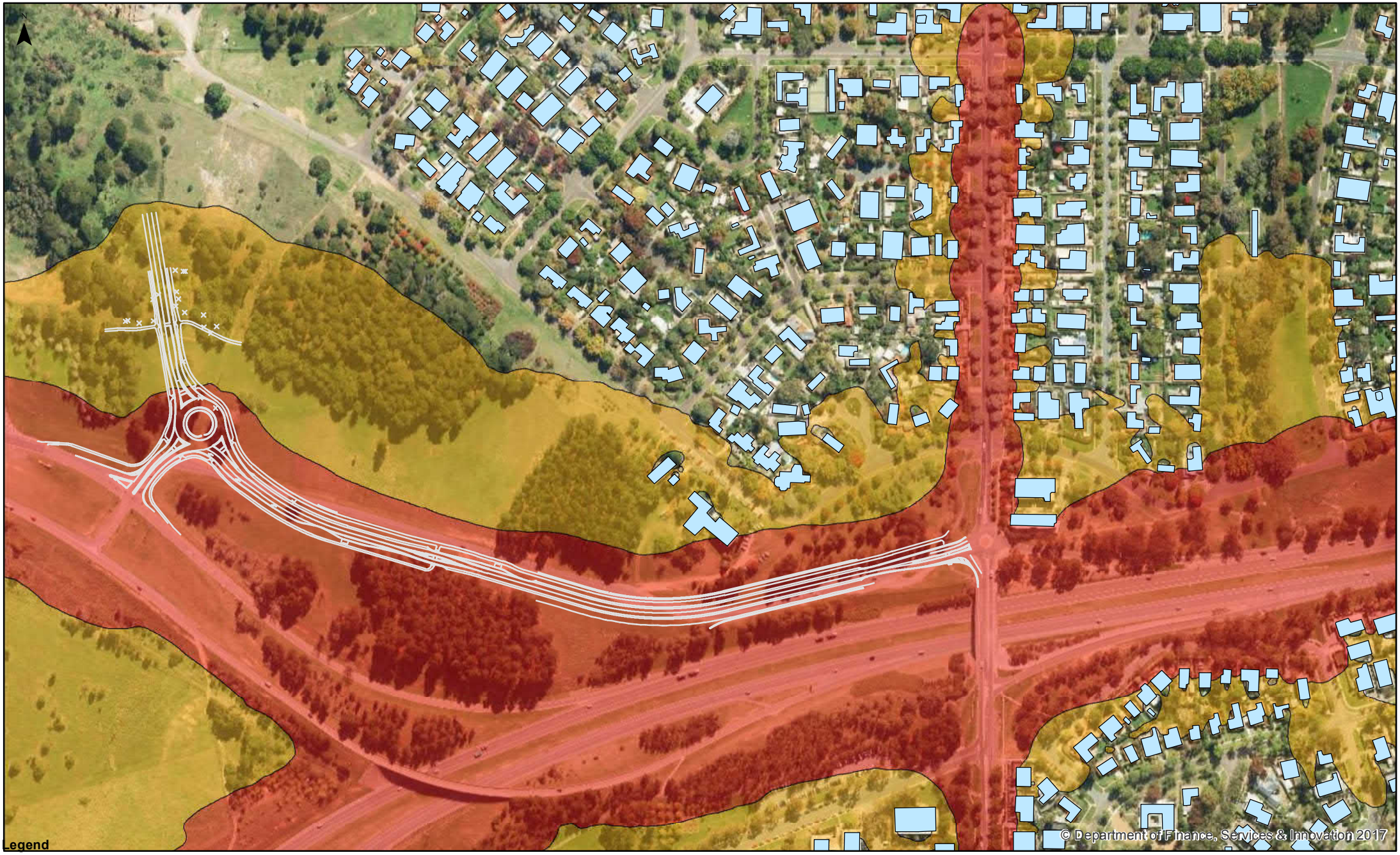
Source: AECOM

0 50 100 200 m

NOV 2017

60533438

Fig. **1**



$L_{A10(18hour)}$ noise levels, dBA

58 - Open space criteria (no facade correction)

63 - Sensitive receiver criteria (facade correction included

Design alignment

Dudley Street Upgrade

Year 2029 - Design Noise Levels

Source: AECOM

0 50 100 200 m

NOV 2017

60533438

Fig. **2**