Eastlakes North – S75W Modification to Operating and Loading Dock Hours - Acoustic Report

Crown Group

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Eastlakes North – S75W Modification to Operating and Loading Dock Hours - Acoustic Report

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1 INTRODUCTION

Pulse Acoustics Consultancy (Pulse Acoustics) has been engaged by Crown Group to undertake an acoustic impact assessment for the proposed S75W Modification to extend the hours of operation for the approved development of the Eastlakes North Shopping Centre.

This report discusses the acoustic criteria adopted for the project and the outcome of the noise impact assessment. A list of acoustic terminology used in this report is included in Appendix A of this report

1.1 Purpose of the Report

The purpose of this report is to assess the noise impacts of increasing operating hours on the Eastlakes North Development.

The Section 75W Modification proposes to extend the hours of operation as indicated below:

Table 1 Centre Operating Hours

Operating Hours	Existing Shopping Centre	S75W Application (Mod 1 – Latest Approval)	NEW Modification – Proposed
Centre Trading Hours	7am-10pm	None stipulated in the consent.	6am – 10pm, 7 days a week
Loading Dock Hours	No restrictions, self-managed to start at 6am	7am-9pm	5am – 10pm
Waste Management Hours	No restrictions, self-managed 6am-9pm	7am-5pm Monday-Saturday	5am – 10pm

Note 1: The EPA defines the daytime, evening and night-time as follows: Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Figure 1 Site Layout

Figure 1 shows that the nearest affected residences to the Eastlakes North development are located on Evans Avenue (16 and 18 Evans Avenue). Additionally, the nearest commercial premise to the development is the existing Eastlakes Shopping Centre, which is located at 19a Evans Ave, Eastlakes.

Also, it should be noted that the existing ambient noise level around the development site are mostly influenced by the local road traffic, in particular along Gardeners Road, Southern Cross Drive, Racecourse Place, and Evans Ave.

The architectural drawings for the Eastlakes North development which have been used in our assessment are included in Appendix C of this report.

Key aspects of this assessment include:

- Assessing road traffic during the night-time shoulder period between 5 am and 7 am;
- Assessing loading dock activities and waste collection during the night-time shoulder period between 5 am and 7 am and the late evening period between 9 pm and 10 pm;
- Assessing sleep arousal potential from dock activity, waste collection and traffic generation of the proposed extended operating hours; and
- Provide recommendations to ameliorate any identified impacts from the proposed extension in operating hours.

2 ACOUSTIC SURVEY

An unattended noise survey was conducted between 8th October 2018 and the 26th October 2018 at Unit 1, 16 Evans Ave and 234 Gardeners Road as shown in Figure 2 and Figure 3 below. This measurement survey was conducted at 16 Evans Ave in order to determine the existing ambient noise levels which are representative of the nearest potentially noise affected receivers to the development. The noise survey at 234 Gardeners Road was conducted to determine traffic noise levels for use in calibrating the noise model developed of the site.

Instrumentation for the survey comprised a Svan 971 noise logger (serial number 39165 and 61521). Calibration of the logger was checked prior to and following the measurements. Drift in calibration did not exceed ±0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Charts presenting summaries of the measured daily noise data are attached in Appendix B. The charts present each 24-hour period and show the L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise levels for the corresponding 15-minute periods. This data has been filtered to remove periods affected by adverse weather conditions based on weather information obtained from Sydney Airport (station ID 066037).

Additionally, the wind speed data obtained from the weather station has been corrected to the height of the noise logger. These corrections were carried out according to the procedures provided in Standard "*AS / NZ 1170.2-2011 Structural design actions – Wind actions"* as outlined in the Proceedings of Acoustics 2004 paper titled "*Converting Bureau of Meteorology wind speed data to local wind speeds at 1.5m above ground level".*

2.1 Noise Measurements for Industrial Noise Assessment

The measurement results for the unattended noise survey are summarised in Table 1 below for the standard Environment Protection Authority (EPA) time periods. These time periods are:

- Monday to Saturday –
    - Daytime 7:00 am – 6:00 pm;
    - Evening 6:00 pm – 10:00 pm; and
    - Night-time 10:00 pm – 7:00 am.
- On Sundays and Public Holidays –
    - Daytime 8:00 am – 6:00 pm;
    - Evening 6:00 pm – 10:00 pm; and
    - Night-time 10:00 pm – 8:00 am

The measurement results have also been processed to account for the morning "shoulder period" where the proposed operating hours extends partially into the EPA night time period. These results are summarised in Table 2 below. These shoulder periods results have been used for the assessment of loading dock activity, waste collection and traffic generation that will occur during the proposed extended operating hours.

Figure 2 Logger Deployment (16 Evans Ave)

Figure 3 Logger Deployment (234 Gardeners Road)

Table 1 Measured ambient noise levels – unattended noise survey

Measurement Location	Daytime[1] 7:00 am to 6:00 pm		Evening[1] 6:00 pm to 10:00 pm		Night-time[1] 10:00 pm to 7:00 am	
	L_{A90}[2]	L_{Aeq}[3]	L_{A90}[2]	L_{Aeq}[3]	L_{A90}[2]	L_{Aeq}[3]
Logger Location (16 Evans Ave)	**53**	**64**	47	58	45	59
Logger Location (234 Gardeners Road)	58	69	51	63	41	62

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{A90} 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 L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Table 2 Measured Ambient Noise Levels – Morning Shoulder Time Periods

Measurement Location	Parameter	
	RBL [1]	L_{Aeq} [2]
Logger Location (16 Evans Ave) Shoulder period: 5:00 am – 7:00 am	**53**	**65**
Logger Location (234 Gardeners Road) Shoulder period: 5:00 am – 7:00 am	55	68

Note 1: 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 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

As can be seen by the noise monitoring results provided in Table 1 and Table 2 above, the background noise level at Evans Avenue is the same in the early morning shoulder period between 5:00 am and 7:00 am as it is for the daytime period generally.

2.2 Road traffic noise measurements

Traffic noise levels are generally represented by the L_{Aeq} noise level for the 15-hour daytime period between 7 am and 10 pm and the 9 hour night period between 10 pm and 7 am. Maximum 1-hour noise levels during the night and day time periods are also used in the assessment of traffic generation.

The traffic noise levels at the monitoring locations are given in Table 3 below.

Table 3 Measured traffic noise levels

Measurement Location	Noise Level, dB(A)			
	Day, $L_{Aeq, 15hr}$	Night, $L_{Aeq, 9hr}$	Day, $L_{Aeq, 1hr}$	Night $L_{Aeq, 1hr}$
Residences (16 Evans Ave)	63	59	65	63
Residences (234 Gardeners Rd)	68	62	70	67

3 ACOUSTIC CRITERIA

The assessment criteria around the proposed site have been established as follows:

- The assessment of noise emissions by vehicle movements on site, loading dock activity and mechanical services associated with the extended operating hours, the criteria have been derived in accordance with the *Noise Policy for Industry* (NSW NPI); refer to Section 3.1 below;
- The assessment of additional traffic on existing roads will be performed against the criteria contained in the NSW *Road Noise Policy* (NSW RNP); refer to Section 3.2 below; and
- The assessment of short-term events with respect to the potential for sleep disturbance; refer to Section 3.3 below.

3.1 NSW Noise Policy for Industry

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

The NSW EPA has recently released a document titled *Noise Policy for Industry* (NSW NPI) which provides a framework and process for determining external noise criteria for the assessment of noise emission from industrial developments. The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

3.1.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15 minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

3.1.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

3.1.3 Area Classification

The NSW NPI characterises the "Urban Residential" noise environment as an area with an acoustical environment which shows the following:

- It is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable sources, consisting mostly of traffic and/or industrial related sounds
- Has through traffic with characteristically heavy and continuous traffic flows during peak periods
- is near commercial districts or industrial districts
- It has a combination of any of the above

Figure 4 is obtained from the NSW Government Planning Portal website and shows the land zoning map of the proposed development and the nearest sensitive receivers. According to Figure 4, the residential area surrounding the proposed development falls under the "Urban" area classification (residential areas located within B2 zones are classified as "urban residential" according to Table 2.3 of the NSW NPI). For residential and non-residential receivers in an urban area, the recommended amenity criteria are shown in Table 4 below.

When the existing noise level from industrial noise sources is close to the recommended "Amenity Noise Level" (ANL) given above, noise from the new source must be controlled to preserve the amenity of the area in line with the requirements of the NSW NPI.

Figure 4 Zoning Map

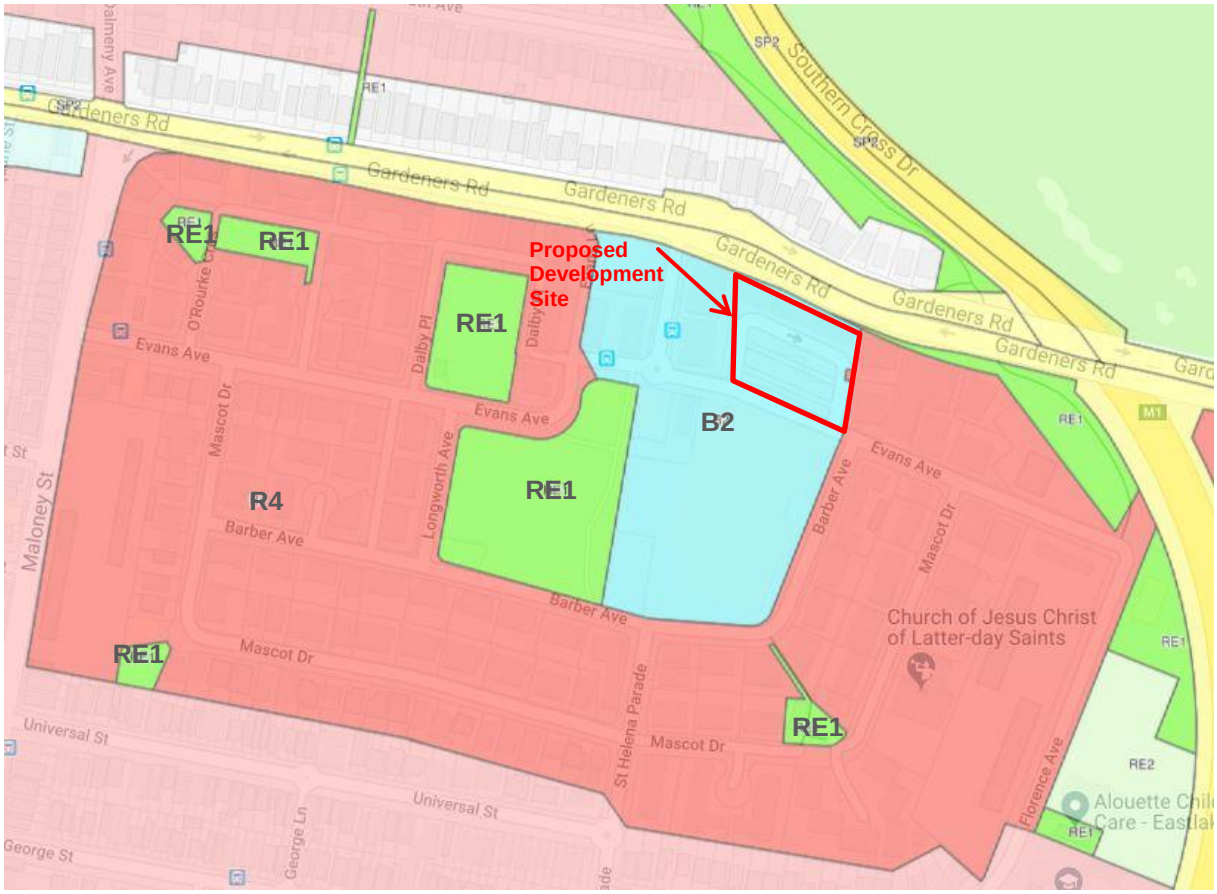


Table 4 NSW NPI – Recommended L_{Aeq} noise levels from noise sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2]
Residence	Urban	Day	60
		Evening	50
		Night	45
Commercial	All	When in use	65

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound

3.1.4 Project Trigger Noise Levels

The intrusive and amenity criteria for industrial noise emissions, derived from the measured data, are presented in Table 5. These criteria determine the maximum noise levels allowed at the noise sensitive receivers and limit the noise emissions from the activities generated from the development.

For each assessment period, the lower (i.e. the more stringent) of the amenity or intrusive criteria are adopted. These are shown in bold text in Table 5.

Table 5 External noise level criteria in accordance with the NSW NPI

Location	Time of Day	Project Amenity Noise Level, $L_{Aeq, period}$ [1] (dBA)	Measured $L_{A90, 15\ min}$ (RBL) [2] (dBA)	Measured $L_{Aeq, period}$ Noise Level (dBA)	Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) [4,5]
Residences (16 Evans Ave)	Day	55	53	64	**58**	**58**
	Evening	45	47	58	52	**51**
	Night	40	45	59	**50**	52
	Shoulder period: 5:00 am – 7:00 am	-	53	65	**58**	**58**
Residences (234 Gardeners Road)	Day	55	58	69	63	**62**
	Evening	45	51	63	**56**	**56**
	Night	40	41	62	**46**	55
	Shoulder period: 5:00 am – 7:00 am	-	55	68	**60**	61
Commercial	When in use	60	-	-	-	**63**

Note 1: Project Amenity Noise Levels corresponding to "Suburban" areas, equivalent to the Recommended Amenity Noise Levels (Table 4) minus 5 dBA

Note 2: L_{A90} Background Noise or Rating Background Level

Note 3: Project Noise Trigger Levels are shown in bold

Note 4: This is based on the assumption that the existing noise levels are unlikely to decrease in the future

Note 5: According to Section 2.2 of the NSW NPI, the LAeq, 15 minutes is equal to the LAeq, period + 3 dB

3.2 Noise Impact on Local Roads

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy (NSW RNP) states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night time periods.

3.3 Sleep Disturbance

The potential for sleep disturbance from maximum noise level events from the premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages. Section 2.5 of the NPI states:

> *Where the subject development/premises night-time noise levels at a residential location exceed:*
>
> - *$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
> - *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*
>
> *a detailed maximum noise level event assessment should be undertaken.*
>
> *The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy.*

The NSW RNP provides a summary of the current literature concerning sleep disturbance.

An accurate representation of sleep disturbance impacts on a community from a noise source is particularly difficult to quantify mainly due to differing responses of individuals to sleep disturbance – this is found even with a single subject monitored at different stages of a single night's sleep or during different periods of sleep.

In addition, the differing grades of sleep state make a definitive definition difficult, and even where sleep disturbance is not noted by the subject, factors such as heart rate, mood and performance can still be negatively affected.

An assessment of sleep disturbance should consider the maximum noise level (L_{Amax}) or $L_{A1(1\ minute)}$, the extent to which the maximum noise level exceeds the background level and the number of times this may happen during the night-time period. Factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10.00pm and 7.00am); and
- Whether there are times of day when there is a clear change in the existing noise environment (such as during early morning shoulder periods).

Currently the information relating to sleep disturbance impacts indicates that:

- Maximum internal noise levels below 50–55 dBA is unlikely to cause an awakening from a sleep state.
- One or two noise events per night with maximum internal noise levels of 65–70 dBA are not likely to affect health and wellbeing significantly.

As a result, the adopted sleep disturbance criterion for the project is an internal noise level of 50 – 55 dB L_{Amax}. This criterion is applicable for noise emissions generated by short term events, such as truck movements and loading dock activity occurring during the night time period.

Allowing for a 10 dB noise reduction through open windows**, the proposed screening noise level criterion for sleep arousal is 60 - 65 dB L_{Amax} external at residential properties**.

4 ACOUSTIC ASSESSMENT

4.1 Vehicular Noise Emissions

4.1.1 Noise Emission Data

Noise levels of vehicular activities expected on site have been obtained from previous project experience on other industrial developments. The sound power levels of vehicles that will access the development are listed in Table 6 below.

Table 6 L_{Aeq} sound power levels for short term events

Parameter	Octave Band Centre Frequency, Hz							Overall dBA
	63	125	250	500	1000	2000	4000	
Truck Activities								
Light Truck Idle	83	81	79	82	81	82	78	**87**
Light Truck Moving	95	87	86	90	92	90	87	**96**
Light Truck Moving and Braking	100	94	91	97	99	98	90	**103**
Light Vehicle movement at 60 km/hr	64	70	73	79	86	94	93	**98**
Light Vehicle movement at 40 km/hr	62	68	71	77	84	92	90	**96**

Note 1: Noise event sound power level represented as a $L_{Aeq,15\ minutes}$ level for one vehicular activity

Additionally, noise information for short term loud events that are likely to cause sleep disturbance is summarised in Table 7. This information is used in our assessment of sleep arousal at the nearest affected residences.

Table 7 L_{max} sound power levels for short term events

Parameter	Octave Band Centre Frequency, Hz							Overall dBA
	63	125	250	500	1000	2000	4000	
L_{Amax} [1]								
Light Truck Braking[2]	99	99	98	103	96	116	110	**119**
Light Truck Idle	92	90	87	88	88	86	76	**92**
Light Truck Reverse	102	92	92	93	98	93	91	**101**
Medium Vehicle moving at 50 km/hr	103	101	99	98	99	96	90	**103**

Note 1: Noise information used for the prediction of short term noise events and sleep arousal assessment.
Note 2: Includes noise events with high frequency content such as "bleeding" brakes

4.1.2 Methodology

A 3D computational model of the site and surrounding area was created and subsequently analysed using the iNoise 2018 acoustic modelling software.

4.1.3 Noise Impact on Local Roads

A computational model has been used to predict the increase in noise level at the nearest sensitive receivers due to the change in traffic flow. This simulation was modelled by generating line sources as traffic flows around the development site.

The traffic noise levels were derived using the document titled *"Noise Assessment Methods in Europe (CNOSSOS-EU)"* issued in 2012. This document provides a methodology to calculate the sound power level of the traffic flow.

The traffic flow volumes were obtained from a report provided by Colston Budd Hunt & Kafes Pty Ltd titled *"Appropriate Traffic and Parking Measures for the Proposed Redevelopment of Eastlakes Shopping Centre"*, dated May 2010. This report provided the existing and predicted traffic flow of the roads around the development during the peak hour, which were used to estimate the current and future noise levels of the traffic flows.

Traffic noise levels were subsequently calibrated against the measured noise levels obtained for the unattended noise logging measurements.

Figure 5 and Figure 6 show the noise impact on local roads for the existing and predicted traffic flows respectively. Additionally, Figure 7 shows the façade noise levels after the completion of the project during the busiest hours. Table 8 summarises the noise levels and their change after the completion of the project at the nearest sensitive receivers.

Figure 5 Noise Impact on Local Roads (existing) – $L_{Aeq(1hr)}$

Figure 6 Noise Impact on Local Roads (prediction) – $L_{Aeq(1hr)}$

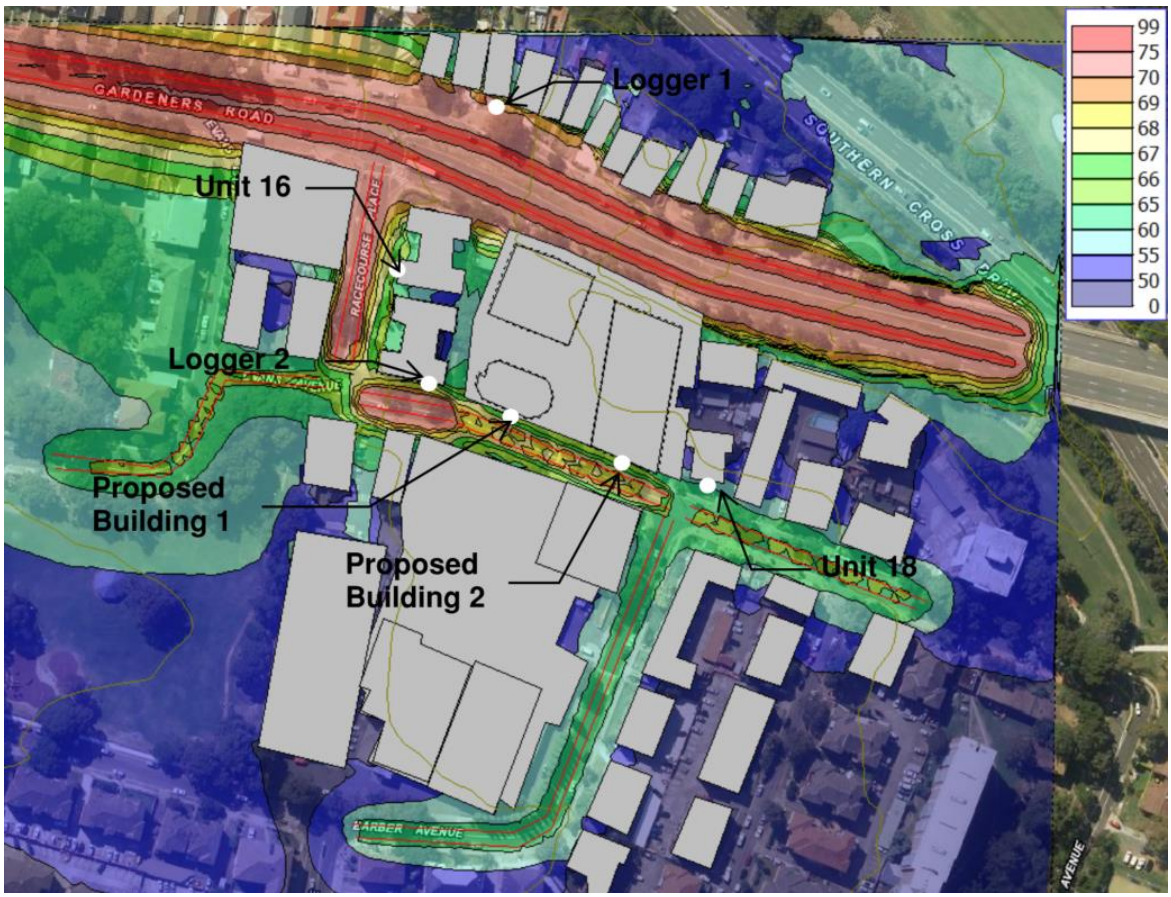


Figure 7 Facade Noise Level with Predicted Traffic Levels - $L_{Aeq(1hr)}$

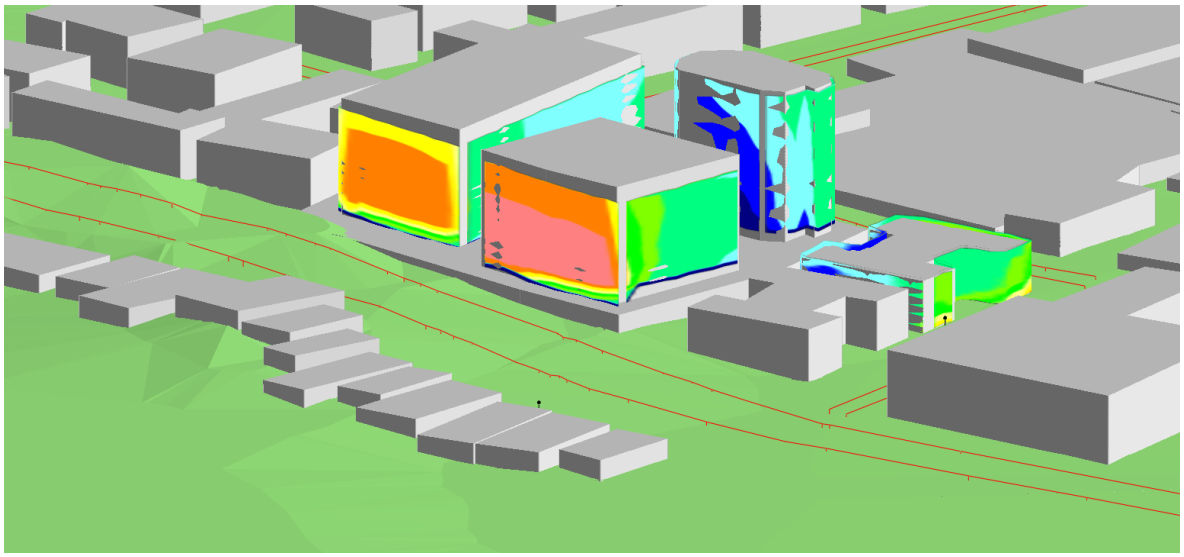


Table 8 Noise Impact on Local Roads

Measurement Location	Noise Levels at sensitive Receivers dBA		
	Existing	Prediction	Change in Noise Level
Logger Locations			
Residences (16 Evans Ave)	65	66	+1
Residences (234 Gardeners Road)	70	70	0
Residential Units			
Proposed Development 1	61	62	+1
Proposed Development 2	62	63	+1
Unit 18, Evans Avenue	58	58	0
Unit 16, Evans Avenue (Facing Racecourse Place)	65	65	0
Note 1: It should be noted that a change of 1 dB or 2 dB in the sound level is generally considered imperceptible.			

This assessment shows that the increase in noise level does not exceed 1 dBA at the sensitive receivers during the worst hour of the day. An increase of 1 dB is considered to be imperceptible and is less than the NSW RNP criteria that requires any increase in the total traffic noise level to be limited to 2 dB during both day and night time periods.

The change in traffic noise levels for the overall daytime ($L_{Aeq, 15hr}$) and night time periods ($L_{Aeq, 9hr}$) will increase by less than 1 dB and will also be imperceptible and result in no change to the overall traffic noise environment in the area.

4.2 Sleep Arousal Assessment

The assessment of potential sleep arousal impacts from loading dock activity and the extension in operating hours of the centre is given below and includes:

- A computational model, similar to Section 4.1.3, has been used to predict the external noise level at the nearest sensitive receivers for short term events during the morning shoulder period for the operational hours (i.e. 5:00 am to 7:00 am). Table 7 summarises these events and their related L_{max} sound power levels. The results were assessed against the sleep arousal criteria outlined in Section 3.3.
- Monitoring the number of occurrence that the L_{Amax} noise levels exceeds the sleep arousal criteria of 65 dBA at the nearest sensitive receiver (16 Evans Ave, Eastlakes) with the existing traffic flow. This was compared with the increase of short term noise events due to vehicular movements related to the proposed development activities during the shoulder period.

4.2.1 Loading Dock Activities Assessments

The sleep arousal assessment consists of calculating the L_{Amax} sound pressure levels at the residential receivers for the short-term noise events that have the highest likelihood of creating sleep disturbance. Four (4) worst case scenarios of loading dock activities have been assessed as follows:

- Scenario 1: Heavy vehicle braking inside the loading dock with the shutter doors left open. The levels include brake bleeding noise.
- Scenario 2: Heavy vehicle idling inside the loading dock with the shutter doors left open
- Scenario 3: Heavy vehicle reversing inside the loading dock with the shutter doors left open
- Scenario 4: Heavy vehicle movement inside the loading dock with the shutter doors left open

4.2.2 Vehicle Pass-by on Evans Ave

Additionally, two (2) worst case scenarios have been estimated for the pass-by of the Heavy/Medium vehicles as they enter the site from Evans Avenue:

- Scenario 5: Heavy vehicle pass-by on Evans Ave and entering the dock via the access driveway
- Scenario 6: Medium vehicle pass-by on Evans Ave and entering the dock via the access driveway

The noise level for all six (6) scenarios outlined in Section 4.2.1 and Section 4.2.2 were calculated to the nearest sensitive receivers. The nearest sensitive receivers were identified to be at Unit 1, 16 Evans Avenue and the residence located on Level 1 above the loading dock of the proposed building. It should be noted that a vehicular movement is considered as either an arrival or a departure from the carpark or loading dock or a pass- by on Evans Avenue.

4.2.3 Predicted Noise Levels

Table 9 Predicted L_{Amax} Noise Levels

Short Term Event	16 Evans Avenue		Level 1 residences of the proposed development above loading dock	
	External L_{Amax} Sound Pressure Level, dBA	Compliance with the sleep arousal criteria (60-65 dB $L_{Amax\ external}$)	External L_{Amax} Sound Pressure Level, dBA	Compliance with the sleep arousal criteria (60–65dB $L_{Amax\ external}$)
Loading Dock Activities				
Scenario 1: Heavy vehicle brake	65	Yes	**68**	**No**
Scenario 2: Heavy vehicle idling	55	Yes	58	Yes
Scenario 3: Heavy vehicle reversing	63	Yes	66	Marginal[1]
Scenario 4: Heavy vehicle movement inside the loading dock	58	Yes	61	Yes
Vehicle Movements on Evans Avenue				
Scenario 5: Heavy vehicle movement	**81**	**No**	**75**	**No**
Scenario 6: Medium vehicle movement	**75**	**No**	**69**	**No**

Note 1: It should be noted that a change of 1 dB or 2 dB in the sound level is generally considered imperceptible.
Note 2: The figures in bold represent exceedances of the noise level criterion.

Table 9 shows the noise levels at the closest residential receiver locations for all assessed worst case scenarios. The results show the following:

- The external L_{Amax} sound pressure level for loading dock activities at 16 Evans Street complies with the sleep arousal criteria
- The external L_{Amax} sound pressure level for loading dock activities at the Level 1 residences exceeds the sleep arousal assessment criterion for the event that includes a heavy vehicle brake event. It should be noted that the noise generated from a heavy vehicle reversing marginally complies with the sleep arousal criteria since a change of 1 dB or 2 dB in the sound level is generally considered imperceptible.
- The external L_{Amax} sound pressure level at 16 Evans Avenue and the residence located above the proposed building exceeds the criteria for all vehicle pass-by on Evans Avenue.

4.2.4 Maximum Number Noise Events Assessment

The number of existing short-term high noise events outside 16 Evans Avenue was measured to assess the impact of increased vehicular movements on Evans Ave during the shoulder period between 5am and 7am.

The L_{Amax} noise levels (with a 1 second integration period) was measured during the night-time period from Friday 2nd November to Saturday 3rd November 2018. The data was processed to extract the number of short-term noise events due to the movement of medium/heavy vehicles. The data was filtered to include only those events with a duration of 3 seconds or more and an L_{Amax} noise level of 65 dBA or higher at the residential receiver. This filtering removes events such as bird noise (by filtering for event duration) and car pass-bys (by filtering for maximum level).

Figure 8 Noise Monitoring (L_{max})

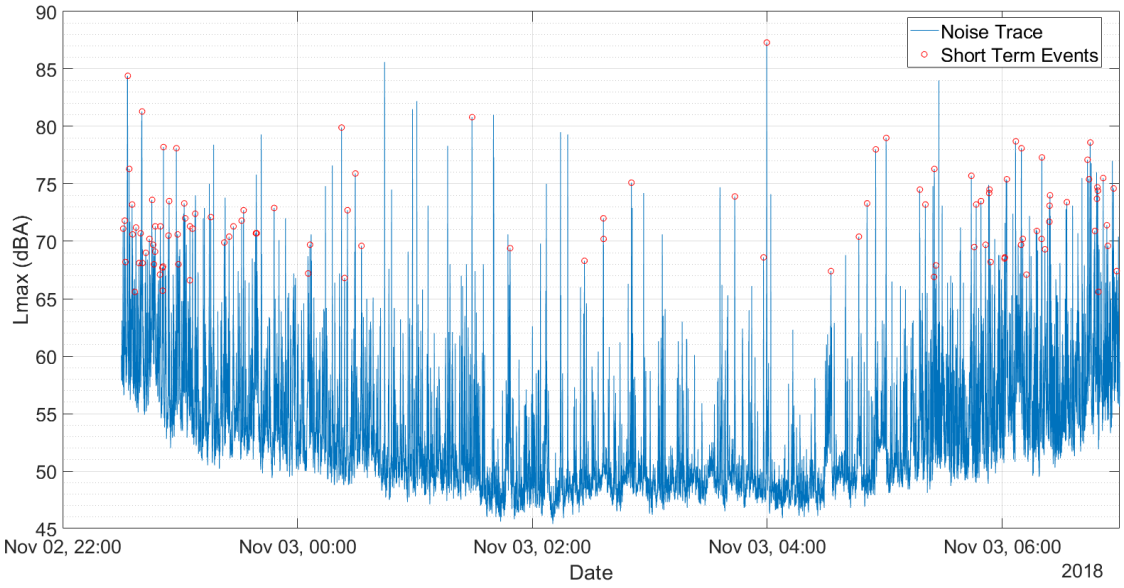


Figure 8 above shows the results of noise monitoring of the existing short-term noise events that exceeded the sleep arousal criteria for more than 3 seconds. It can be observed that the shoulder period contains several short-term events compromising of both heavy and medium vehicles.

Table 10 below summarises the number of existing exceedance during the night-time and shoulder period caused by heavy/medium vehicular pass-by.

Table 10 Maximum Noise Level Results

	L_{max} during the night (dB(A))			Number of high noise events	
Measurement Location	**Highest**	**2nd highest**	**3rd highest**	**Night-time[1]**	**Shoulder Period**
Residences (16 Evans Ave)	87	86	84	109	44

Note 1: The number of high noise events are obtained by counting the number of times L_{Amax} exceeded 65 dB(A)

The results show that the sleep arousal criterion has been exceeded approximately 44 times during the shoulder period between 5am and 7am with the existing traffic flow. This number of exceedances indicates that the noise sensitive local residents probably adjust to these existing noise events by keeping their windows closed during the night.

The anticipated additional heavy and medium vehicle traffic flow during the shoulder period corresponding to the proposed extension in operating hours for the loading dock is summarised in Table 11 below. As shown in the assessment of existing traffic flows, the pass-by of medium / heavy vehicles is likely to generate L_{Amax} noise levels greater than 65 dBA. It should be noted that there are two (2) movements per vehicle accessing the loading dock and each movement exceeds the sleep arousal criteria.

Table 11 Shoulder Period Traffic Data

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Heavy Vehicles	3[1]	5[2]	1	1	1	1	1
Medium Vehicles	5	5	5	5	5	5	5
Total	8	10	6	6	6	6	6
Vehicular Movement[3]	16	20	12	12	12	12	12

Note 1: Two (2) trucks come every fortnight during the shoulder period
Note 2: Four (4) garbage trucks come during the shoulder period
Note 3: There are two (2) movements per vehicle and each movement exceeds the sleep arousal criteria

Table 11 shows that the number of exceedance will increase by (at most) 20 due to the heavy / medium vehicle movements during the morning shoulder period.

This increase is less than half the exiting number of maximum noise events due to the existing traffic flow, which currently has 44 exceedances during the shoulder period, and is not considered to affect the acoustic amenity of the existing residential area significantly.

It should be noted that the assessment assumes that the residences have their windows open. The internal noise levels will be significantly lower (by perhaps an additional 15 dB depending on glazing area and thickness) with closed windows and is likely to be below the internal noise level criteria for sleep arousal. External noise levels of approximately 80 dBA are anticipated to meet the internal sleep arousal noise criterion with windows closed. Figure 8 shows that very few existing external noise levels events exceed a noise level of 80 dBA.

4.3 General Waste Management

Garbage trucks will collect the waste from the proposed development in the garbage collection area located in the loading dock, as shown in Figure 9. Table 12 shows the garbage truck traffic data for the waste collection expected during the week for the commercial premise only. The table shows that:

- Tuesday will be the only day scheduled for the garbage trucks during the morning shoulder period. (5 am to 7 am)
- Garbage trucks are expected to come from Monday to Saturday during the daytime period (between 7 am to 12 pm).

Additionally, it has been advised by Council that garbage trucks are expected to collect residential waste twice a week and it is possible that they may collect this waste from 6 am (i.e. during the morning shoulder period).

Figure 9 Garbage Collection Area

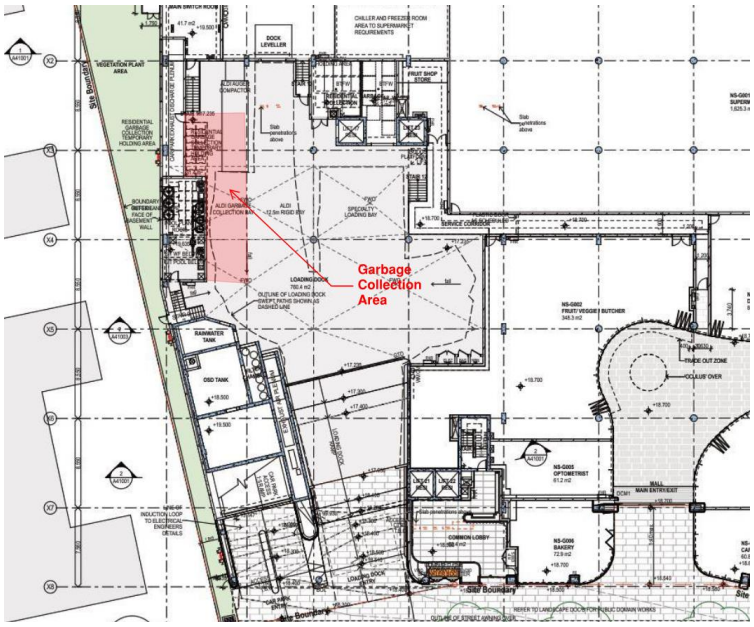


Table 12 General Waste Management Traffic Data

	Number of Garbage Trucks						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday[1]
Morning Shoulder Period (5 am to 7 am)	0	4	0	0	0	0	0
Daytime period (7 am to 12 pm)	4	1	2	1	2	3	0
Total	4	5	2	1	2	3	0

Note 1: On Sunday, the morning shoulder period is between 5 am to 8 am, and the daytime period is between 8 am to 6 pm.

The relevant assessment of the general waste management for each time period is as follows:

- The garbage truck activities during the morning shoulder time period are to be assessed against the sleep arousal criteria nominated in Section 4.2. It should be noted that garbage trucks are considered heavy vehicles, therefore, the predicted noise levels at the residential receivers are similar the noise levels outlined in Table 9.
- The table shows the sleep arousal criteria is exceeded during some loading dock activities (truck idling and truck braking) and during vehicular pass by.

Appropriate noise mitigation strategies have been recommended in Section 4.5.1 to minimise the noise impact to the sensitive receivers.

Garbage truck traffic generation has also been assessed to determine its noise impact on local roads during the daytime period, in accordance with the procedures outlined in the NSW RNP (See Section 3.2).

- Table 12 shows that the worst-case scenario occurs on Monday as four (4) garbage trucks enter and leave the proposed development between 7 am and 12 pm (with Council collecting residential waste on two additional occasions, perhaps from as early as 6 am).
- This traffic is considered insignificant considering the predicted traffic flows on the local roads are expected to have approximately 200-500 vehicular pass-bys per hour during the daytime. This is shown in the Figure 4 of the traffic report titled *"Appropriate Traffic and Parking Measures for the Proposed Redevelopment of Eastlakes Shopping Centre"*, prepared by Colston Budd Hunt & Kafes Pty Ltd dated May 2010.
- Therefore, the noise contribution from the garbage traffic is compliant to the NSW RNP since it will not significantly impact the traffic noise on the local roads.

4.4 Mechanical Services

4.4.1 Recommended Noise Limits

In order to provide for a quantifiable assessment of the mechanical services during the detailed design stage, noise limits have been specified for the major items of externally located mechanical plant and the ductwork outlets for internally located plant. The locations of these noise sources are shown in Figure 10, Figure 11 and Figure 12. These noise emission limits were determined to ensure the NSW NPI criteria will be met noise at relevant residential receiver locations. The residential noise levels were calculated using the 3-D noise model of the proposed development.

Figure 10 Ground Floor Mechanical Services Assessment

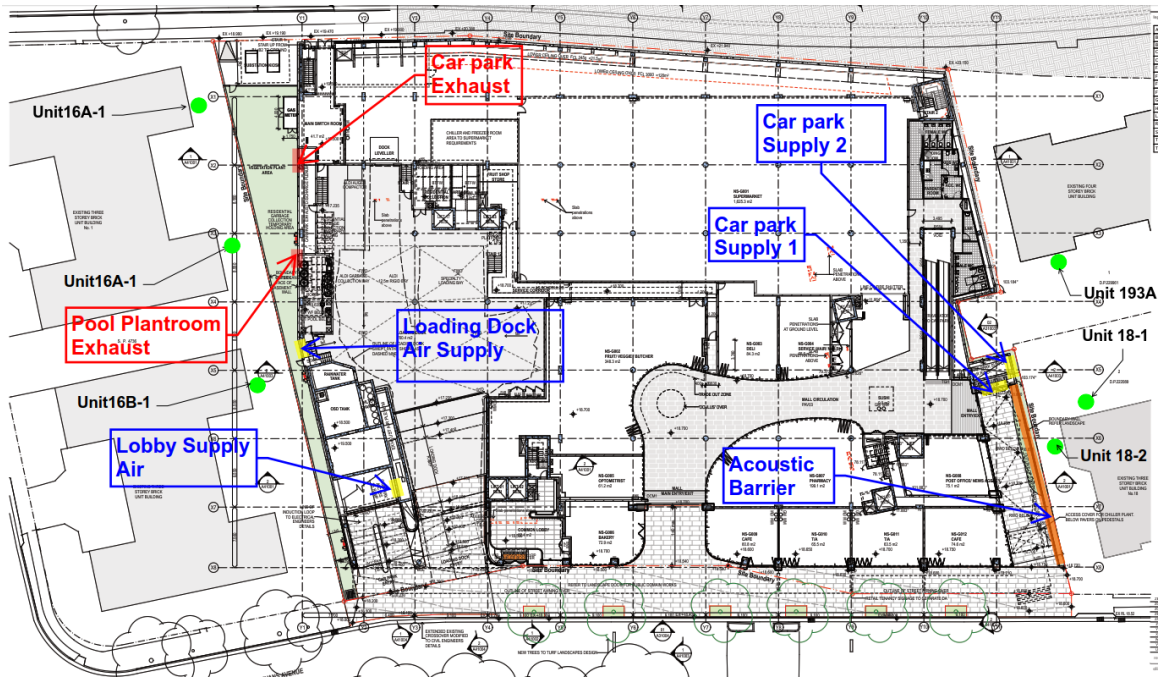


Figure 11 Building 1 & 1A Rooftop Mechanical Assessment

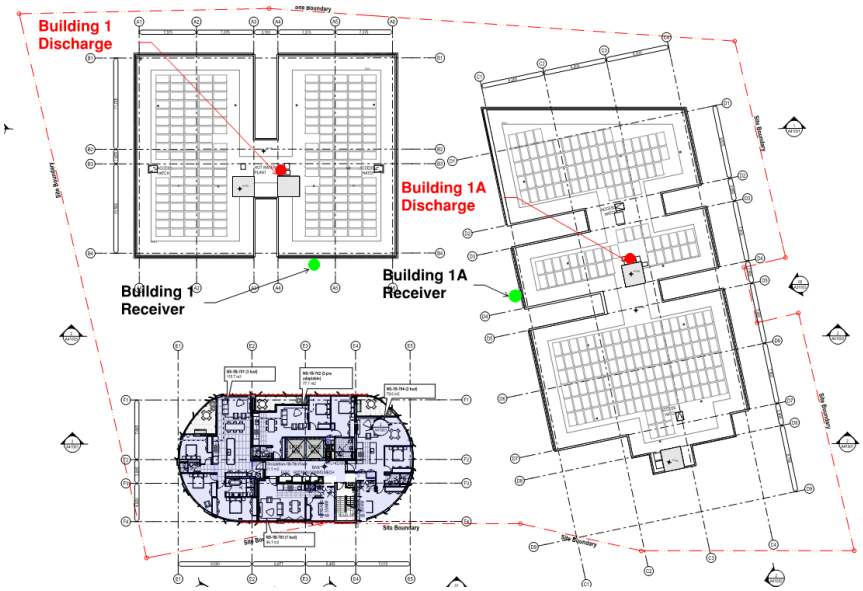
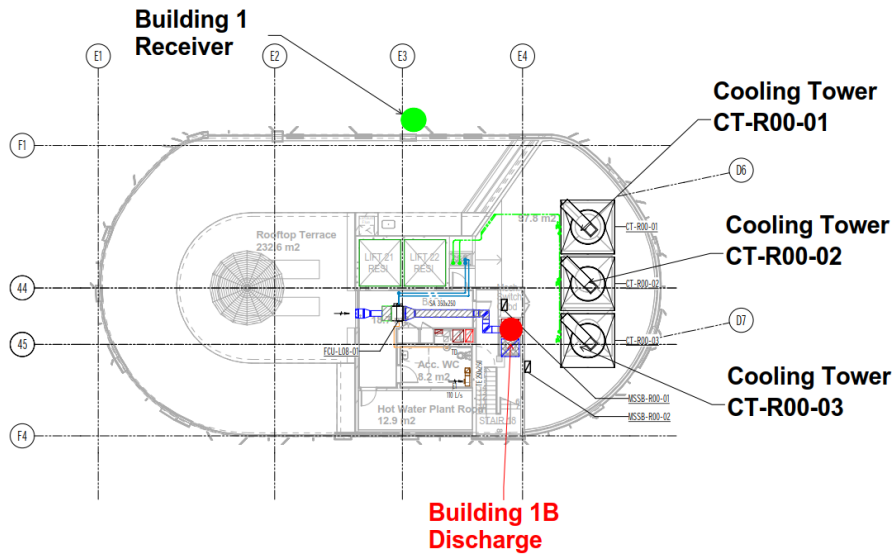


Figure 12 Building 1B Rooftop Mechanical Assessment



The maximum recommended noise emission levels for the mechanical services outlets are nominated in Table 13 below. Where some items are not operational during the night-time and / or evening periods, it will only be necessary to comply with the evening or daytime noise emission limits.

Table 13 Recommended Noise Emission Limits

Mechanical Outlets	Sound Power Emission Level (at outlets) dBA [1]			
	Morning Shoulder Period (5am-7am)	Day	Evening	Night
Loading Dock				
Loading Dock Air Supply	71	71	63	61
Common Lobby Air Supply	82	82	82	82
Pool Plantroom Exhaust	71	71	63	61
Carpark Exhaust	77	77	69	67
Carpark Supply				
Carpark Air Supply 1	74	74	67	66
Carpark Air Supply 2	74	74	67	66
Residential Discharge				
Building 1 Discharge	82	82	74	69
Building 1A Discharge	82	82	74	69
Building 1B Discharge	82	82	68	63
Cooling Towers				
CT-R00-01[1]	89	89	82	82
CT-R00-02[1]	89	89	82	82
CT-R00-03[1]	89	89	82	82
Note 1: It should be noted that the noise level limits represent the sound power levels.				

The noise emissions from the mechanical outlets were assessed using the noise model at the following locations:

- 234, Gardeners Road
- Unit 16A, Evans Avenue
- Unit 16B, Evans Avenue
- Unit 163 Gardeners Road
- Unit 18, Evans Avenue

Using the maximum recommended noise emission levels for the mechanical service outlets nominated in Table 13 above, the resultant noise levels at the residential receivers are shown in Table 14. The results show that the noise levels at the residential receivers will comply with the criteria outlined in the NSW NPI.

Table 14 Noise Levels at the Receivers

	Noise Levels at Sensitive Receivers dBA			
Measurement Location	**Morning Shoulder Period (5 am to 7 am)**	**Day**	**Evening**	**Night**
Unit 16A – 1	55	55	47	45
Unit 16A – 2	59	59	51	49
Unit 16B – 1	58	58	50	48
Unit 193A	54	54	47	46
Unit 18 – 1	58	58	51	50
Unit 18 - 2	45	45	38	37
234, Gardeners Road	44	44	37	36
Building 1	58	58	51	50
Building 1A	57	57	50	50
Building 1B	57	57	50	49

4.4.2 Initial Mechanical Services Noise Assessment

"Eastlakes Town Centre – North, Mechanical Specification" prepared by WSP for Crown Group and issued in October 2018, outlines the layout and proposed equipment selection of the mechanical services for the proposed development. An initial noise assessment was conducted at the nearest sensitive receivers to investigate the need for additional noise mitigation measures to be included in the mechanical services design to meet the noise criteria associated with the proposed extended hours of operation.
The assessment consisted of calculating the noise level at the outlets using the relevant mechanical services ductwork design and fan sound power levels outlined in Table 15 and comparing them to the recommended noise levels outlined in Table 13. The results of the noise impact assessment are summarised in Table 16.

Table 15 Mechanical Services Sound Power Level

Reference	Model	Octave Band Centre Frequency, Hz								Overall dBA
		63	125	250	500	1000	2000	4000	8000	
Carpark Exhaust										
CEF-B01-02	AP0632LP6/14	98	91	93	89	89	86	83	80	**94**
CEF-B01-03	AP1256CP9/31	98	91	93	89	89	86	83	80	**94**
CEF-B02-01	AP1256DP6/26	97	96	93	95	91	89	84	78	**97**
CEF-B03-02	AP0804CP6/25	87	90	84	84	85	81	77	73	**89**
LDE-L00-01	TD-2000/315ECO	97	91	89	90	89	89	88	85	**96**
Pool Plantroom Exhaust										
EAF-L00-L01	TD-1300/250SIL (Low speed)	55	60	66	68	66	56	46	42	**69**
Loading Dock Air Supply										
SAF-L00-01	AP0634LP6/29	85	79	75	77	76	75	72	65	**81**
Common Room Air Supply										
SPF-L00-01	AP0904CP6/21	88	91	85	85	85	82	78	74	**89**
Carpark Air Supply 1 & 2										
CSF-B01-01	AP0804CP6/28	88	91	85	85	86	82	78	74	**90**
OAF-B01-01	TD-2000/315ECO	66	70	77	74	75	72	63	58	**78**
ATT-B01-01[1]	C2-080	-5	-8	-12	-22	-23	-16	-15	-10	**-**
CSF-B02-01	AP0804CP12/20	90	84	87	84	84	82	77	71	**89**
OAF-B02-01	TD-2000/315ECO	66	70	77	74	75	72	63	58	**78**
ATT-B02-01[1]	C2-080	-5	-8	-12	-22	-23	-16	-15	-10	**-**
CSF-B03-01	AP0804CP6/20	86	89	83	83	84	80	76	72	**88**
Cooling Towers										
CT-R00-01	PCT0808-P3-L	89	88	87	84	77	72	70	61	**85**
CT-R00-02	PCT0808-P3-L	89	88	87	84	77	72	70	61	**85**
CT-R00-03	PCT0808-P3-L	89	88	87	84	77	72	70	61	**85**

Note 1: Attenuator located near the carpark supply fan

Table 16 Noise Impact Assessment

Mechanical Outlets	Calculated SPL	Recommended Sound Pressure Level dBA			
		Morning Shoulder Period (5am to 7am)	Day	Evening	Night [3]
Loading Dock					
Loading Dock Air Supply	74	71 (+3)	71 (+3)	63 (+11)	63 [3]
Common Room Air Supply	79	82 (-3)	82 (-3)	82 (-3)	82 (-3)
Pool Plantroom Exhaust	59	71 (-12)	71 (-12)	63 (-4)	61 (-2)
Carpark Exhaust	73	77 (-4)	77 (-4)	69 (+4)	67 [3]
Carpark Air Supply					
Carpark Air Supply 1	77	74 (+3)	74 (+3)	67 (+10)	66 [3]
Carpark Air Supply 2	80	74 (+6)	74 (+6)	67 (+13)	66 [3]
Cooling Towers					
CT-R00-01	85	89 (-4)	89 (-4)	82 (+3)	82 (+3)
CT-R00-02	85	89 (-4)	89 (-4)	82 (+3)	82 (+3)
CT-R00-03	85	89 (-4)	89 (-4)	82 (+3)	82 (+3)

Note 1: It should be noted that the noise levels represent the sound power levels at the outlet (not the sound pressure levels at the receiver locations).

Note 2: The number inside the parenthesis indicate the difference between the calculated and the recommended noise levels. A red number indicates an exceedance.

Note 3: The loading dock and carpark fans will not be operational during the night

A summary of the results of the noise assessment and the additional noise control recommendations being introduced to meet the noise criteria for the extended hours of operation are outlined in the section below. These noise control recommendations are currently being documented into the workshop drawings and will be included in the constructed mechanical systems.

- The noise emission from the loading dock air supply (SAF-L00-01) exceeds the recommended noise emission limits by up to 11 dB.
- The Common Room Supply Fan and the Pool Plantroom Exhaust fans comply with the recommended noise levels during all time periods. No further noise mitigation is required.
- The noise emission from the carpark exhaust exceeds the criteria during the evening by 4 dB.
- The noise generated by the carpark supply air fans exceeds the recommended noise emission limits by up to 13 dB.
- The cooling towers comply with the daytime noise criteria and marginally exceed the recommended sound power levels by 3 dB during the evening and night-time period with all three towers operating at capacity.
- The noise emission from the discharge outlets of building 1, 1A and 1B will also need to be limited to the sound power levels specified in Table 13.

4.5 Noise Control Measures

4.5.1 Loading Dock

As outlined in Section 4.2.3, the sleep criterion is marginally exceeded at the Level 1 residences above the driveway for some loading dock activities during the early morning shoulder period hours (between 5:00 am and 7:00 am).

To meet the sleep arousal criterion, the following noise mitigation measure is being implemented to reduce the noise transmitted to the affected receivers:

To meet the noise criterion, the following noise mitigate measures are being implemented to the loading dock:

- The reverberant noise level inside the loading dock can be sufficiently reduced to meet the noise emission criteria with the loading dock door open by applying 250m^2 of sound absorbing material to the loading dock concrete soffit (or wall areas).
- Examples of suitable sound absorbing materials include:
    - Acoustic spray-on insulation to the underside of the concrete soffit (for example, Envirospray 300). This product should be applied to an overall thickness of approximately 50mm to achieve a noise reduction coefficient (NRC) performance of 0.8 or greater.
    - Glasswool or polyester insulation such as 25mm thick, 32kgm^3 Tontine AcoustiSorb2 with a perforated foil facing such as CSR Thermofoil HD Perf (this product has a 10 % perforation factor). These products have an NRC of approximately 0.7 – 0.8. The insulation can be pinned to the underside of the slab by gluing metal pins to the soffit and impaling the insulation unto the pins and securing with a speed clip. The spacing of the pins should be as per the manufacturer's recommendations for a horizontal installation.

It should be noted that maximum noise levels due to heavy vehicle pass-bys on Evans Avenue will exceed the sleep arousal criteria. This will be the case whether the extension of operating hours is approved or not. Table 8 summarises the predicted noise levels with the treatments outlined above.

Table 17 Predicted Noise Levels with Treatments

Short Term Event from Loading Dock Activity	Absorbing Material with an NRC of 0.8
Loading Dock Activity	
Scenario 1: Heavy vehicle brake	64
Scenario 2: Heavy vehicle idling	54
Scenario 3: Heavy vehicle reversing	62
Scenario 4: Heavy vehicle movement inside the loading dock	48
Note 1: It should be noted that a change of 1 dB or 2 dB in the sound level is generally considered imperceptible.	

4.5.2 Mechanical Services

The maximum allowable noise emissions at the external outlets of the mechanical services have been provided in Table 13. These limits have been specified to ensure that the noise criteria for the extended hours of operation will be satisfied. Provided these noise limits are not exceeded, the noise emission levels are the relevant receiver locations will comply with the NSW NPI criteria. The locations of these outlets are shown in Figure 10, Figure 11 and Figure 12.

An assessment of the major items of mechanical plant has been conducted. This assessment is based on the sound power levels provided in the mechanical services specification report titled *"Eastlakes Town Centre – North, Mechanical Specification"*. The sound power levels at the external outlets have been calculated and compared with the noise limits recommended in Table 16.

A summary of the additional noise control recommendations being introduced to meet the noise criteria for the extended hours of operation are outlined below. These noise control recommendations are currently being documented into the workshop drawings and will be included in the installed mechanical systems.

- Additional internal duct lining is being introduced to the ductwork associated with loading dock supply air fan (SAF-L00-01) so that noise levels at the building façade meets the external sound power noise emission limits.
- The carpark exhaust system is connected to a plenum before discharging to the outside air. This plenum will be lined with 50 mm thick acoustic insulation to achieve the required levels of additional noise reduction.
- The length of the attenuators associated with the carpark supply air fans have been extended in the workshop drawings to reduce the noise emission from these fans to meet the noise criteria.
- The cooling towers are fitted with variable speed fans and will operate at a reduced speed during the evening and night-time periods due to the reduced load at these times. Additionally, it is also noted that only two cooling towers will operate simultaneously (as the third unit is provided for redundancy). Noise emissions will therefore achieve the required noise level criterion.
- Noise attenuation is also being provided to the ductwork associated with the mechanical services associated with building 1, 1A and 1B to limit to the sound power levels at the outlets to the sound power criteria specified in Table 13.

5 CONCLUSION AND SUMMARY

Pulse Acoustics has undertaken an acoustic assessment of the extension of the proposed mixed-use development located at the northern site of the Eastlakes Shopping Centre. The following sub-sections discuss the level of compliance with the acoustic criteria established in Section 3 of this report.

5.1 Sleep Disturbance

The potential for sleep disturbance was assessed according to the RNP criteria and consisted of following methodology:

- A computational model was used to predict the external noise level at the nearest noise sensitive receivers from short term events from loading dock activities during the morning shoulder period of the proposed extended hours of operation (i.e. 5:00 am to 7:00 am). The nearest sensitive receivers are located at 16 Evans Ave and the residences located in the proposed development above the loading dock.
- The number of existing L_{Amax} noise level events that exceed the sleep arousal criteria of 65 dBA at the nearest sensitive receiver (16 Evans Ave, Eastlakes) was determined with the existing traffic flow. This was compared with the increase in short term noise events due to the anticipated truck movements during the early morning shoulder period for the proposed extension in operation hours.

The results of the assessment outlined above show that:

- The external L_{Amax} sound pressure level at 16 Evans Avenue complies the sleep arousal criteria for loading dock activities.
- The sleep arousal criterion is marginally exceeded for the Level 1 residences located above the loading dock for heavy vehicle parking brake operations. It should be noted that the noise generated from a heavy vehicle reversing is considered as being marginally compliant with the sleep arousal criteria, since a change of 1 dB or 2 dB in the sound level is generally considered imperceptible. With the additional sound absorbing material being provided to the loading dock walls (and / or ceiling), the sleep arousal criterion will be achieved at the Level 1 residences for loading dock activity.
- The external L_{Amax} sound pressure level at 16 Evans Avenue and the residence located above the proposed building exceeds the criteria for all vehicle pass-by on Evans Avenue. The sleep arousal criterion is currently being exceeded approximately 44 times during the morning shoulder period with the existing traffic flow due to heavy/medium vehicle pass-bys. The proposed extension in operating hours will result in an increase in the number of exceedances by at most 20 during the morning shoulder period. This increase is less than half number that currently occurs with the existing traffic flows. It should be noted that the assessment assumes that the residences have their windows open. The internal noise levels will be significantly lower (by perhaps an additional 15 dB depending on glazing area and thickness) with closed windows and is likely to be below the internal noise level criteria for sleep arousal.

5.2 Noise Impact on Local Roads

The assessment of the change in traffic flow is outlined in Section 4.1.3 and the results of the computational model predict that the change in traffic flow will be approximately 1 dB. This satisfies the criteria outlined by the NSW Road Noise Policy (RNP) of limiting noise level increases to less than 2 dB.

5.3 General Waste Management

The general waste management of the proposed development shows that the garbage collection will occur inside the loading dock in the garbage collection area shown in Figure 9. Table 18 shows the expected waste management vehicular movements which were used to provide this acoustic assessment.

Table 18 Waste Management Traffic data

	Number of Garbage Trucks						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday[1]
Morning Shoulder Period (5 am to 7 am)	0	4	0	0	0	0	0
Daytime period (7 am to 12 pm)	4	1	2	1	2	3	0
Total	4	5	2	1	2	3	0

Note 1: On Sunday, the morning shoulder period is between 5 am to 8 am, and the daytime period is between 8 am to 6 pm.

The assessment shows that:

- The garbage trucks activities during the morning shoulder time period are assessed against the sleep arousal criteria in Section 4.2. Garbage truck noise levels at the residential receivers are summarised in Table 9. The table shows the sleep arousal criterion is exceeded during some loading dock activities (truck idling and truck braking) and during vehicular pass-bys. Appropriate noise mitigation strategies, in the form of sound absorbing materials being added to the walls and / or ceiling of the loading dock (as specified in Section 4.4.2) will reduce these noise emissions to the noise criterion at the nearest sensitive receivers.
- Table 18 shows that the worst-case scenario occurs on Monday as four (4) garbage trucks enter and leave the proposed development between 7 am and 12 pm. This increase is considered insignificant considering the predicted traffic flows on the local roads are expected to include approximately 200 - 500 vehicular pass-bys per hour during the daytime. This is shown in Figure 4 of the traffic report titled *"Appropriate Traffic and Parking Measures for the Proposed Redevelopment of Eastlakes Shopping Centre"*, prepared by Colston Budd Hunt & Kafes Pty Ltd dated May 2010. Noise contribution from garbage truck traffic is therefore considered compliant with the NSW RNP since it will not significantly affect the existing traffic noise levels from the local roads.

5.4 Mechanical Services

A noise assessment of the proposed mechanical services was conducted using the 3-D noise model created for the Eastlakes North development. Noise emission limits that result in acceptable noise levels at relevant receiver locations are nominated in this report.

An assessment of the proposed services has also been provided and consists of comparing the predicted sound power levels at the duct outlets (i.e. at the outlet locations on the building façade) with the nominated sound power noise emission limits. This assessment uses the fan sound power levels provided in the mechanical services specification report titled *"Eastlakes Town Centre – North, Mechanical Specification"*). The results of this assessment are summarised in Table 16.

Modifications to the mechanical services are being documented in the workshop drawings to enable the noise emissions to comply with the proposed extended hours of operations. These modifications are summarised in Section 0 and will ensure that the noise emissions will comply with the noise criteria derived in accordance with the NSW NPI.

5.5 Summary of Introduced Noise Control Measures

5.5.1 Loading Dock

Noise breakout from loading dock activities will be reduced to meet the established criterion through the implementation of the following acoustic treatment:

- Approximately 250m^2 of sound absorbing material (such as Envirospray 300), with an acoustic performance of approximately NRC 0.8, will be provided to the wall areas and / or the underside of the concrete soffit of the loading dock to reduce the reverberant build-up of noise levels in this space.

5.5.2 Mechanical Services

Modifications to the mechanical services to mitigate the noise emissions to the nearby sensitive receivers, required to meet the noise criteria for the proposed extended operating hours, have been provided in Section 0.

5.6 Final Remarks

A few slight modifications to the current development design are being documented in the workshop drawings to ensure that noise emissions from the development comply with the proposed extension of operation hours.

Noise generated from the loading dock, general waste management and the mechanical services during increased operating hours of the shopping centre will be acceptable in terms of noise impacts to the surrounding noise sensitive locations. This includes the future residences located within the residential component of the development.

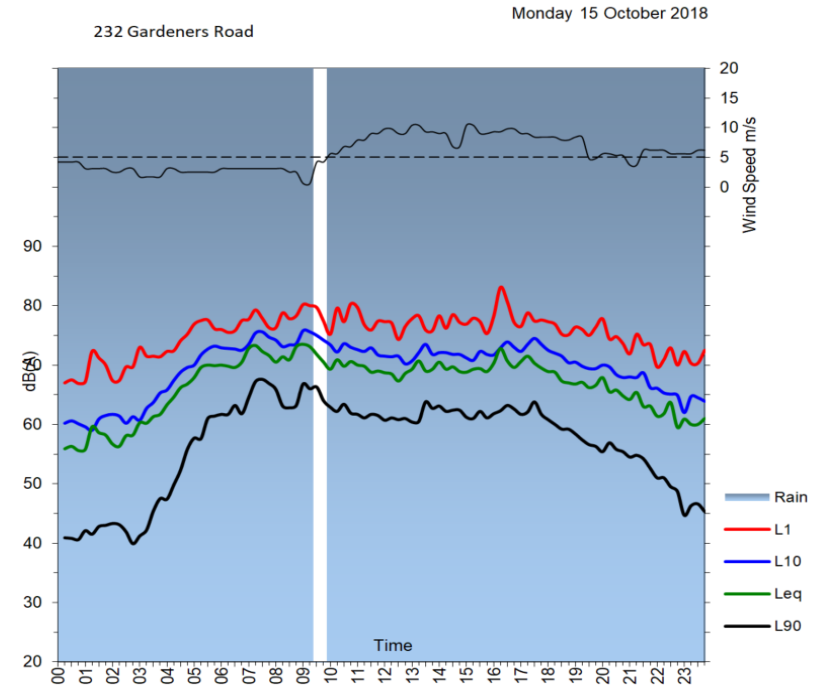
It should also be noted that the assessment of sleep arousal impacts was undertaken with open window conditions. The internal noise levels will be significantly lower with closed windows and are likely to be compliant with the established criteria for most noise events.

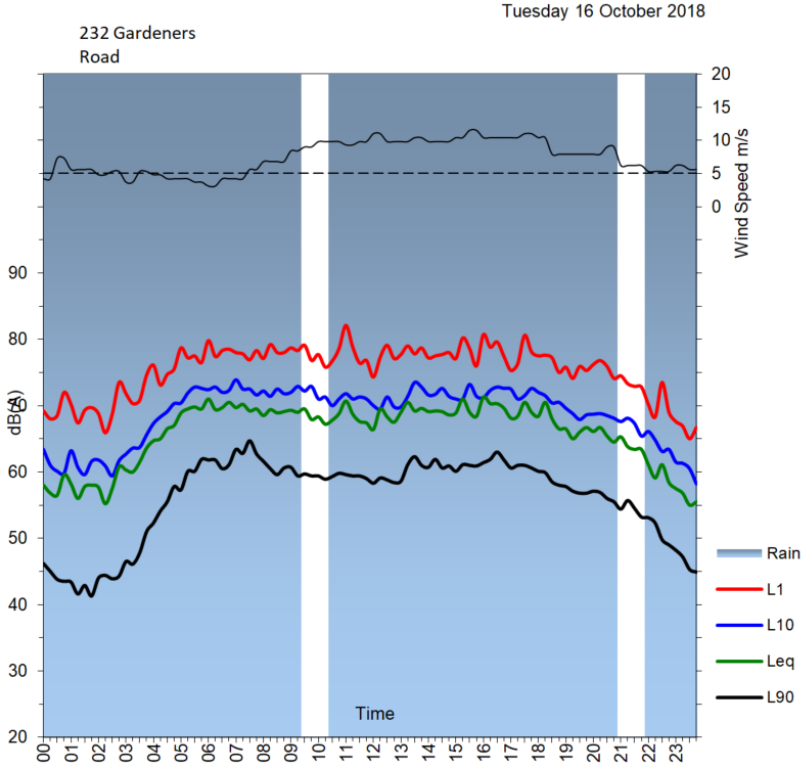
APPENDIX A: ACOUSTIC TERMINOLOGY

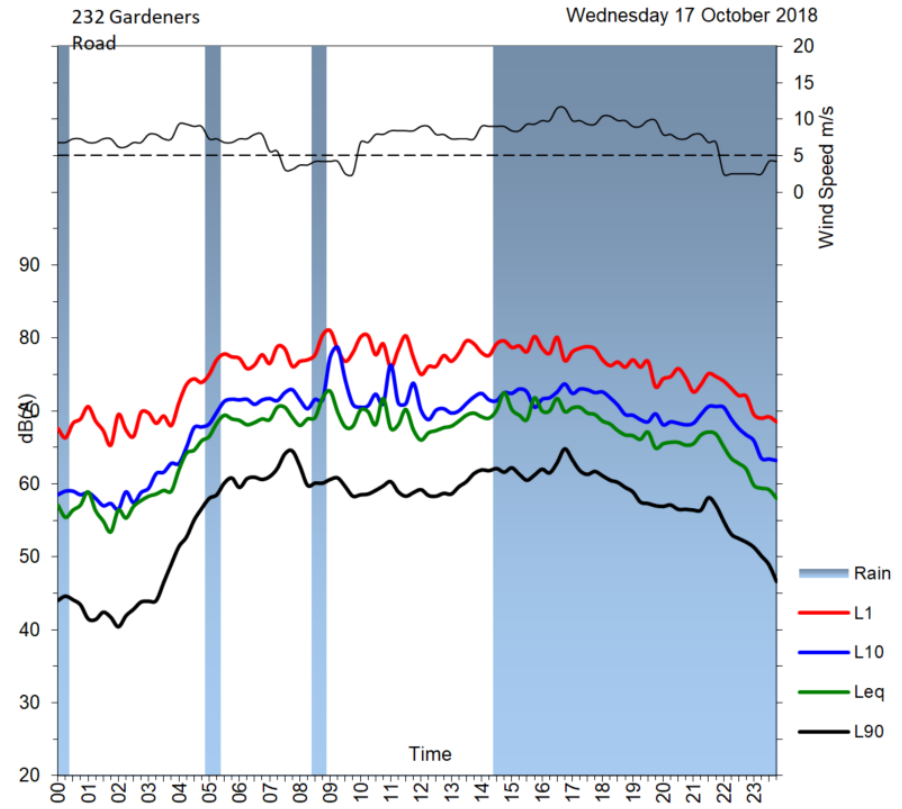
Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB the faintest sound we can hear 30dB a quiet library or in a quiet location in the country 45dB typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB the sound of a car passing on the street 80dB loud music played at home 90dB the sound of a truck passing on the street 100dB the sound of a rock band 115dB limit of sound permitted in industry 120dB deafening
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Frequency	Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Background Sound Low	The average of the lowest levels of the sound levels measured in an affected area in the absence of noise from occupants and from unwanted, external ambient noise sources. Usually taken to mean the L_{A90} value
Ctr	A frequency adaptation term applied in accordance with the procedures described in ISO 717.

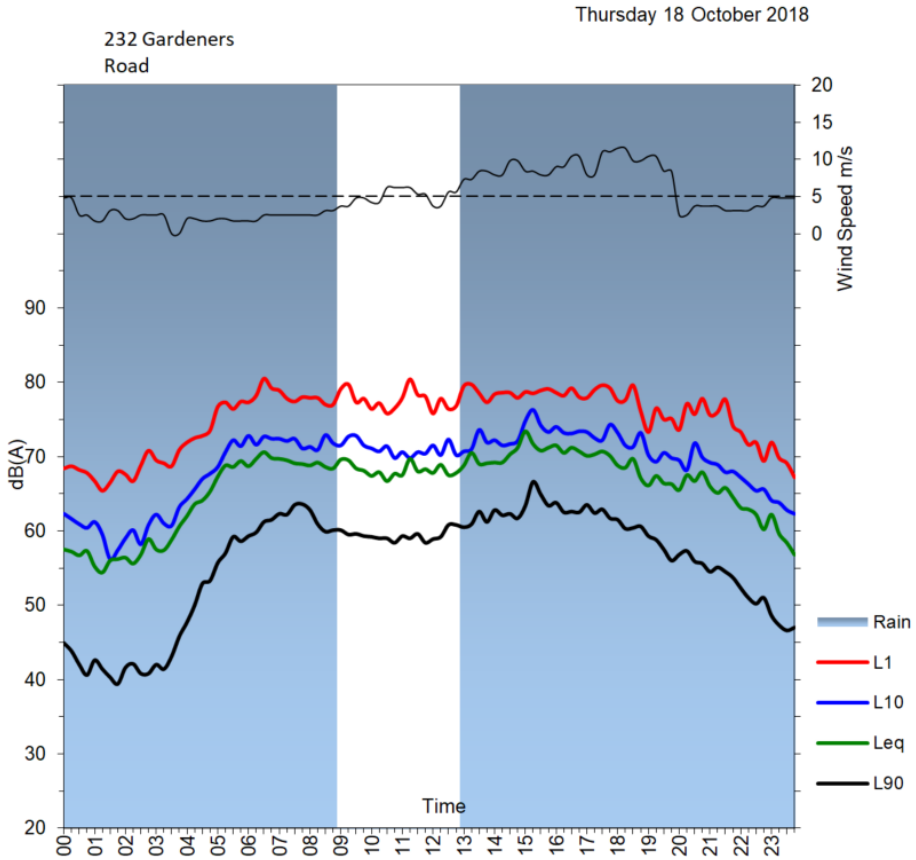
dB (A)	'A' Weighted overall sound pressure level
Noise Reduction	The difference in sound pressure level between any two areas. The term "noise reduction" does not specify any grade or performance quality unless accompanied by a specification of the units and conditions under which the units shall apply
NR Noise Rating	Single number evaluation of the background noise level. The NR level is normally around 5 to 6 dB below the "A" weighted noise level. The NR curve describes a spectrum of noise levels and is categorised by the level at 1000 Hz ie the NR 50 curve has a value of 50 dB at 1000 Hz. The NR rating is a tangential system where a noise spectrum is classified by the NR curve that just encompasses the entire noise spectrum consideration.
R_w	Weighted Sound Reduction Index - Laboratory test measurement procedure that provides a single number indication of the acoustic performance of a partition or single element. Calculation procedures for Rw are defined in ISO 140-2:1991 "Measurement of Sound Insulation in Buildings and of Building Elements Part 2: Determination, verification and application of precision data".
R'_w	Field obtained Weighted Sound Reduction Index - this figure is generally up to 3-5 lower than the laboratory test determined level data due to flanked sound transmission and imperfect site construction.
Sound Isolation	A reference to the degree of acoustical separation between any two areas. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The term "sound isolation" does not specify any grade or performance quality and requires the units to be specified for any contractual condition
Sound Pressure Level, L_P dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.
Sound Power Level, L_w dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt
Speech Privacy	A non-technical term but one of common usage. Speech privacy and speech intelligibility are opposites and a high level of speech privacy means a low level of speech intelligibility. It should be recognised that acceptable levels of speech privacy do not require that speech from an adjacent room is inaudible.
Transmission Loss	Equivalent to Sound Transmission Loss and to Sound Reduction Index in terminology used in countries other than Australia. A formal test rating of sound transmission properties of any construction, by usually a wall, floor, roof etc. The transmission loss of all materials varies with frequency and may be determined by either laboratory or field tests. Australian Standards apply to test methods for both situations.

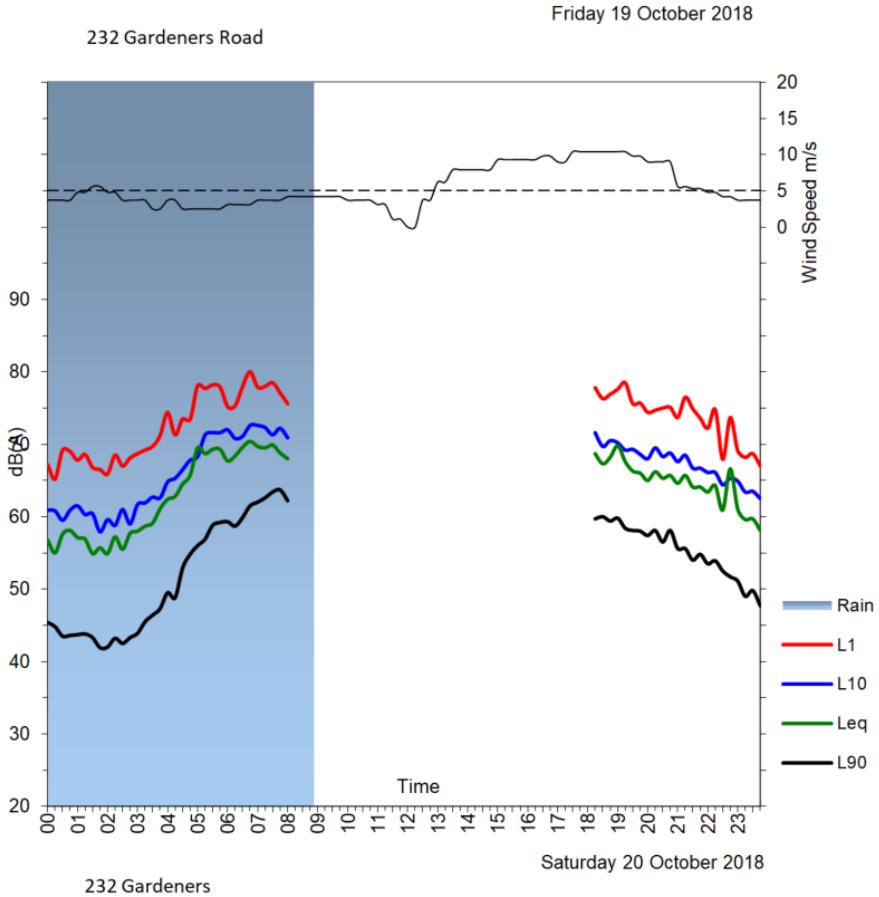
APPENDIX B: UNATTENDED NOISE MEASUREMENTS 232, GARDENERS ROAD

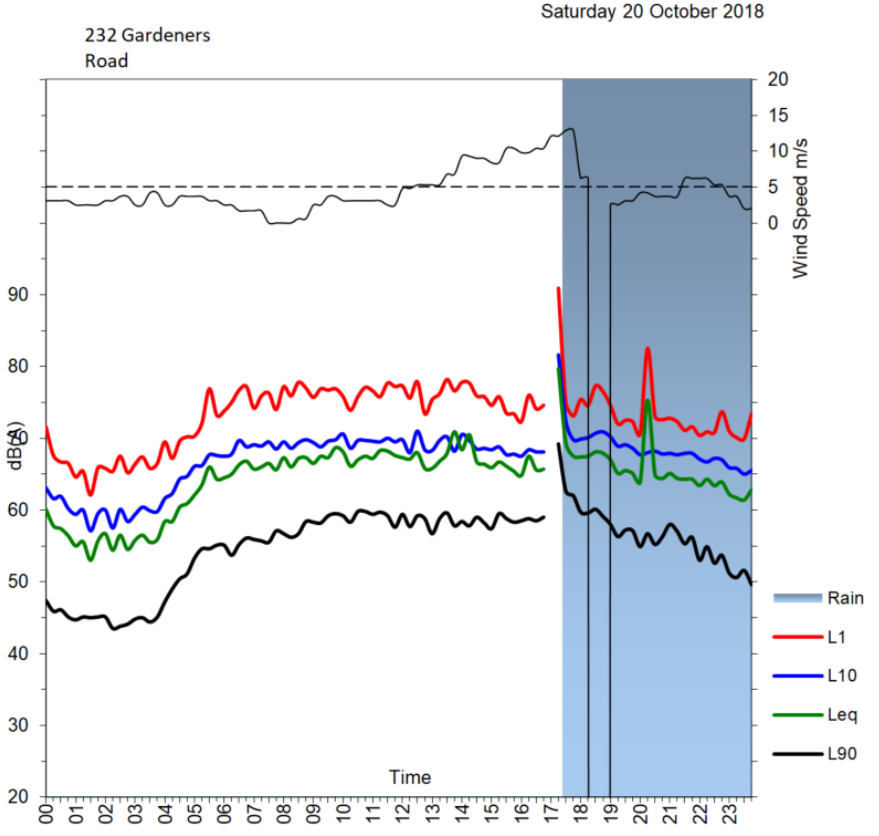


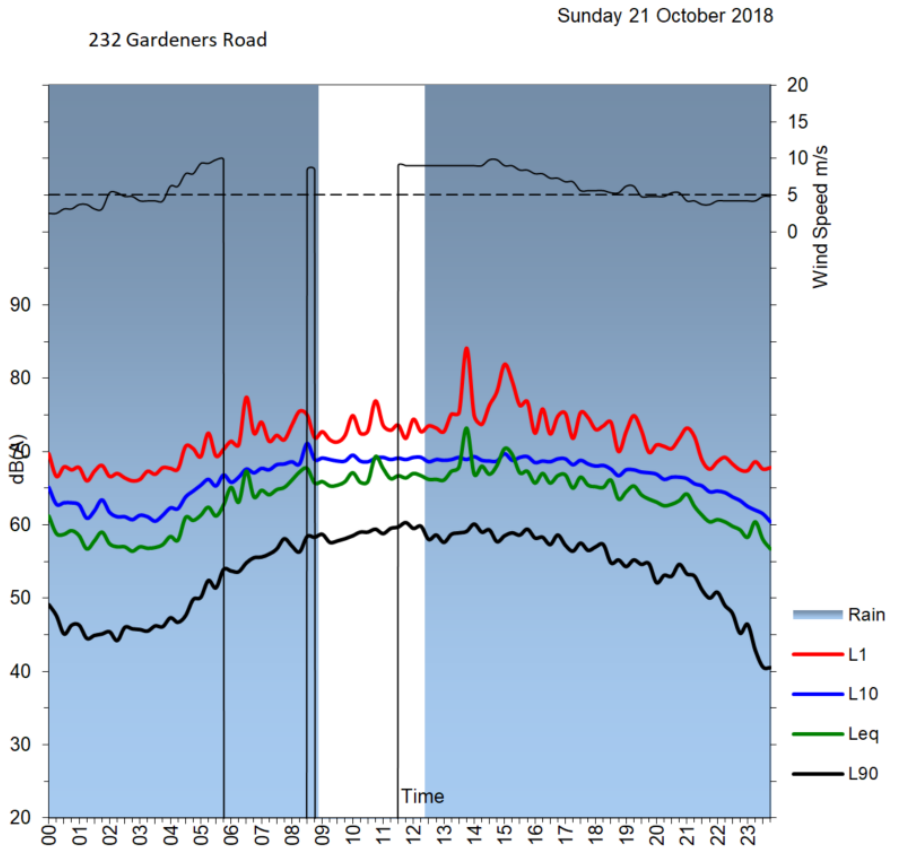


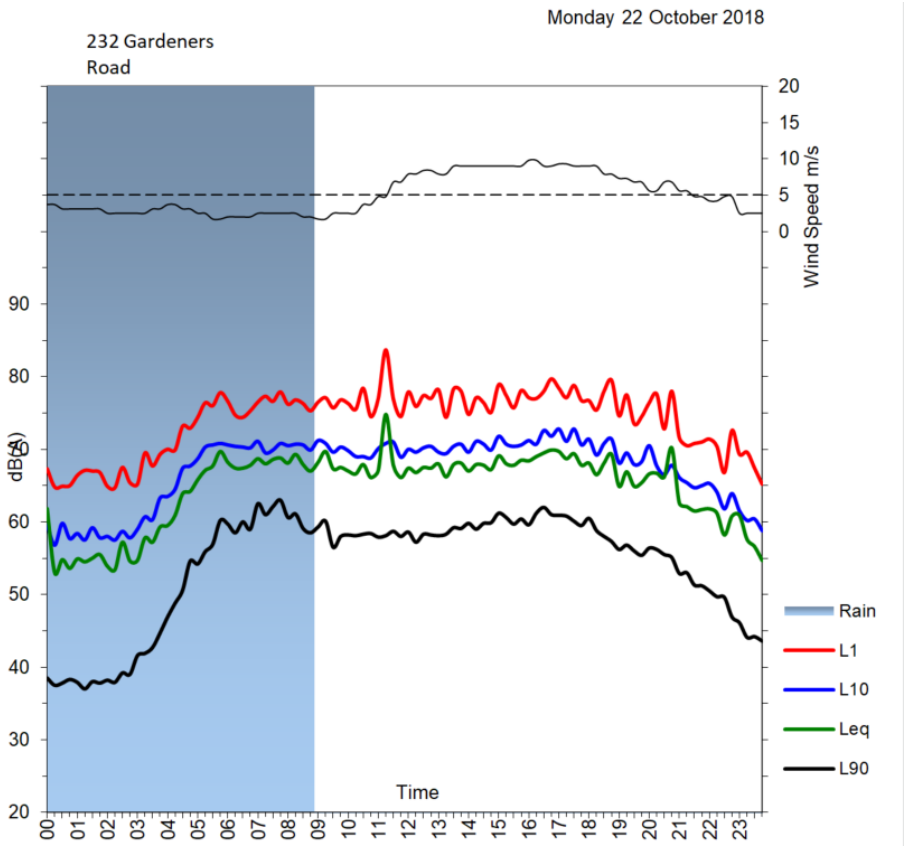

232 Gardeners Road
Wednesday 17 October 2018
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

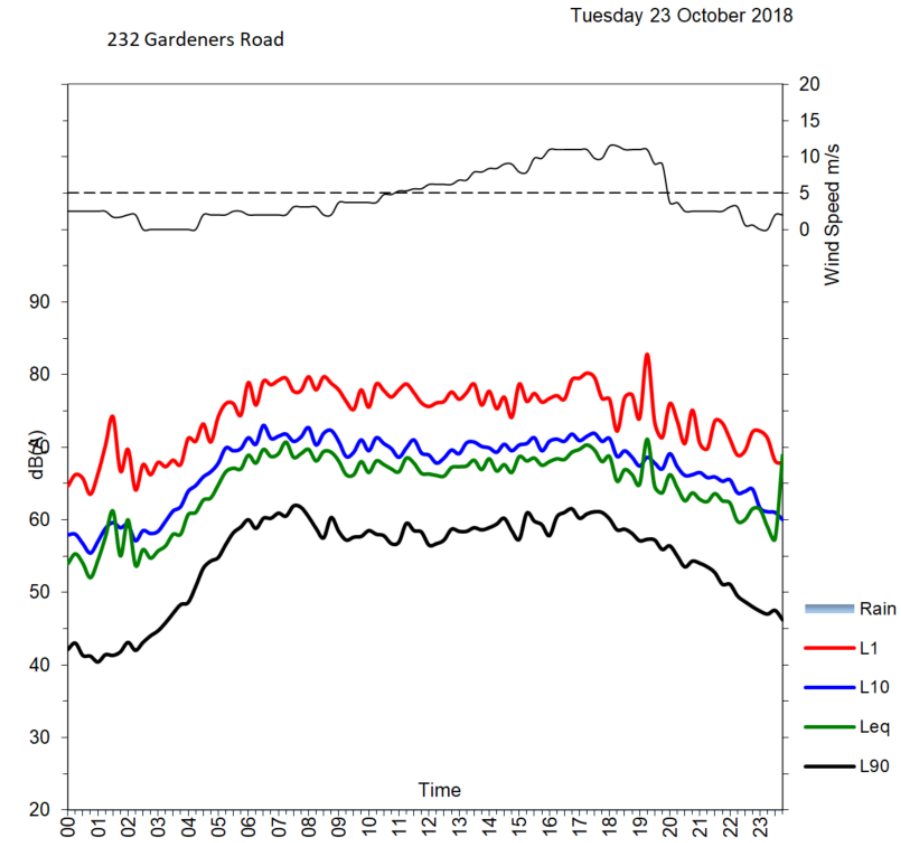

Thursday 18 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

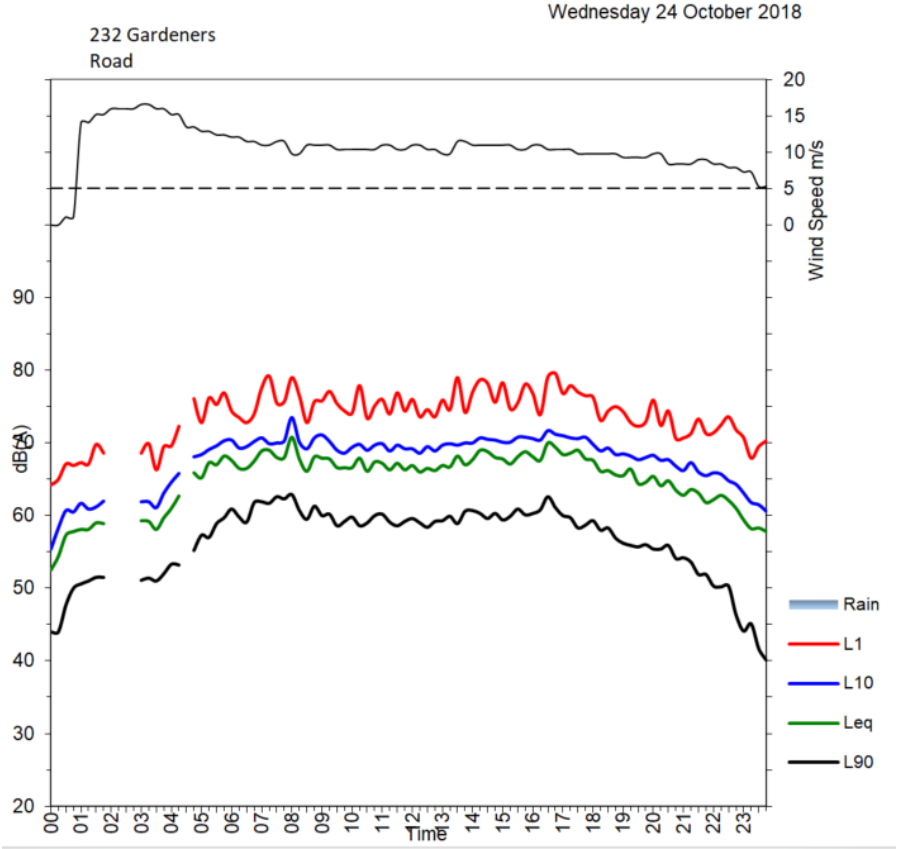

Friday 19 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

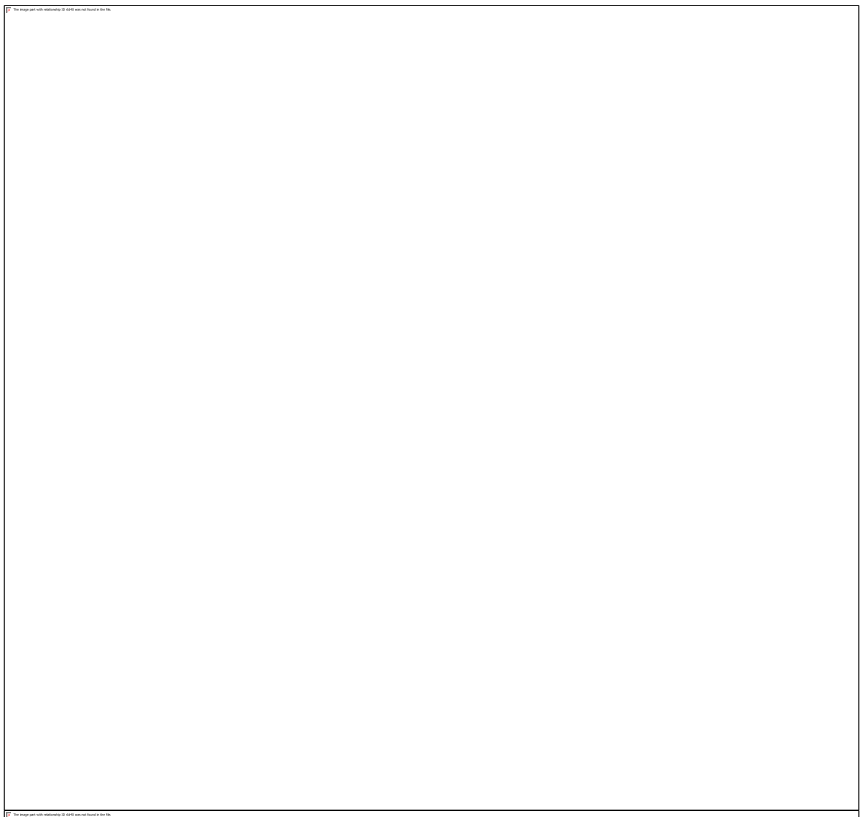

Saturday 20 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

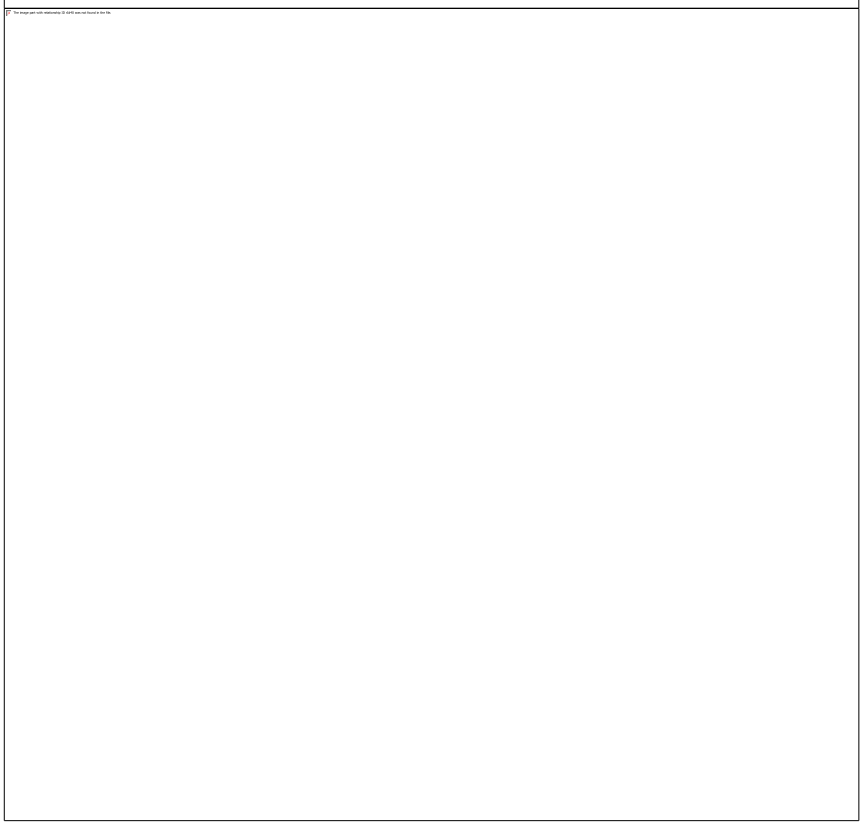

Sunday 21 October 2018
232 Gardeners Road
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90


Monday 22 October 2018
232 Gardeners Road
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90

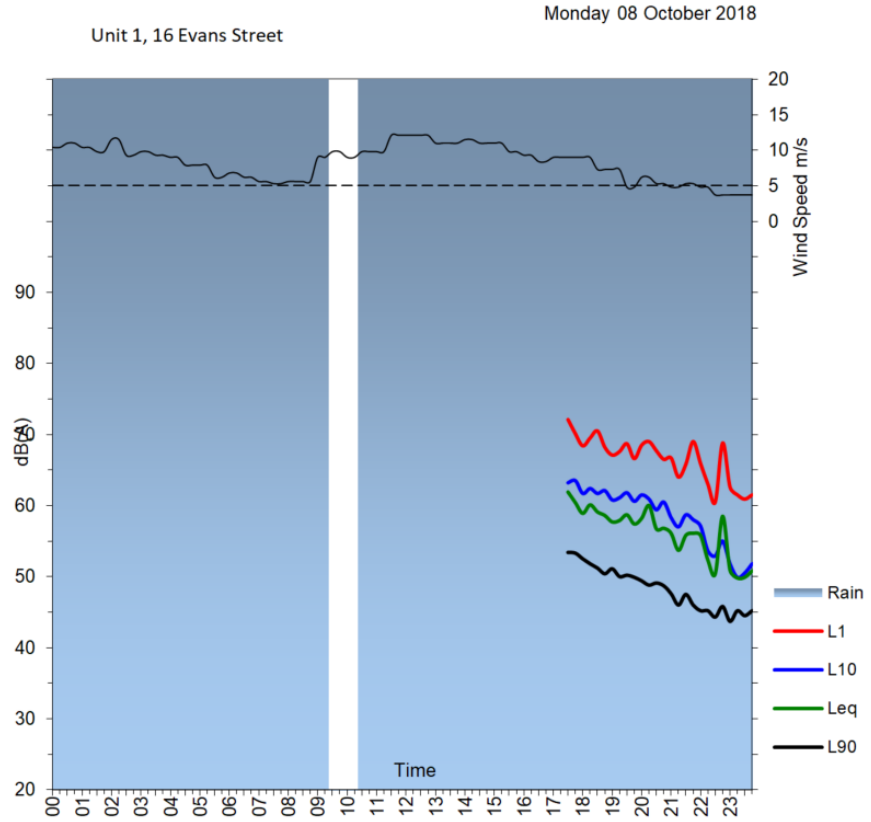

Tuesday 23 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

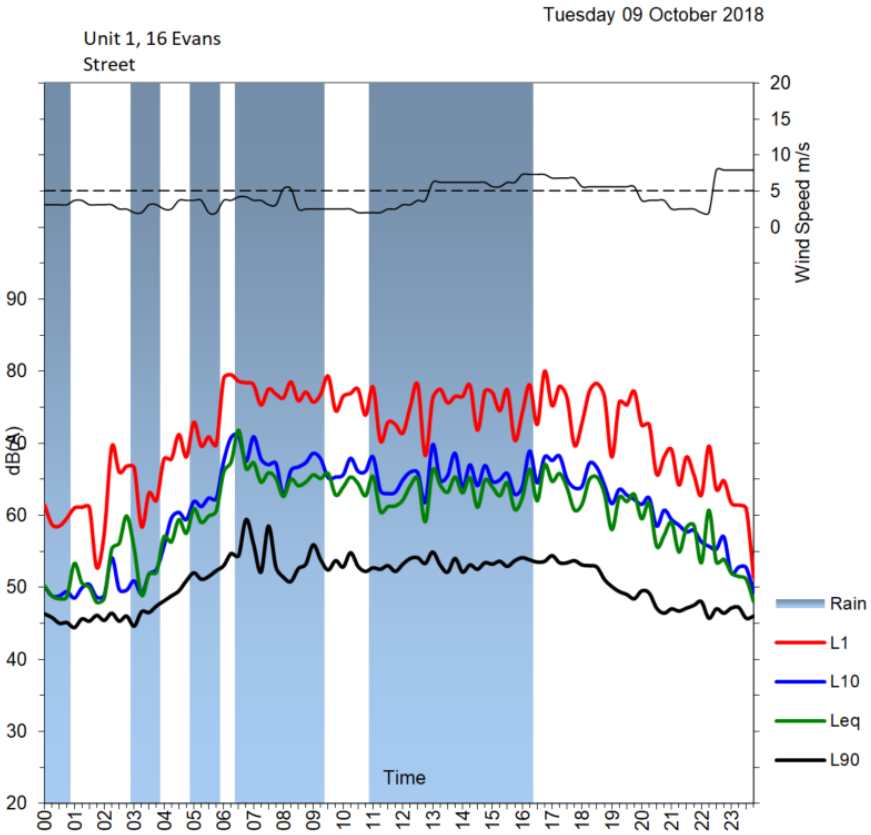

Wednesday 24 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

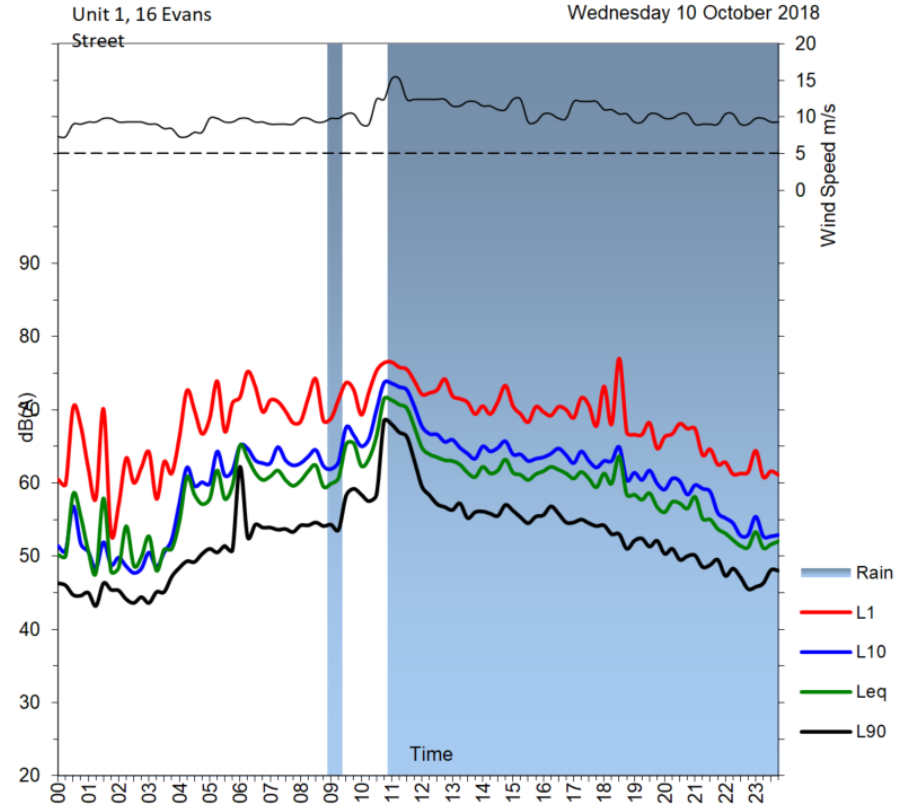


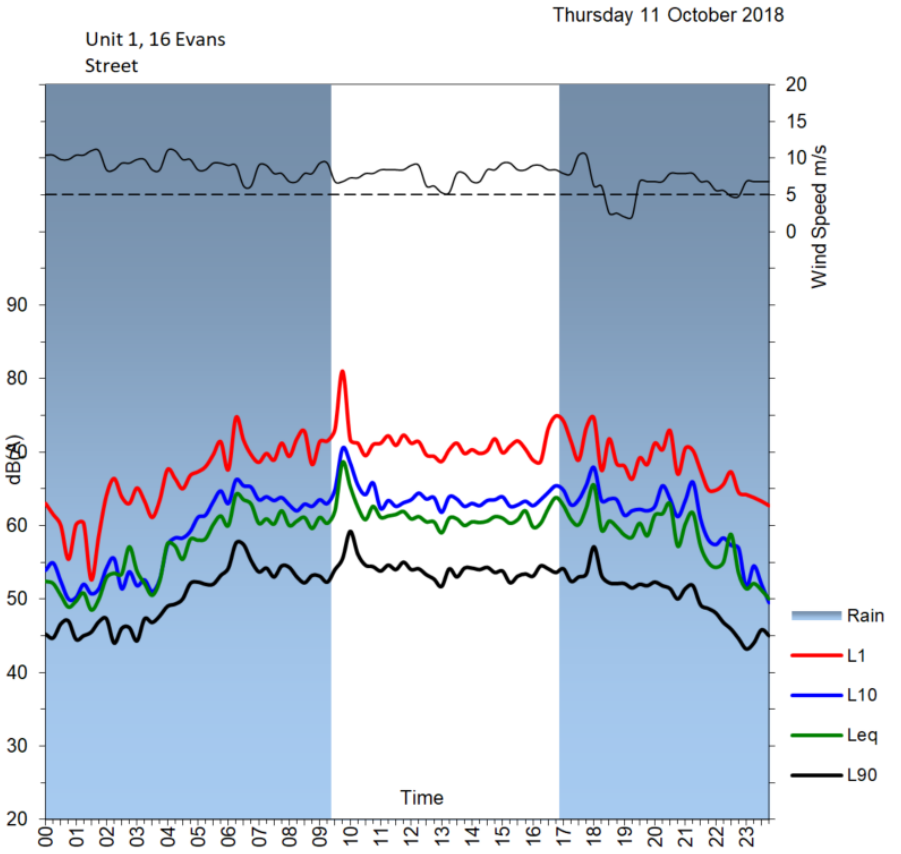


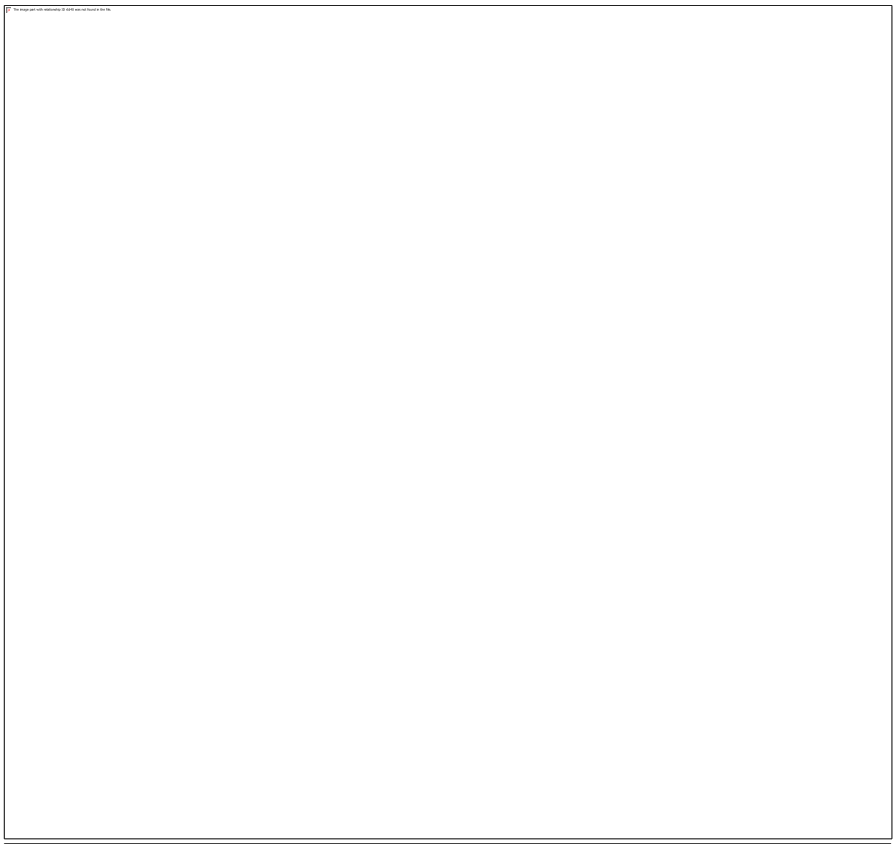
APPENDIX B: UNATTENDED NOISE MEASUREMENTS UNIT 1, EVANS AVENUE

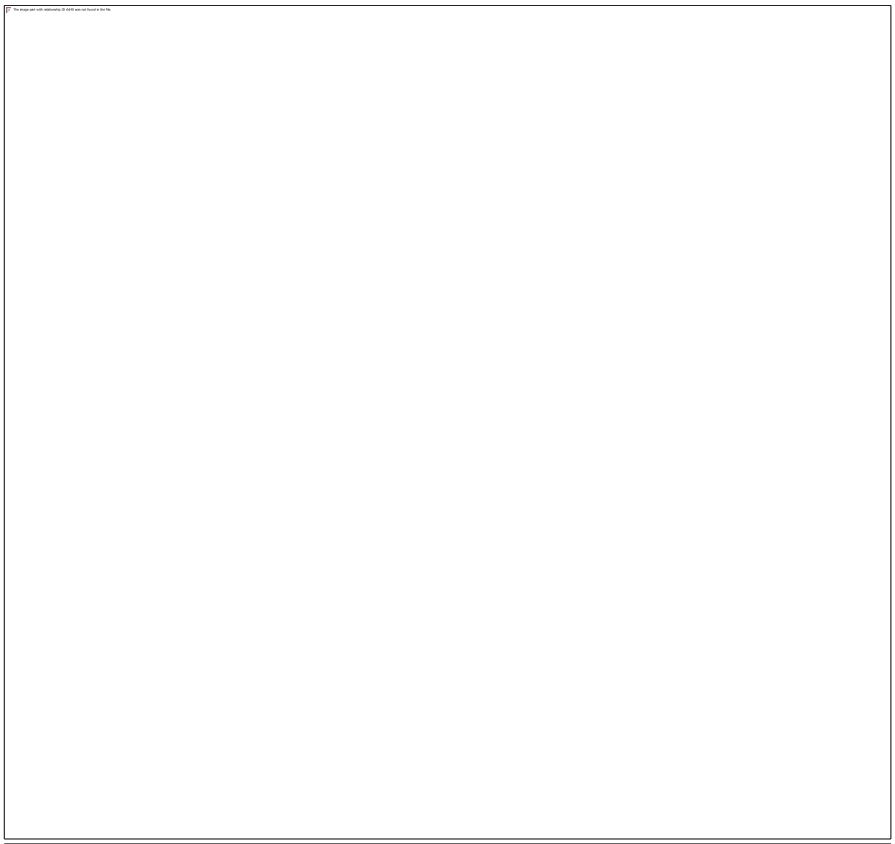


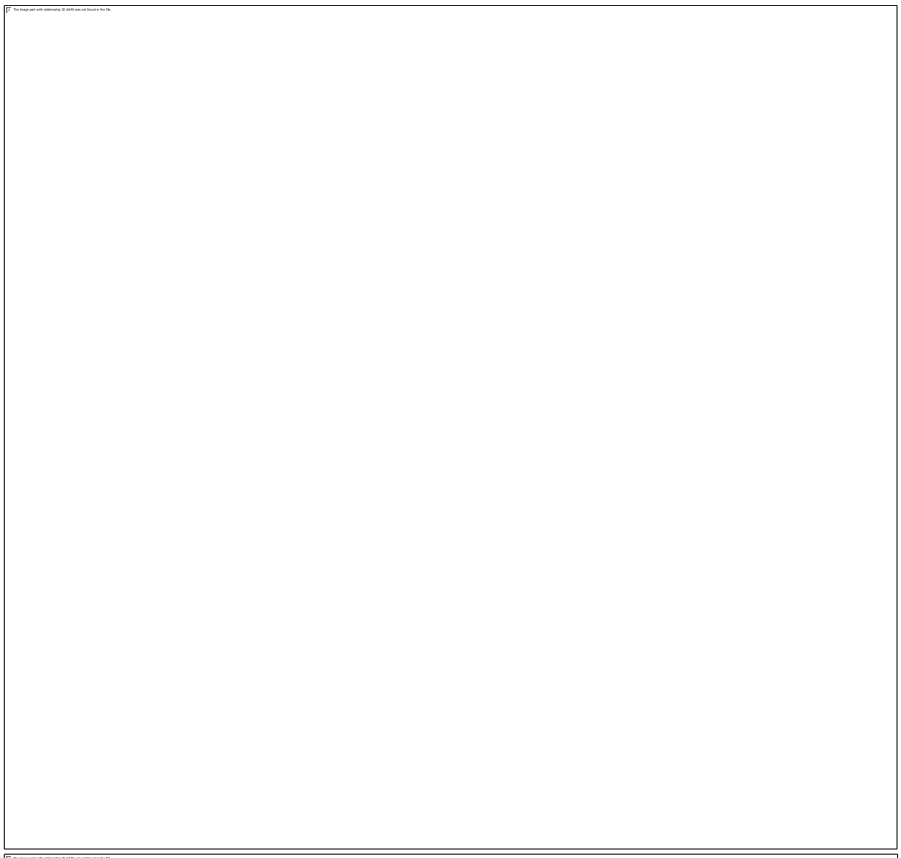


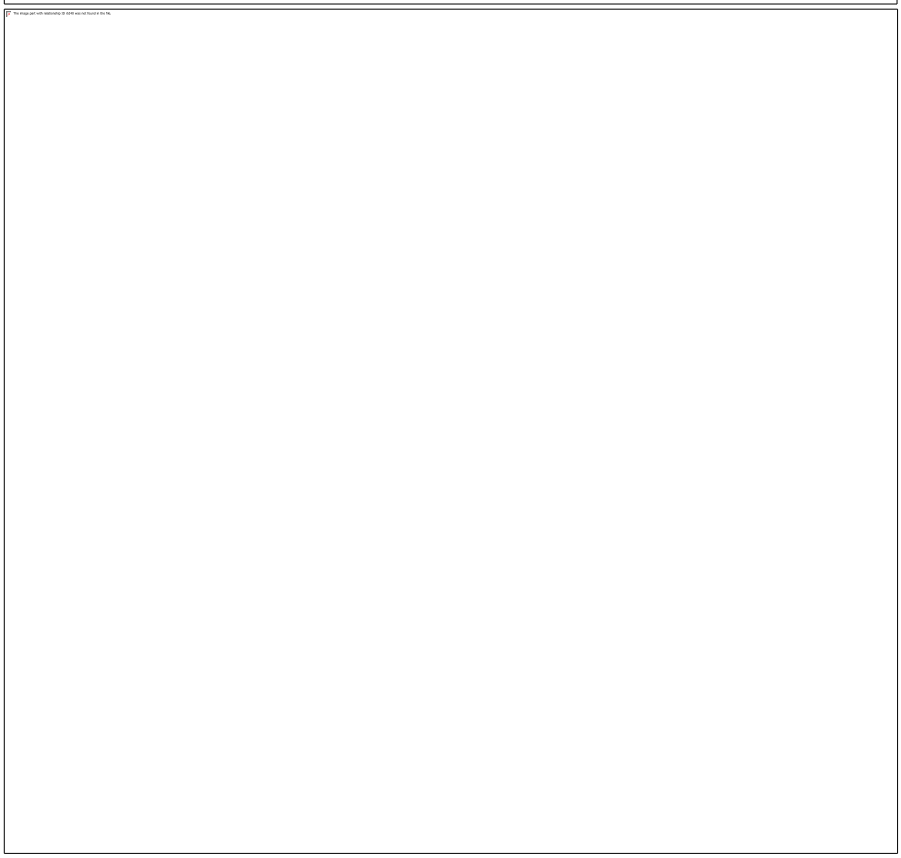

Unit 1, 16 Evans Street
Wednesday 10 October 2018
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

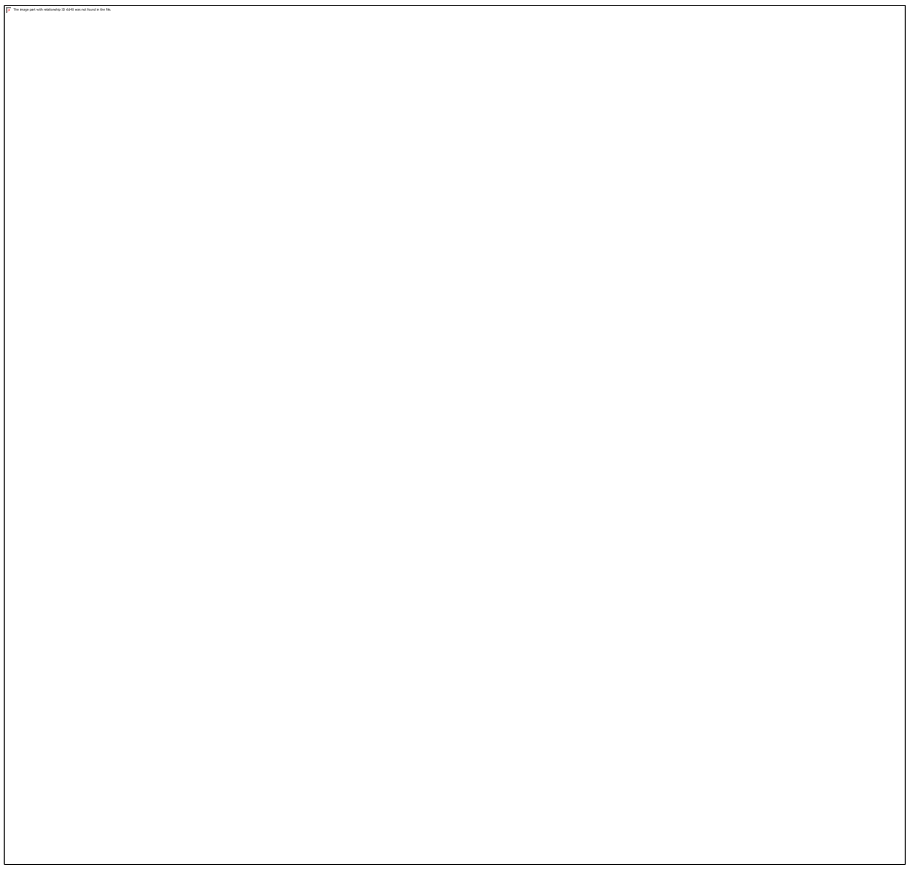

Thursday 11 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

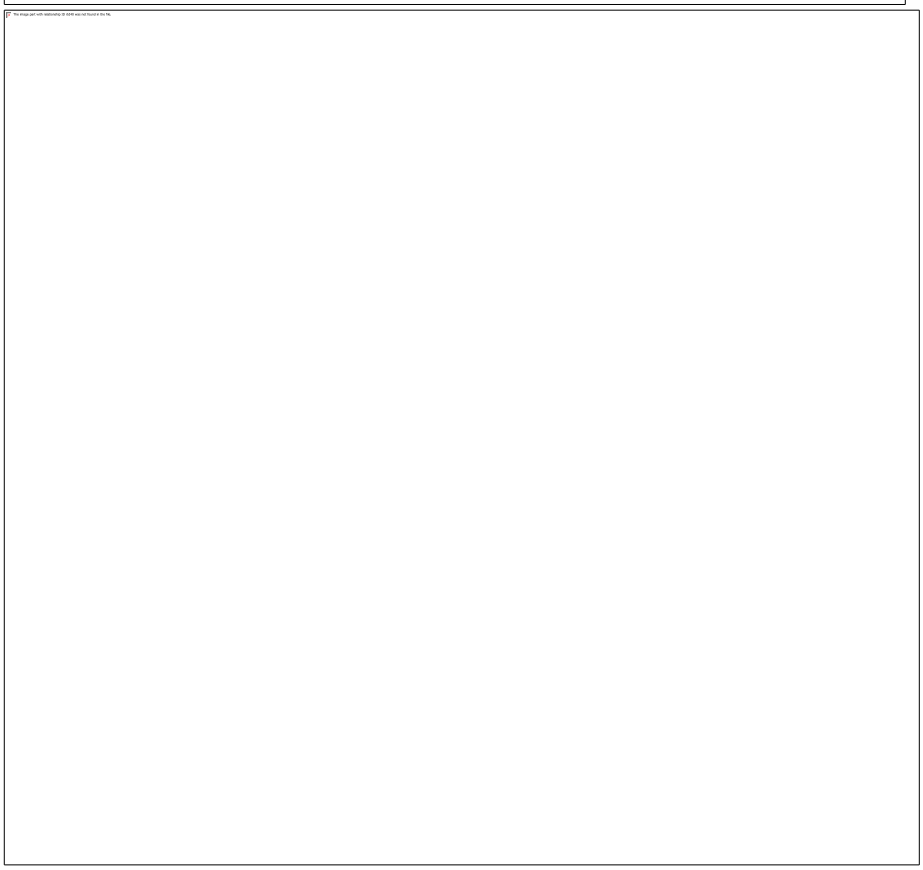












APPENDIX C: ARCHITECTURAL DRAWINGS