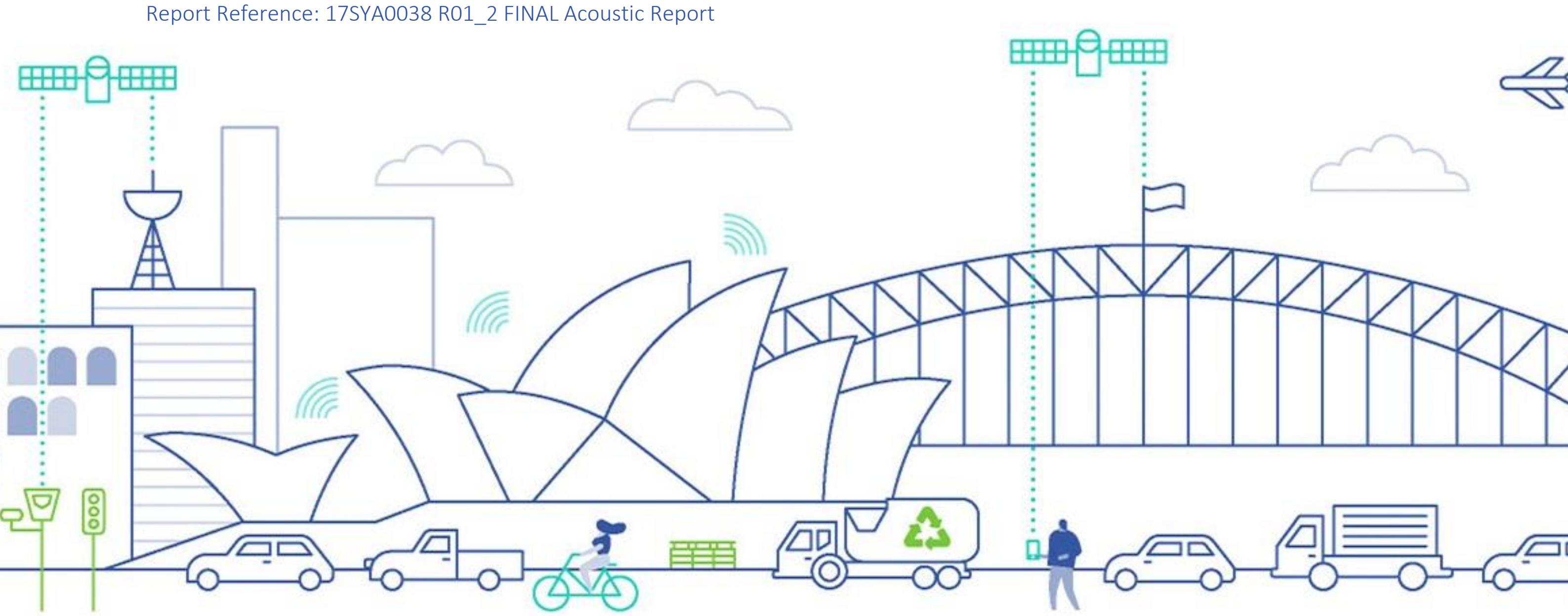
Acoustic Consulting

88-92 Elizabeth Drive, Liverpool

St George Community Housing

Acoustic Report

Prepared for St George Community Housing Ltd
Report Reference: 17SYA0038 R01_2 FINAL Acoustic Report



ttm

About TTM

For 30 years, we've been at the centre of the Australian development and infrastructure industry. Our unique combination of acoustics, data, traffic and waste services is fundamental to the success of any architectural or development project.

We have over 50 staff, with an unrivalled depth of experience. Our industry knowledge, technical expertise and commercial insight allow us to deliver an exceptional and reliable service.

T: (02) 9418 3033
F: (02) 9418 3112
E: ttmnsw@ttmgroup.com.au

Acoustics Data Traffic Waste

Revision Record

No.	Author	Reviewed/Approved	Description	Date
1.	K. Dhayam	-	Draft – Issued to client	07/11/2017
2.	K. Dhayam	K. Hewett	Final – Issued to client	13/11/2017
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5.				

Executive Summary

TTM conducted a noise assessment for the proposed new community housing project at 88-92 Elizabeth Drive, Liverpool for St George Community Housing Ltd (SGCH). Noise monitoring of existing ambient and road traffic noise levels were conducted and noise impact levels were predicted.

The development is predicted to comply with the Liverpool Development Control Plan (LDCP) 2008, and relevant standards and guidelines with the inclusion of acoustic treatments to windows, walls and roof, and a detailed acoustic assessment of mechanical plant during detailed design stage.

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1 Introduction

1.1 Background

TTM was engaged by St George Community Housing Ltd (SGCH) to undertake a noise impact assessment of a proposed new community housing project at 88-92 Elizabeth Drive, Liverpool. This report will form part of the development application for consideration by Liverpool City Council.

The assessment is based on the following:

- Liverpool Development Control Plan (LDCP) 2008
- NSW Road Noise Policy[1]
- Australian Standard AS2107[2]
- NSW Noise Policy for Industry[3]
- Acoustic building envelope design in accordance with AS 3671[4]
- Architectural plans by Smith & Tzannes, Rev A, dated 19/01/2018, as presented in Appendix A
- Noise measurements, analysis and calculations conducted by TTM.

1.2 Scope

The assessment includes the following:

- Description of the development site and proposal.
- Measurement of existing ambient and traffic noise levels.
- Statement of assessment criteria relating to road traffic noise and environmental noise emissions.
- Assess potential noise impact of surrounding road network onto the development, and noise impact of the development on the local community.
- Building envelope recommendations.
- Details of noise control recommendations to be incorporated to achieve predicted compliance.

[1] NSW Department of Environment, Climate Change and Water (2011), NSW Road Noise Policy

[2] AS NZS 2107:2016. Acoustics - Recommended design sound levels and reverberation times for building interiors

[3] NSW Environment Protection Authority (2017), Noise Policy for Industry

[4] AS 3671:1989. Acoustics - Road traffic noise intrusion - Building siting and construction

2 Site Description

The site is located at 88-92 Elizabeth Drive, Liverpool. There are currently residential units on the site, which will be demolished to make way for the new development.

The site fronts Elizabeth Drive to the north. Elizabeth Drive is a dual carriageway with three lanes in each direction. The site is also bounded by residential properties to the south, east and west. Across the road to the north are residential properties.

An aerial image of the site locality is shown in Figure 1.

Figure 1: Site locality

The current acoustic environment of the site is typical of an urban area with dense transportation, with road traffic noise from Elizabeth Drive being the dominant noise source.

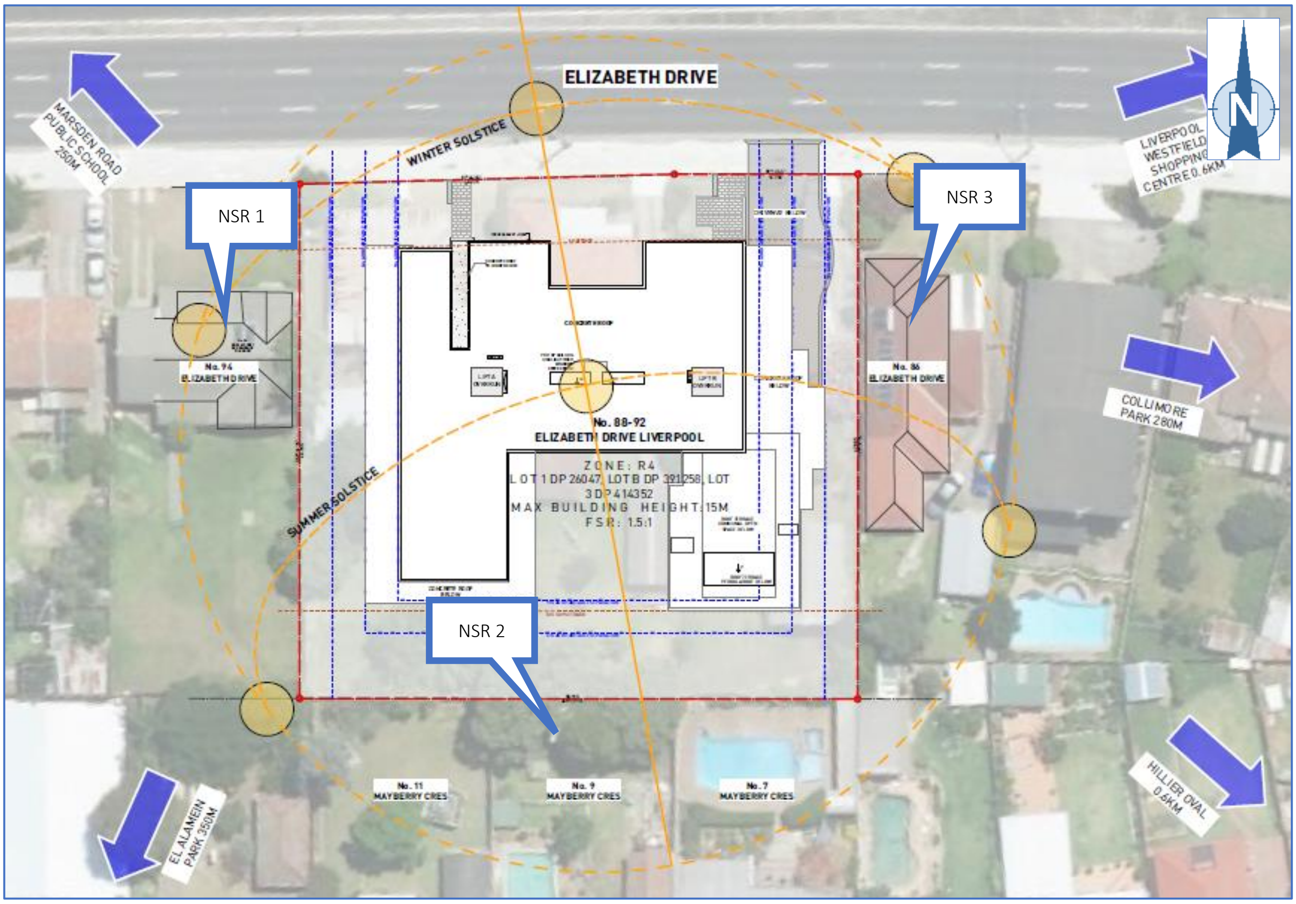
3 Proposed Development

3.1 Development Description

The proposed development involves the demolition of the existing structures and the construction of a five-storey residential apartment building with one basement car parking level. The development comprises of one and two-bedroom units, a communal open space at ground level, and a roof terrace communal open space.

A site plan of the proposed development is shown in Figure 2.

Figure 2: Development Site Plan



3.2 Noise Sensitive Receivers (NSRs)

To the east, west and south of the future development, are residential properties which may be adversely impacted by noise from the development. The closest NSRs have been identified (Refer to Figure 2) and are as follows:

1. NSR 1 – Lowset residential building – 94 Elizabeth Drive

2. NSR 2 – Lowset residential building – 7-11 Mayberry Crescent
3. NSR 3 – Lowset residential building – 86 Elizabeth Drive

Should the derived noise limits in this report be met at the above identified NSRs with recommended noise mitigation measures, if any, compliance with the noise criteria is also expected to be met at properties located further away due to increased distance attenuation.

4 Noise Measurements

4.1 Equipment

The following equipment was used to measure existing ambient and traffic noise levels at the site:

- Unattended ambient and traffic noise:
  - Brüel & Kjær Type 2250 Light, Noise Logger (S/N 3006261)
  - Norsonic Nor140, Noise Logger (S/N 1406507)
- Attended measurements:
  - Brüel & Kjær Type 2250, Type 1 Sound Level Meter (S/N 3004473)
- Calibrator:
  - Brüel & Kjær Type 4231, Sound Calibrator (S/N 3009809)

All equipment was calibrated by a National Association of Testing Authorities (NATA) accredited laboratory. The equipment was calibrated before and after the measurement session. No significant drift from the reference signal was recorded.

4.2 Noise Monitoring

4.2.1 Unattended Ambient and Road Traffic Noise

Unattended noise monitoring was undertaken to measure existing ambient and road traffic noise levels. The noise monitoring locations are shown in Figure 3.

One noise monitor was placed as close as possible to Elizabeth Drive to capture road traffic noise levels from the road on the front yard of the existing residential property at 88 Elizabeth Drive, considering access and safety of equipment, shown as Location 1 on Figure 3. The monitor was approximately nine metres from the edge of the closest lane of Elizabeth Drive. At that location, the monitor had an unobstructed view of the road to capture representative road traffic noise levels across the site.

A second monitor was placed in the backyard of the residential property at 92 Elizabeth Drive shielded from road traffic noise to capture typical ambient noise levels in the area, shown as Location 2 on Figure 3. The monitor was approximately 35 metres away from the edge of the closest lane of Elizabeth Drive.

Both microphones were in a free-field position at a height of approximately 1.5 metres above ground level.

Average, maximum and statistical noise parameters were recorded by the noise monitors at 15-minute intervals in fast response. The weather throughout the monitoring period was generally fine with light wind breeze for most days. Rain and high wind were recorded from 11.30pm on the 26th to 2.30am on the 27th October, from 6.00pm to 11.45om on the 30th October, and from 3.15pm to 10.45pm on the 31st October.

Noise data recorded during these periods and data affected by extraneous noise have been discarded and have not been included in the measurement summary.

Figure 3: Noise Monitoring Locations

4.2.2 Attended noise measurements

Attended noise measurements were also undertaken at the monitoring locations during logger installation and collection. The measurements were taken using a Brüel & Kjær Type 2250, Type 1 Sound Level Meter (S/N 3004473). The measurements are used to verify and supplement the unattended noise monitoring data.

The Sound Level Meter was secured on a tripod and its microphone was positioned next to the microphone of the noise logger. Average, maximum and statistical noise parameters were recorded for a duration of 15 minutes in fast response. The weather throughout the attended measurements was described as fine with a light breeze. The sound level meter was checked for calibration before and after the measurement and no significant drift was observed.

4.3 Results of Noise Survey

4.3.1 Ambient Noise Monitoring Results

Table 1 presents the measured ambient noise levels at Locations 1 and 2 (Refer to Figure 3). The noise monitoring results are represented graphically in Appendix B. The monitoring results were used to determine the assessment criteria for the development.

Table 1: Ambient Noise Monitoring Results

Period	Existing Noise Levels in dB(A)			
	Rating Background Noise Levels, RBL L_{90}	L_{eq}	L_{10}	L_1
Location 1 – Road traffic noise measured at 88 Elizabeth Drive				
Day	55	69	73	80
Evening	54	69	73	79
Night	38	66	72	79
Location 2 – Ambient noise measured at 92 Elizabeth Drive				
Day	48	54	56	62
Evening	47	53	55	60
Night	40	48	51	56

Note:
- Day-time period is from 0700 to 1800 (Monday to Saturday) and 0800 to 1800 (Sundays and Public Holidays)
- Evening period is from 1800 to 2200
- Night-time period is from 2200 to 0700 (Monday to Saturday) and 2200 to 0800 (Sundays and Public Holidays)

The existing noise levels at Location 1 are representative of road traffic noise from Elizabeth Drive at the front of the site. At Location 2, the existing noise levels represent typical ambient noise levels shielded from road traffic noise at the back of the site.

The measured noise levels are generally similar throughout the day, evening and night, except for the L_{90} parameter, which drops during the night-time at both measurement locations. The drop in the L_{90} parameter at night-time is due to lower road traffic volumes in that period which is expected in residential areas.

4.3.2 Road Traffic Noise Monitoring Results

The unattended noise monitoring results at Location 1 (Refer to Figure 3) have been summarised in terms of the NSW road traffic noise descriptors and the CoRTN Method descriptor (*Calculation of Road Traffic Noise, Department of Transport, Welsh Office*, UK 1988) in Table 2.

Table 2: Road Traffic Noise Monitoring Results – Location 1

Period (T)	Existing Noise Level in dB(A)		
	NSW Road Noise Policy descriptor		CoRTN $L_{10,18h}$ (6am to 12am)
	$L_{eq,T}$	$L_{eq,1h}$ (Average maximum 1 hour)	
Day (7am - 10pm)	68.5	70.4	72.1
Night (10pm - 7am)	63.9	67.0	

4.3.3 Attended measurements

The results of the attended noise measurements are summarised in Table 3, along with the corresponding measured unattended noise measurement to confirm the validity of the measurements.

Table 3: Summary of attended noise measurements

Meas. Ref.	Meas. Location (Refer to Figure 3)	Approx. Start Date/Time	Measured Noise Levels in dB(A)*						Comments
			L_{min}	L_{90}	L_{eq}	L_{10}	L_1	L_{max}	
A1	Location 1	26/10/2017 11:35	47	57	72	73	79	100	Road traffic noise dominant. Site close to traffic lights, acceleration noise frequent. Low heavy vehicles percentage, mainly buses. High L_{max} due to ambulance siren passby.
			49	**57**	**69**	**72**	**78**	**95**	
A2	Location 2	26/10/2017 11:55	43	47	52	54	58	72	Road traffic noise still dominant although to a lesser extent due to shielding from the existing building. Natural sounds from trees and insects.
			44	**47**	**52**	**54**	**59**	**63**	
A3	Location 1	03/11/2017 15:56	48	59	70	73	77	84	Road traffic noise dominant. Site close to traffic lights, acceleration noise frequent. Low heavy vehicles percentage.
			48	**59**	**70**	**73**	**76**	**83**	
A4	Location 2	03/11/2017 16:12	43	47	53	55	61	71	Road traffic noise dominant. Kids in neighbouring backyard playing. Natural sounds from trees and insects.
			43	**48**	**56**	**55**	**63**	**86**	

Note: * Unattended noise monitor logging data in **BOLD**.

From the noise measurements and site inspection, the site is predominately impacted by road traffic noise from Elizabeth Drive. Due to the traffic lights near the site, acceleration engine noise was also frequent. Buses was also observed to stop at the bus stop close to the site, resulting in acceleration noise from buses.

The attended noise measurements show a snap-shot sample of the noise environment in the area. The sample measurements are similar to the long-term unattended noise monitoring results, generally within ±3 dB difference in the presented statistical parameters, except the L_{max} parameter. As such, the attended measurements confirm the validity of the unattended noise survey for the purpose of the noise impact assessment.

5 Noise Criteria

The main guidelines, standards and other policy documents relevant to the assessment contained in this acoustic report include:

- Liverpool Development Control Plan (LDCP) 2008
- NSW Road Noise Policy
- NSW SEPP Infrastructure
- NSW Noise Policy for Industry

5.1 Liverpool Development Control Plan (LDCP) 2008

LDCP 2008 provide controls for residential development to ensure that it achieves a high standard of urban design, that is compatible with the amenity and character of the area. The relevant sections of the LDCP 2008 to the proposed development for the acoustic assessment are summarised below:

- Noise attenuation measures should be incorporated into building design to ensure acoustic privacy between on-site and adjoining buildings.
- Buildings having frontage to a Classified Road and impacted upon by traffic related noises must incorporate the appropriate noise and vibration mitigation measures into the design in terms of the site layout, building materials and design, orientation of the buildings and location of sleeping and recreation areas.
- The proposed buildings must comply with the Environment Protection Authority criteria and the current relevant Australian Standards for noise and vibration and quality assurance.
- Arrange dwellings within a development to minimise noise transition between dwellings by:
  - Locating busy, noisy areas next to each other and quieter areas next to other quiet areas, for example, living rooms with living rooms, bedrooms with bedrooms
  - Using storage or circulation zones within a dwelling to buffer noise from adjacent dwellings, mechanical services or corridors and lobby areas
  - Minimising the number of common walls with other dwellings
  - Design the internal dwelling layout to separate noisier spaces from quieter spaces by grouping uses within a dwelling - bedrooms with bedrooms and service areas like kitchen, bathroom, and laundry together.

5.2 NSW Road Noise Policy

The NSW Road Noise Policy sets out noise assessment criteria for residential land uses affected by road traffic noise on freeway/arterial/sub-arterial roads, which are summarised in Table 4.

Table 4: NSW Road Noise Policy noise assessment criteria

Road type	Period	Assessment criteria, in dB(A)
Freeway/arterial/sub-arterial (City Road)	Day (7am - 10pm)	60 dB(A) $L_{eq,1\ hour}$ (external)
	Night (10pm - 7am)	55 dB(A) $L_{eq,1\ hour}$ (external)

The NSW Road Noise Policy also sets out noise assessment criteria for other sensitive land uses affected by road traffic noise. The criteria are summarised in Table 5.

Table 5: NSW Road Noise Policy – Road traffic noise assessment for non-residential uses

Sensitive Land Use	Period	Criteria
Open Space (Passive use)	When in use	55 dB(A) $L_{eq,15\ hour}$ (external)

5.3 Australian Standard AS2107

AS2107 has been referred to investigate the impact of road traffic noise onto the proposed development. AS2107 provides internal design sound levels for the different types of occupancy and are summarised in Table 6.

Table 6: Summary of internal design sound levels for each type of occupancy

Type of occupancy	AS2107 – Recommended design sound level L_{eq} in dB(A)	Design sound levels for the project L_{eq} in dB(A)
Residential – Living areas	35-45 (Near major roads)	45
Residential – Sleeping areas	30-40 (Near major roads)	40

For the proposed development, the maximum internal design sound levels have been selected, as advised by the project manager.

5.4 NSW Noise Policy for Industry

The policy sets out the procedure to determine the project noise trigger levels relevant to assess noise from mechanical plant and equipment. The project noise trigger level applies to existing noise-sensitive receivers.

The project noise trigger level provides a benchmark or objective for assessing a proposal or site. It is not intended for use as a mandatory requirement. The project noise trigger level is a level that, if exceeded, would indicate a potential noise impact on the community, and so ‘trigger’ a management response; for example, further investigation of mitigation measures.

The project noise trigger level is the lower (that is, the more stringent) value of the project intrusiveness noise level and project amenity noise level determined in Sections 2.3 and 2.4 of the policy.

5.4.1 Project Intrusiveness Noise Level

The Noise Policy for Industry states:

> *The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold. This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment.*

The intrusiveness noise level is determined as follows:

$$L_{Aeq,\ 15min} \leq \text{Rating Background Noise Level} + 5\ \text{dB}$$

5.4.2 Amenity Noise Levels and Project Amenity Noise Levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the Noise Policy for Industry where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The noise amenity area is defined as urban residential and the relevant noise amenity levels are given in Table 7.

Table 7: Amenity noise levels

Receiver/ Noise amenity area	Assessment period	Recommended amenity noise level, L_{eq} dB(A)
Residential Urban	Day	60
	Evening	50
	Night	45

Note:
- Day-time period is from 0700 to 1800 (Monday to Saturday) and 0800 to 1800 (Sundays and Public Holidays)
- Evening period is from 1800 to 2200
- Night-time period is from 2200 to 0700 (Monday to Saturday) and 2200 to 0800h (Sundays and Public Holidays)

The recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows:

Project amenity noise level for industrial developments = Recommended amenity noise level minus 5 dB(A)

Although road traffic noise is dominant at the site, high traffic project amenity noise level does not apply as existing traffic noise levels are less than 10 dB below the recommended noise level for the area.

5.4.3 Project Noise Trigger Level

The project noise trigger level (PNTL) has been determined in Table 8.

Table 8: NSW Noise Policy for Industry Evaluated criteria

Assessment period	Project Intrusiveness Noise Level $L_{eq,15min}$ dB(A)*	Project Amenity Noise Level L_{eq} dB(A)	Project Noise Trigger Level L_{eq} dB(A)
Day	53	55	**53**
Evening	52	45	**45**
Night	45	40	**40**

Note:
- Day-time period is from 0700 to 1800 (Monday to Saturday) and 0800 to 1800 (Sundays and Public Holidays)
- Evening period is from 1800 to 2200
- Night-time period is from 2200 to 0700 (Monday to Saturday) and 2200 to 0800h (Sundays and Public Holidays)

* Based on measured noise levels at Location 2, Refer to Table 1.

Table 8 shows that the project intrusiveness noise level is more stringent during the day-time period, and the project amenity noise level is more stringent during the evening and night-time periods and are therefore the PNTL for the development.

By meeting the PNTLs at the identified NSRs, all other properties located further away from the development site are expected to comply with INP noise requirements.

6 Noise Assessment

This section of the report assesses road traffic noise intrusion from Elizabeth Drive into the proposed development, road traffic noise generated by the development and noise emissions from the development to the local community.

6.1 Road Traffic Noise Intrusion – Elizabeth Drive

The proposed development is subject to road traffic noise intrusion from Elizabeth Drive. Elizabeth Drive is a dual carriageway with three lanes in each direction with a signed speed zone of 70km/h. During the site inspection, it was observed that traffic was free flowing and vehicles were travelling at the posted speed. Due to the nearby intersection and traffic lights, engine noise from the accelerating vehicles was also observed. There is also a bus stop nearby, causing engine acceleration noise from buses.

6.1.1 Noise Prediction Model

Road traffic noise levels were predicted using the CoRTN[5] Method for the 10-year horizon from the planning stage to 2028 using SoundPLAN, a CoRTN based noise modelling software. The parameters used in the model are summarised in Table 9.

Table 9: Parameters used in SoundPLAN model

Parameter		Value
Façade correction		+2.5 dB
Façade receiver heights	Ground floor	1.5 m above ground level
	First floor	4.3 m above ground level
Speed limit	Elizabeth Drive	70 km/h (Posted limit)
Road surface correction		None

The model has been designed to predict road traffic noise from Elizabeth Drive. Elevation contours of the site and the road used in the model were extracted from the drawings provided by Smith & Tzannes Architects and Google Earth, where required.

The traffic volume and growth rate information used in the SoundPLAN model were obtained from the NSW RMS Traffic Volume Viewer[6] (Elizabeth Drive – West of Flowerdale Road) and further advice.

Based on the available information, ultimate traffic volumes for Year 2028 were calculated for the future road network. The growth rate for Elizabeth Drive was calculated from traffic volumes for the past five years, and found to be 0% to 2%. A 2% growth rate has been adopted to represent a conservative model.

[5] *Calculation of Road Traffic Noise, Department of Transport, Welsh Office*, UK 1988

[6] http://www.rms.nsw.gov.au/about/corporate-publications/statistics/traffic-volumes/index.html

The growth rate was used to predict ultimate traffic volumes for Year 2028 on Elizabeth Drive. The traffic volumes, growth rate and percentage of heavy vehicles (HV) used in the model are summarised in Table 10.

Table 10: Traffic data for Elizabeth Drive

Road name	Existing – Year 2017		Growth rate (%)	% HV	Ultimate – Year 2028	
	AADT	18-hour traffic (94%)			AADT	18-hour traffic (94%)
Elizabeth Drive – Eastbound	23,540	22,120	2	6	29,260	27,500
Elizabeth Drive – Westbound	22,020	20,700	2	6	27,380	25,740

6.1.1.1 Verification of Road Traffic Noise Model

The measured and predicted free-field noise levels at Location 1 (Refer to Figure 3) for the existing situation (year 2017) are shown in Table 11.

Table 11: Comparison of measured and predicted free-field noise levels – Existing Year 2017 situation

Measurement Location (Refer to Figure 3)	Sound Pressure Levels, $L_{10,18h}$ in dB(A)		
	Measured	Predicted	Difference
Location 1	72.1	72.2	+0.1

The predicted road traffic noise level using SoundPLAN is 0.1 dB higher than the measured noise level. The model is within the accepted model variance of ±2 dB and is therefore validated.

6.1.1.2 Model Parameter Offsets

Road traffic noise predictions using the CoRTN Method on SoundPLAN are output in the $L_{10,18h}$ parameter. To convert to L_{eq} parameters, offsets based on the measured road traffic noise at Location 1, as shown in Table 2, have been determined. The offsets are summarised in Table 12.

Table 12: Offsets between $L_{10,18h}$ and L_{eq} parameters

Period (T)	Offset in measured noise levels, in dB	
	Between $L_{10,18h}$ and $L_{eq,T}$	Between $L_{10,18h}$ and $L_{eq,1h}$
Day (7am – 10pm)	-3.5	-1.7
Night (10pm – 7am)	-8.2	-5.1

6.1.2 Future Situation Model – Year 2028

Road traffic noise levels have been predicted to the facades of the development using the SoundPLAN model, to represent the future road traffic noise impact for Year 2028. The location of the receivers is shown in Appendix C. The offsets given in Table 12 and a façade correction of +2.5 dB have been applied to determine the façade-corrected L_{eq}. The predicted results are summarised in Table 13.

Table 13: Future Road Traffic Noise Predictions – Façade-corrected

Receiver Ref. (Façade direction) – Refer to Appendix C	Floor level	Predicted $L_{10,18h}$ dB(A)	Noise levels in dB(A)			
			$L_{eq\ Day}$	$L_{eq,1h\ Day}$	$L_{eq\ Night}$	$L_{eq,1h\ Night}$
Type A (NW)	GF	72	68	70	64	67
Type A/J/K (SW)	GF	61	57	59	53	56
Type A/B (N)	GF	76	73	74	68	71
Type A/E/J/K (S)	GF	43	39	41	35	38
Type B/F/M (N)	GF	76	72	74	68	71
Type D (W)	GF	65	61	63	57	60
Type F/M (E)	GF	68	65	67	60	63
Type G (E)	GF	56	53	55	48	51
Type G/H (S)	GF	52	48	50	43	47
Type A (NW)	F 1	74	70	72	66	69
Type A/J/K (SW)	F 1	65	62	64	57	60
Type A/B (N)	F 1	78	74	76	70	73
Type A/E/J/K (S)	F 1	44	41	43	36	39
Type B/F/M (N)	F 1	78	74	76	70	73
Type D (W)	F 1	69	65	67	61	64
Type F/M (E)	F 1	72	68	70	63	66
Type G (E)	F 1	61	58	60	53	56
Type G/H (S)	F 1	54	51	52	46	49
Type A (NW)	F 2	74	71	73	66	69
Type A/J/K (SW)	F 2	69	65	67	61	64
Type A/B (N)	F 2	78	74	76	70	73
Type A/E/J/K (S)	F 2	46	43	45	38	41
Type B/F/M (N)	F 2	78	74	76	70	73
Type D (W)	F 2	72	68	70	64	67
Type F/M (E)	F 2	73	70	72	65	68
Type G (E)	F 2	65	62	64	57	60
Type G/H (S)	F 2	55	52	54	47	50
Type A (NW)	F 3	74	71	72	66	69
Type A/J/K (SW)	F 3	70	67	68	62	65
Type A/B (N)	F 3	78	74	76	69	73
Type A/E/J/K (S)	F 3	49	46	48	41	44
Type B/F/M (N)	F 3	78	74	76	69	73
Type D (W)	F 3	72	69	70	64	67
Type F/M (E)	F 3	74	70	72	65	68
Type G (E)	F 3	68	64	66	59	63
Type G/H (S)	F 3	56	53	55	48	51
Type A (NW)	F 4	74	70	72	66	69

Receiver Ref. (Façade direction) – Refer to Appendix C	Floor level	Predicted $L_{10,18h}$ dB(A)	Noise levels in dB(A)			
			$L_{eq\ Day}$	$L_{eq,1h\ Day}$	$L_{eq\ Night}$	$L_{eq,1h\ Night}$
Type A/J/K (SW)	F 4	71	67	69	62	65
Type A/B (N)	F 4	77	74	76	69	72
Type A/E/J/K (S)	F 4	54	51	53	46	49
Type B/F/M (N)	F 4	77	74	76	69	72
Type D (W)	F 4	72	69	70	64	67
Type F/M (E)	F 4	73	70	72	65	68
Type G (E)	F 4	69	65	67	61	64
Type G/H (S)	F 4	58	55	56	50	53
Communal Space	GF	42	39	41	34	37
Rooftop Communal Space	Roof	58	55	56	50	53

The prediction results show that the future development will be exposed to façade-corrected road traffic noise levels of:

- 76-78 dB(A) $L_{10,18hr}$ on the northern façade facing Elizabeth Drive
- From 74 dB(A) $L_{10,18hr}$ on the western façade closer to the road to 61-71 dB(A) $L_{10,18hr}$, further back along the facade
- From 68-74 dB(A) $L_{10,18hr}$ on the eastern façade closer to the road to 56-69 dB(A) $L_{10,18hr}$, further back along the façade
- 43-58 dB(A) $L_{10,18hr}$ on the southern façade facing away from Elizabeth Drive
- 42 dB(A) $L_{10,18hr}$ at the ground floor communal space, and
- 58 dB(A) $L_{10,18hr}$ at the rooftop communal space.

Generally, the predicted road traffic noise levels increase with height. The increase in noise levels are due to less shielding from neighbouring buildings, and a greater angle of view/line of sight to the road noise source at higher elevation.

6.1.3 Building Acoustic Treatments

The future development has been predicted to be exposed to road traffic noise levels greater than the NSW Road Noise Policy criteria of 60 dB(A) $L_{eq,1hr\ Day}$ and 55 dB(A) $L_{eq,1hr\ Night}$ (Refer to Table 4). Acoustic treatment to the building is therefore required to meet the internal design sound levels of 40 dB(A) $L_{eq\ Night}$ for bedrooms, and 45(A) dB $L_{eq,24hr}$ for main living areas.

The predicted façade-corrected road traffic noise levels have been used to determine the minimum acoustic performance requirements of the external façade of the development in accordance with the calculation methods contained in AS 3671[7] to meet the internal noise levels for each type of occupancy.

The acoustic performance requirements for the building envelope are summarised in Table 14. Alternative construction methods meeting the minimum acoustic rating are also acceptable.

Table 14: Acoustic performance requirements for building envelope

Building element	Minimum acoustic performance required, R_W	Typical construction details
Walls	56	*Refer to System No. CSR 5410, in CSR The Red Book, dated February 2017:* • External Masonry veneer wall, minimum 90mm thick and 170kg/m^2 with sarking • 90mm thick steel studs • 90mm Bradford Acoustigard R2.2 (14kg/m3) cavity in-fill • 1 layer of 16mm Gyprock Fyrchek Plasterboard internal.
Roof	54	Minimum 150mm thick concrete roof
Windows/ Sliding Doors	18-24	4mm Monolithic glass and standard weather seals
	25-27	6mm Monolithic glass and full perimeter acoustic seals
	28-32	6.38mm Laminated glass and full perimeter acoustic seals
	33-35	10.38mm Laminated glass and full perimeter acoustic seals
	38-41	Double glazing system with separate panes from Viridian: 12.5mm VLam Hush, 16mm airspace, 8.5mm VLam Hush with full perimeter acoustic seals

The glazing requirements for each unit type are summarised in Table 15. It is recommended to obtain a glazing certificate from the manufacturer stating the acoustic rating of any alternative glazing system.

Table 15: Glazing acoustic performance requirements

Floor level	Unit Type	Occupancy Type (Façade)	Minimum acoustic performance required, R_W
Ground	Type A	Bedroom – Window (N)	28
		Bedroom – Window (W)	27
		Living – Sliding Door (N)	35
		Living – Window (W)	33
	Type B	Bedroom – Sliding Door (N)	36
		Living – Window (N)	33
		Living – Sliding Door (E)	36
	Type C	Living – Sliding Door (N)	27
	Type D	Bedroom – Sliding Door (W)	29
		Living – Window (W)	30
		Living – Sliding Door (N)	35
	Type E	Living – Window (S)	16

[7] AS 3671:1989. Acoustics - Road traffic noise intrusion - Building siting and construction

Floor level	Unit Type	Occupancy Type (Façade)	Minimum acoustic performance required, R_W
		Living – Sliding Door (E)	21
		Other areas	No acoustic requirements
	Type G	Bedroom – Window (E)	20
		Living – Window (E)	23
		Living – Sliding Door (S)	23
	Type H	Bedroom – Window (W)	18
		Living – Sliding Door (S)	18
		Other areas	No acoustic requirements
	Type K	Bedroom – Window (S)	18
		Living – Sliding Door (S)	19
		Living – Window (W)	19
		Bedroom – Window (W)	26
Level 1	Type A (Northern façade)	Bedroom (N)	28
		Bedroom (W)	27
		Living – Sliding Door (N)	35
		Living – Window (W)	33
	Type A (Southern façade)	Bedroom – Sliding Door (S)	18
		Living – Sliding Door (S)	19
		Living – Window (W)	19
		Bedroom – Window (W)	26
	Type B	Bedroom – Sliding Door (N)	36
		Living – Window (N)	33
		Living – Sliding Door (E)	36
	Type C	Living – Sliding Door (N)	27
	Type D	Bedroom – Sliding Door (W)	29
		Living – Window (W)	30
		Living – Sliding Door (N)	35
	Type E	Living – Window (S)	16
		Living – Sliding Door (E)	21
		Other areas	No acoustic requirements
	Type F	Bedroom – Window (N)	20
		Living – Sliding Door (N)	39
		Living – Window (E)	35
	Type G	Bedroom – Window (E)	20
		Living – Window (E)	23
		Living – Sliding Door (S)	23
	Type H	Bedroom – Window (W)	18
		Living – Sliding Door (S)	18
		Other areas	No acoustic requirements

Floor level	Unit Type	Occupancy Type (Façade)	Minimum acoustic performance required, R_W
Level 2	Type A (Northern façade)	Bedroom (N)	28
		Bedroom (W)	27
		Living – Sliding Door (N)	35
		Living – Window (W)	33
	Type A (Southern façade)	Bedroom – Sliding Door (S)	18
		Living – Sliding Door (S)	19
		Living – Window (W)	19
		Bedroom – Window (W)	26
	Type B	Bedroom – Sliding Door (N)	36
		Living – Window (N)	33
		Living – Sliding Door (E)	36
	Type C	Living – Sliding Door (N)	27
	Type D	Bedroom – Sliding Door (W)	29
		Living – Window (W)	30
		Living – Sliding Door (N)	35
	Type E	Living – Window (S)	16
		Living – Sliding Door (E)	21
		Other areas	No acoustic requirements
	Type F	Bedroom – Window (N)	20
		Living – Sliding Door (N)	39
		Living – Window (E)	35
	Type G	Bedroom – Window (E)	20
		Living – Window (E)	23
		Living – Sliding Door (S)	23
	Type H	Bedroom – Window (W)	18
		Living – Sliding Door (S)	18
		Other areas	No acoustic requirements
Level 3	Type A (Northern façade)	Bedroom (N)	28
		Bedroom (W)	27
		Living – Sliding Door (N)	35
		Living – Window (W)	33
	Type A (Southern façade)	Bedroom – Sliding Door (S)	18
		Living – Sliding Door (S)	19
		Living – Window (W)	19
		Bedroom – Window (W)	26
	Type B	Bedroom – Sliding Door (N)	36
		Living – Window (N)	33
		Living – Sliding Door (E)	36
	Type C	Living – Sliding Door (N)	27

Floor level	Unit Type	Occupancy Type (Façade)	Minimum acoustic performance required, R_W
	Type D	Bedroom – Sliding Door (W)	29
		Living – Window (W)	30
		Living – Sliding Door (N)	35
	Type E	Living – Window (S)	16
		Living – Sliding Door (E)	21
		Other areas	No acoustic requirements
	Type F	Bedroom – Window (N)	20
		Living – Sliding Door (N)	39
		Living – Window (E)	35
	Type G	Bedroom – Window (E)	20
		Living – Window (E)	23
		Living – Sliding Door (S)	23
	Type H	Bedroom – Window (W)	18
		Living – Sliding Door (S)	18
		Other areas	No acoustic requirements
Level 4	Type I	Bedroom (N)	28
		Bedroom (W)	27
		Living – Sliding Door (N)	35
		Living – Window (W)	33
	Type J	Bedroom – Sliding Door (S)	18
		Living – Sliding Door (S)	19
		Living – Window (W)	19
		Bedroom – Window (W)	26
	Type M	Bedroom – Sliding Door (N)	36
		Living – Window (N)	33
		Living – Sliding Door (E)	36
	Type N	Living – Sliding Door (N)	27
	Type M	Bedroom – Window (N)	20
		Living – Sliding Door (N)	39
		Living – Window (E)	35

6.2 Road traffic generated by development

Due to the high traffic volume on Elizabeth Drive, traffic generated from the development is not expected to cause any significant increase in road traffic noise to other developments.

6.3 Communal Space

The ground floor communal space and the rooftop communal space are predicted to experience road traffic noise levels of 39 dB(A) $L_{eq,15\ hour}$ and 55 dB(A) $L_{eq,15\ hour}$ from Elizabeth Drive respectively.

Both communal spaces comply with the NSW Road Noise Policy criteria for open spaces of 55 dB(A) $L_{eq,15\ hour}$ (external).

6.4 Mechanical Plant Noise

Mechanical ventilation will be required for the units impacted by road traffic noise to meet the internal design sound levels. External windows and doors are to be kept closed, since if these are opened for ventilation purposes, road traffic noise reduction of the building envelope will be significantly reduced.

Future mechanical plant may have an adverse effect onto nearby noise sensitive receivers, and are required to meet the PNTL derived in this report from the NSW Noise Policy for Industry. The most stringent PNTL is during the night-time period at **40 dB(A) L_{eq}** (Refer to Table 8).

The exact locations of air conditioning plant are yet to be finalised. However, recommendations have been made to assist in choosing the appropriate plant and their location on-site.

Based on the floor plans of the development and aerial photographs, the closest off-site noise sensitive receivers (NSRs) are the residential properties to the south, east and west (NSR 1-3, Refer to Figure 2).

Considering a worst-case scenario where mechanical plant is located at the site's boundary, the cumulative noise limit of mechanical plant is **54 dB(A) L_{eq}** measured at one metre from the source to achieve compliance. However, should mechanical plant be installed on the rooftop, the cumulative noise limit of mechanical plant increases to **66 dB(A) L_{eq}** measured at one metre from the source to achieve compliance. Further noise control such as, an acoustic enclosure may be required to achieve compliance.

7 TTM recommendations

Based on the noise assessment, recommendations have been made to ensure compliance with the relevant noise criteria is achieved.

7.1 Building Acoustic Treatments

Acoustic treatments are required to be incorporated onto the external building envelope of the development to achieve the internal sound design noise levels defined in the NSW SEPP Infrastructure.

Typical construction details have been provided as a guide. Should alternative construction methods be required, the minimum acoustic rating should be met.

For the recommended glazing R_W performance specification, the following applies:

- The R_W rating relates to the full glazing system including the frame, seals and the glass. Where acoustic seals are necessary, glazing will require a Q-Lon seal or equivalent product.
- Alternative glazing may be used provided the specified R_W rating can be achieved and certified by the window manufacturer with a NATA report (on request). Generic reports should not be accepted.
- Depending on the type of window system, the framing can significantly reduce the performance. This should be investigated with the glazing supplier thoroughly (referring to NATA certified test report data) to ensure the minimum R_W is being achieved.
- It is imperative that the minimum R_W rating is achieved and that the presented glazing thickness is used as a guide only. If the glazing thickness does not comply with the R_W rating, thicker glass should be considered until the R_W rating is achieved.

It is recommended that a glazing certificate be obtained from the glazier demonstrating that the installed glazing meets the minimum weighted sound reduction index (R_W) requirements. The certificate should be retained for certification of the completed dwellings.

7.2 Mechanical Plant Noise

Plant may need to be acoustically treated to prevent noise emissions from adversely impacting NSRs. This may include selecting the quietest plant possible, or treating the plant and equipment with enclosures, acoustic louvres, barriers, duct lining and silencers, etc.

It is also recommended to install mechanical plant away from residential boundaries and bedroom windows, to minimise noise impact during the night-time period.

A detailed mechanical plant noise assessment should be conducted by a suitably qualified acoustic consultant once plant selections are made. The noise assessment should include noise source levels of plant, location, adjustments for mechanical plant noise characteristics and application of practical and effective noise control to verify compliance with the relevant noise criteria derived in this report (40 dB(A) L_{eq} at the residential noise affected boundary).

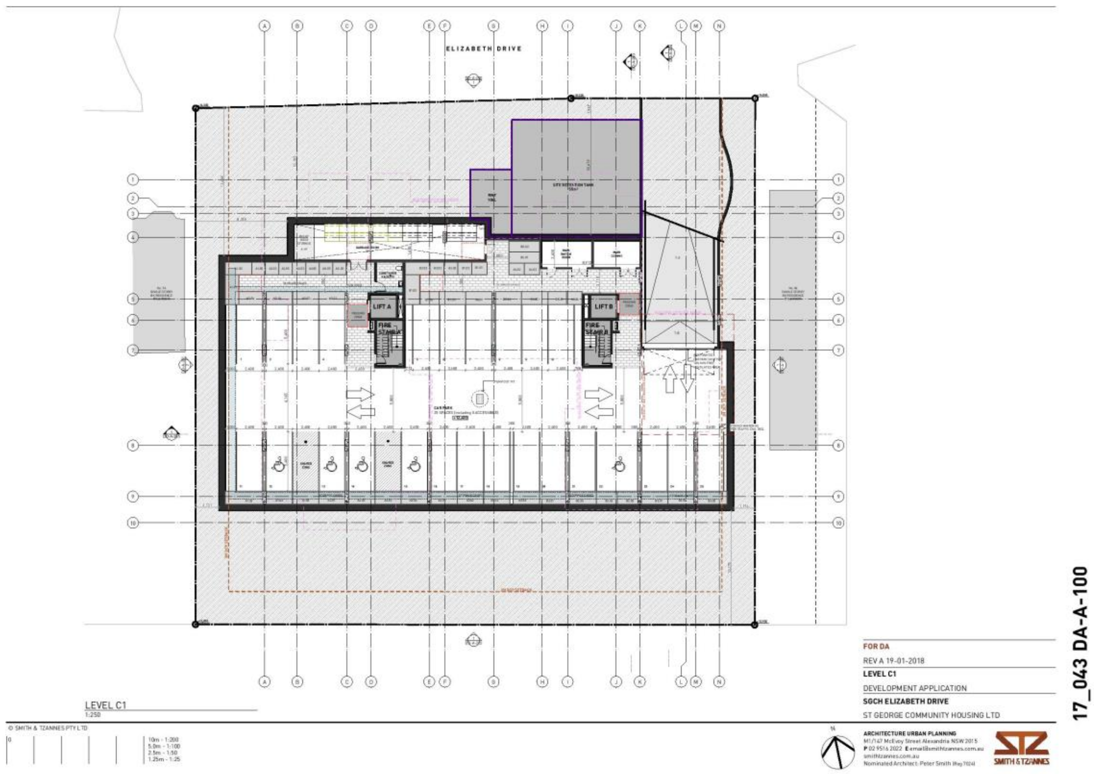
8 Conclusion

Following a noise assessment conducted by TTM for St George Community Housing Ltd (SGCH) specifically for the proposed new community housing project at 88-92 Elizabeth Drive, Liverpool, TTM concludes the following:

- Acoustic treatments to the windows, walls and roof are required to meet the internal sound design levels contained in Australian Standard AS2107.
- The cumulative noise emissions of all mechanical plant, including corrections for tonal and impulsive noise characteristics, must not exceed 54 dB(A) and 66 dB(A) measured at one metre from the source when located at the boundary and the rooftop respectively.
- A detailed noise assessment of the mechanical plant during the detailed design stage is recommended. The noise assessment should include noise source levels of plant, location, adjustments for plant noise characteristics, the cumulative noise effect of all plant noise, and practical effective noise control where required to verify compliance with the criteria.

The assessment and recommendations contained in this report demonstrate the development is feasible and reasonable, whilst keeping an appropriate acoustic amenity and controlled noise impact onto the local community.

Appendix A Relevant Development Plans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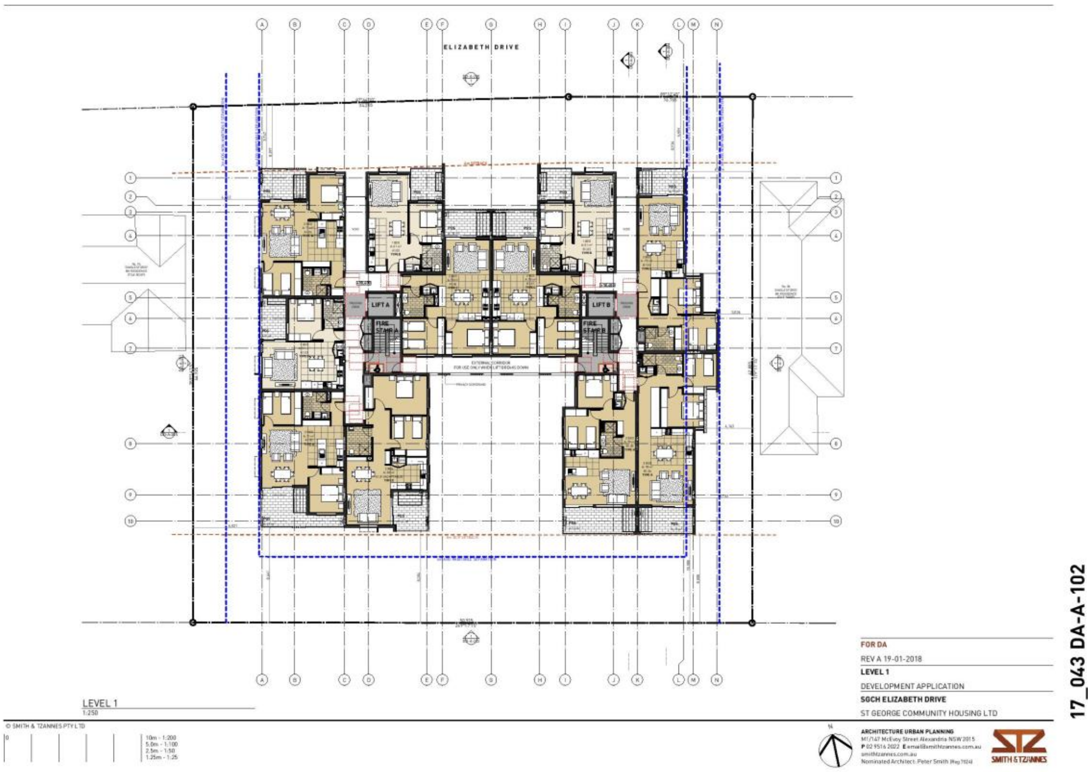
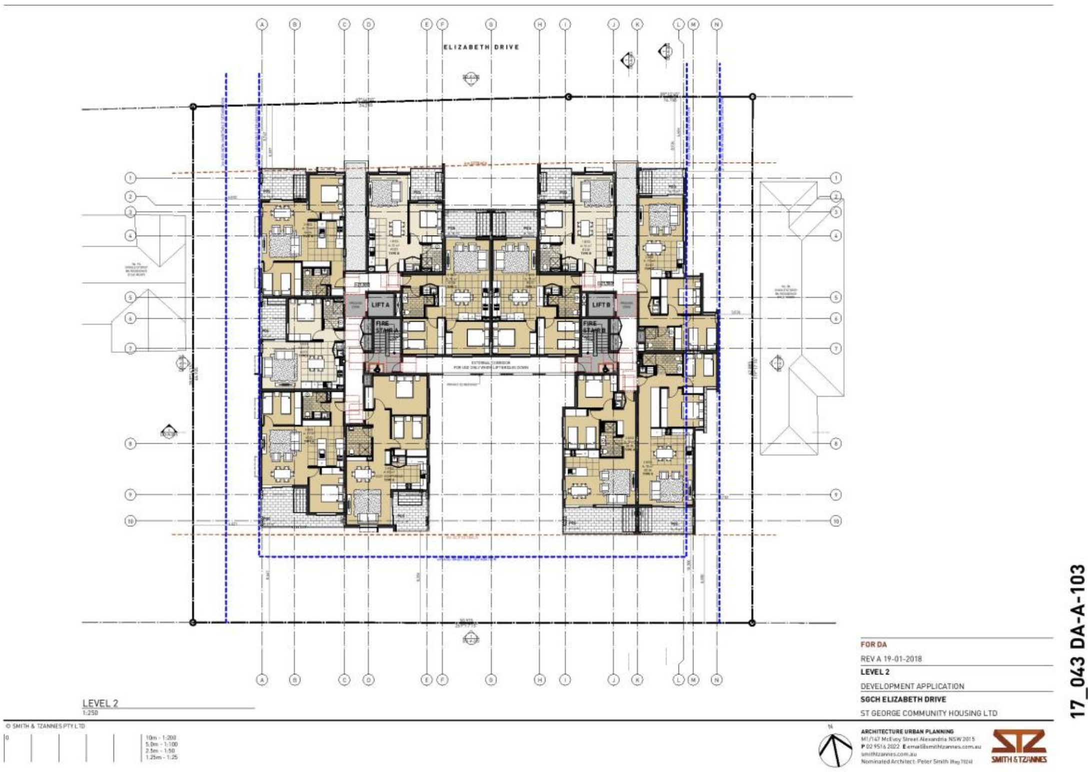
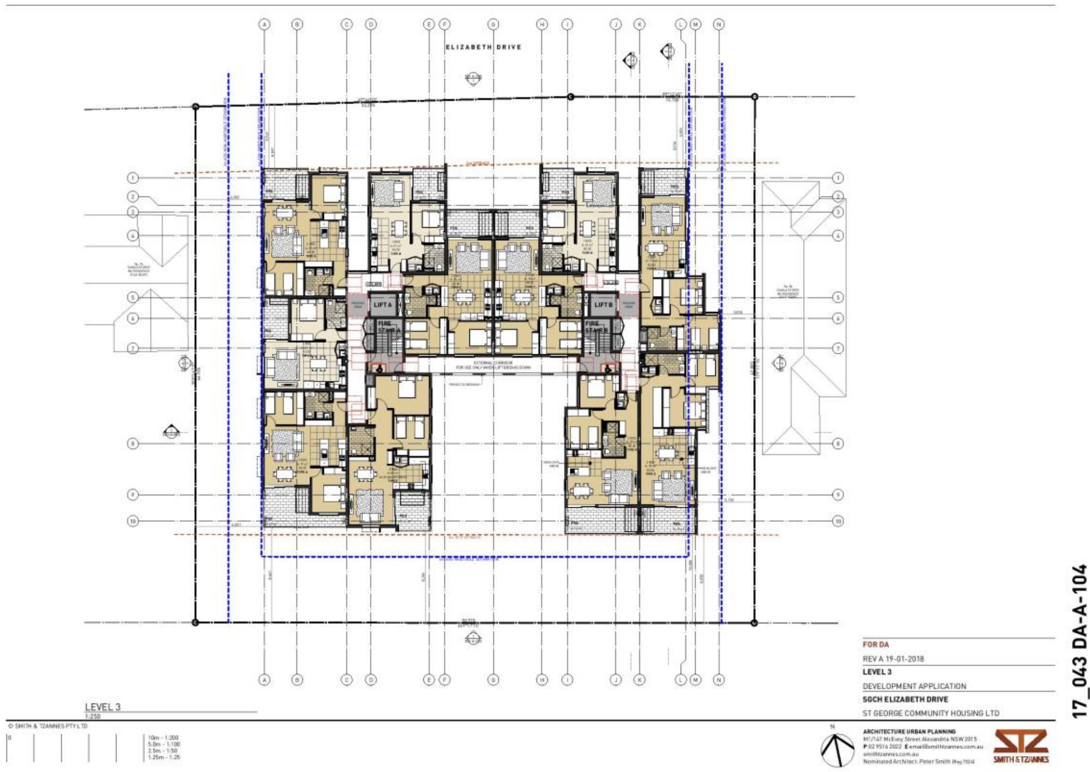
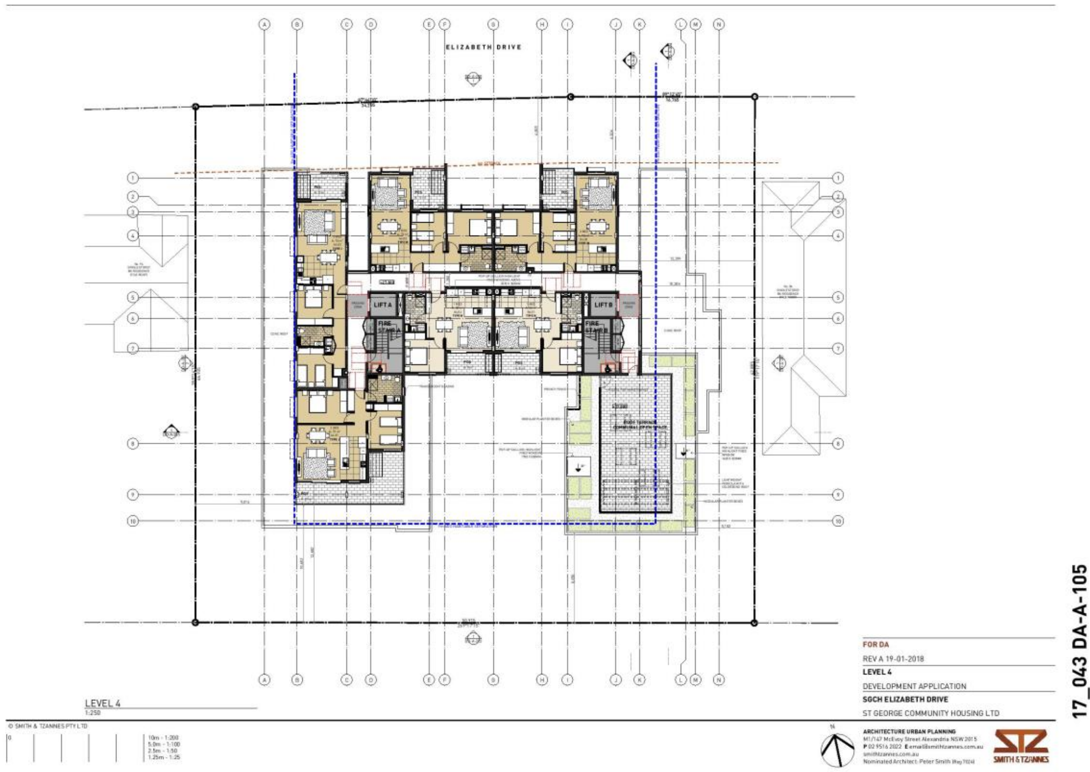
LIFT A
LIFT B
LEVEL C1
1:250
FOR DA
REV A 19-01-2018
LEVEL C1
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES
17_043 DA-A-100

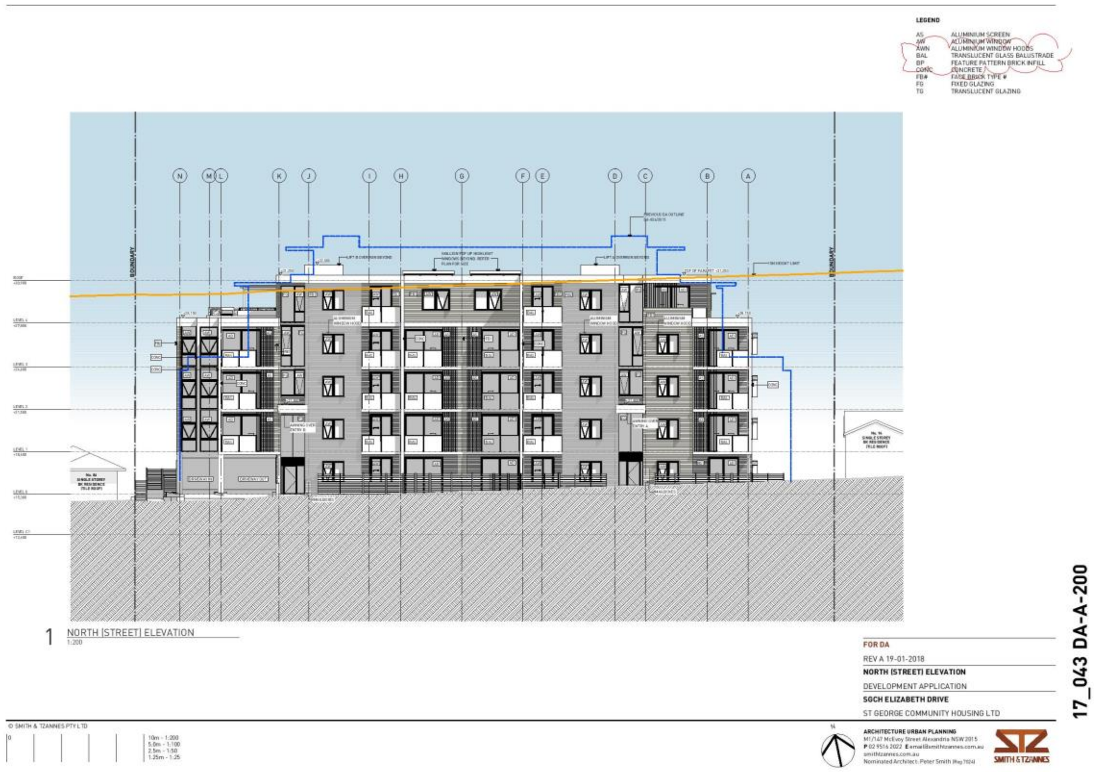

ELIZABETH DRIVE
LIFT A
LIFT B
HYD & FIRE PUMP ROOM
COMMUNAL OPEN SPACE
LEVEL 0
1:250
FOR DA
REV A 19-01-2018
LEVEL 0 (GROUND)
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES
17_043 DA-A-101


ELIZABETH DRIVE
LIFT A
LIFT B
LEVEL 1
1:250
FOR DA
REV A 19-01-2018
LEVEL 1
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES
17_043 DA-A-102


ELIZABETH DRIVE
LIFT A
LIFT B
LEVEL 2
1:250
FOR DA
REV A 19-01-2018
LEVEL 2
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES
17_043 DA-A-103


ELIZABETH DRIVE
LIFT A
LIFT B
LEVEL 3
1:250
FOR DA
REV A 19-01-2018
LEVEL 3
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES
17_043 DA-A-104


ELIZABETH DRIVE
LIFT A
LIFT B
LEVEL 4
1:250
FOR DA
REV A 19-01-2018
LEVEL 4
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES
17_043 DA-A-105


LEGEND
AS ALUMINIUM SCREEN
AW ALUMINIUM WINDOW
AWN ALUMINIUM WINDOW HOODS
BAL TRANSLUCENT GLASS BALUSTRADE
BP FEATURE PATTERN BRICK INFILL
CONC CONCRETE
FB# FACE BRICK TYPE #
FG FIXED GLAZING
TG TRANSLUCENT GLAZING
1 NORTH (STREET) ELEVATION
1:200
FOR DA
REV A 19-01-2018
NORTH (STREET) ELEVATION
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
17_043 DA-A-200
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ARCHITECTURE URBAN PLANNING
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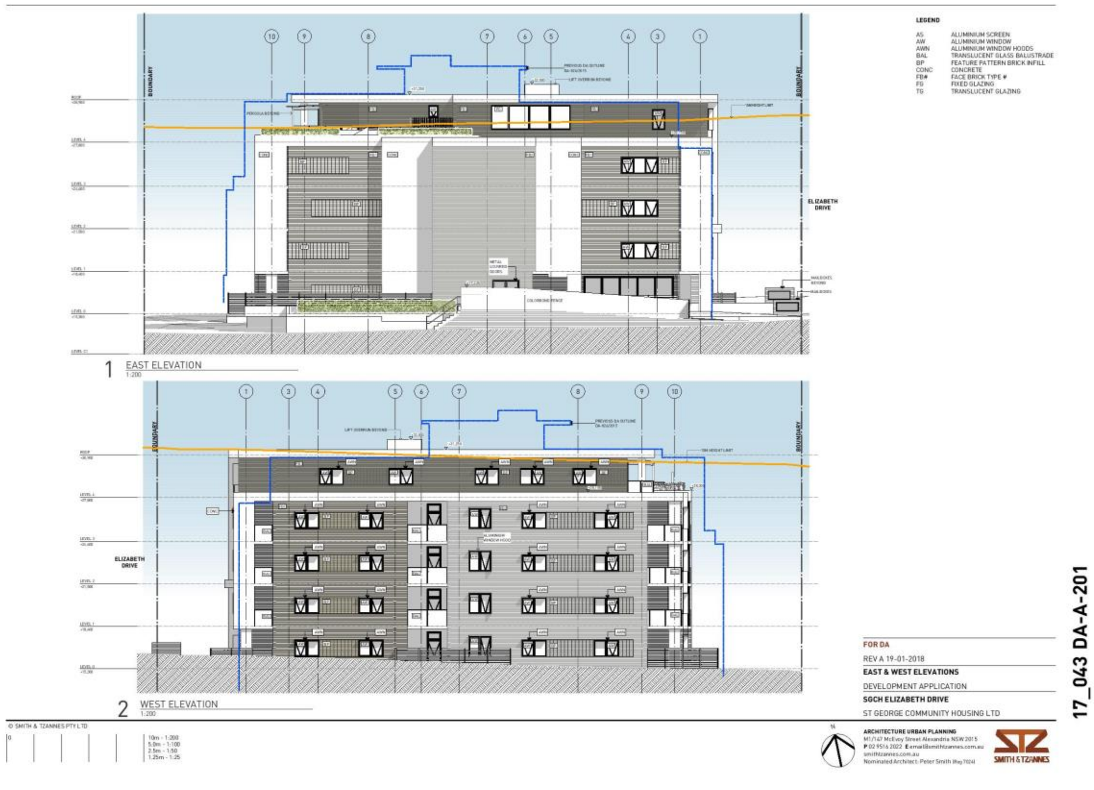
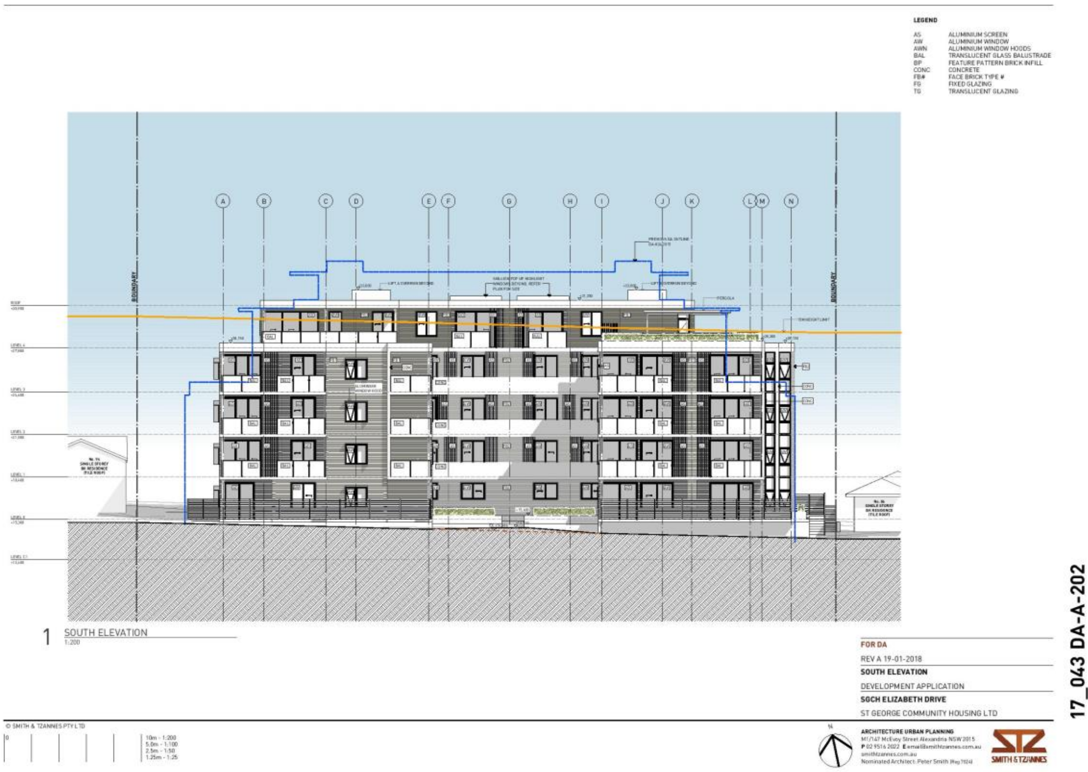

LEGEND
AS ALUMINIUM SCREEN
AW ALUMINIUM WINDOW
AWN ALUMINIUM WINDOW HOODS
BAL TRANSLUCENT GLASS BALUSTRADE
BP FEATURE PATTERN BRICK INFILL
CONC CONCRETE
FB# FACE BRICK TYPE #
FG FIXED GLAZING
TG TRANSLUCENT GLAZING
ELIZABETH DRIVE
1 EAST ELEVATION
1:200
2 WEST ELEVATION
1:200
FOR DA
REV A 19-01-2018
EAST & WEST ELEVATIONS
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
17_043 DA-A-201
© SMITH & TZANNES PTY LTD
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES



LEGEND
AS ALUMINIUM SCREEN
AW ALUMINIUM WINDOW
AWN ALUMINIUM WINDOW HOODS
BAL TRANSLUCENT GLASS BALUSTRADE
BP FEATURE PATTERN BRICK INFILL
CONC CONCRETE
FB# FACE BRICK TYPE #
FG FIXED GLAZING
TG TRANSLUCENT GLAZING
1 SOUTH ELEVATION 1:200
FOR DA
REV A 19-01-2018
SOUTH ELEVATION
DEVELOPMENT APPLICATION
SGCH ELIZABETH DRIVE
ST GEORGE COMMUNITY HOUSING LTD
17_043 DA-A-202
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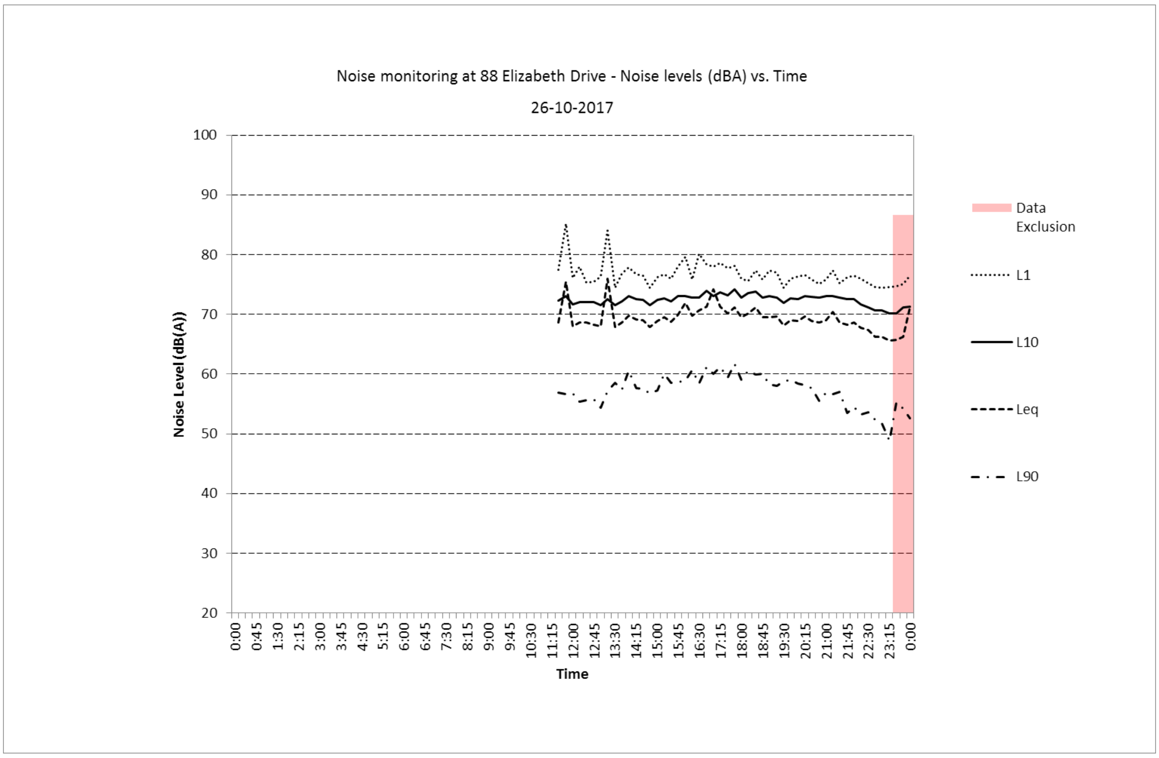
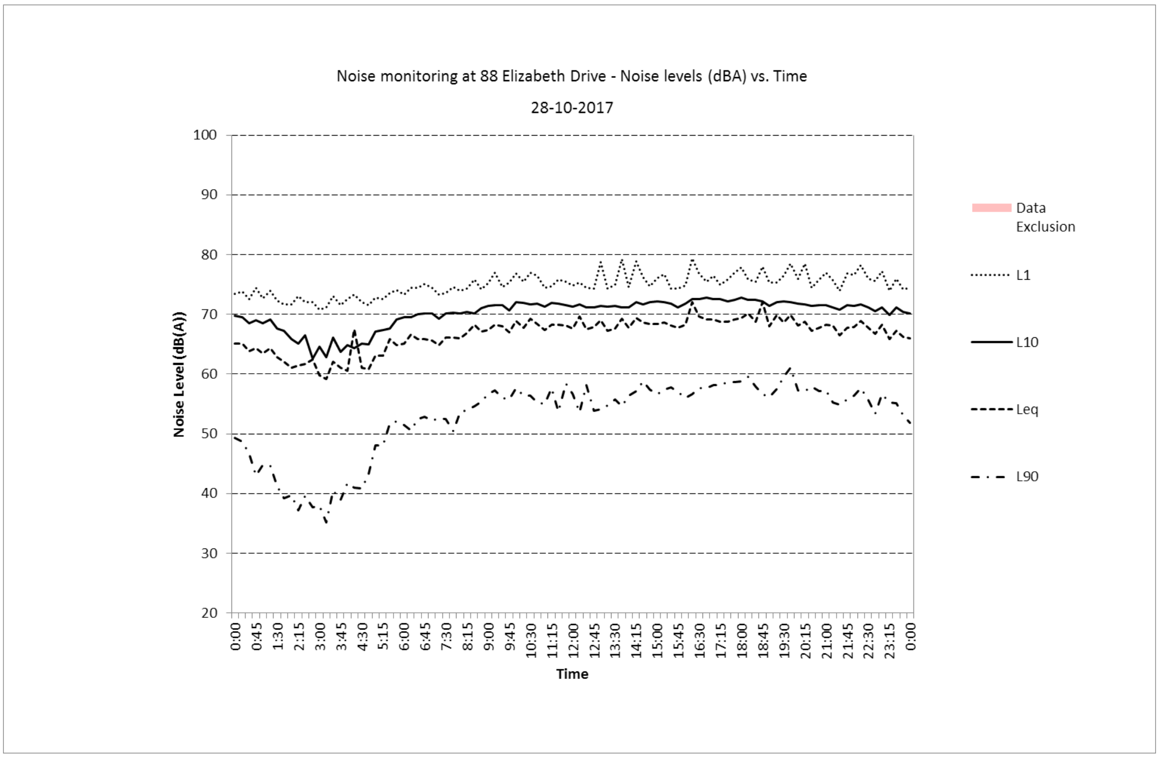
ARCHITECTURE URBAN PLANNING
SMITH & TZANNES

Appendix B Unattended Noise Monitoring Graphs

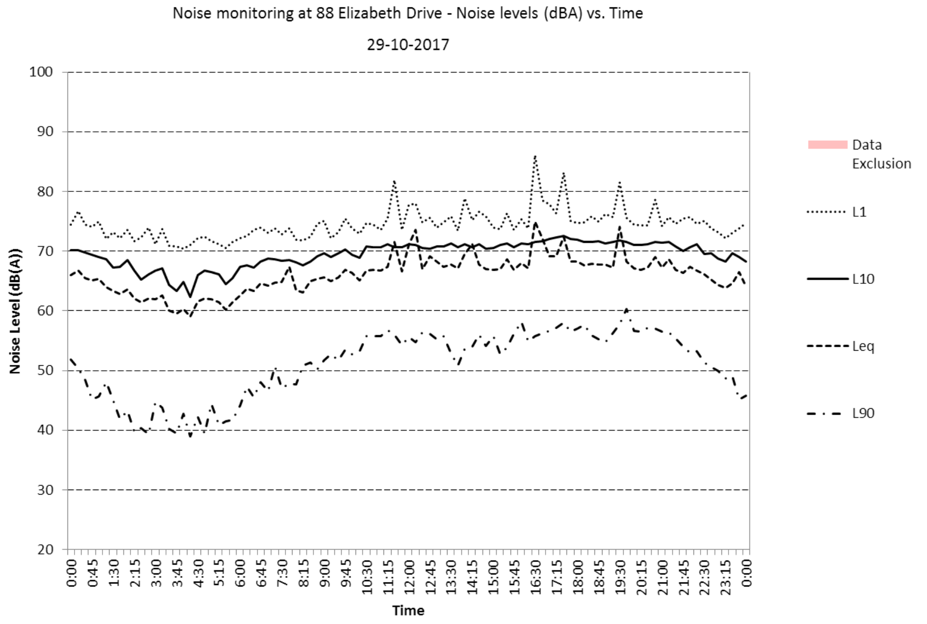
Location 1 – 88 Elizabeth Drive – Road Traffic Noise



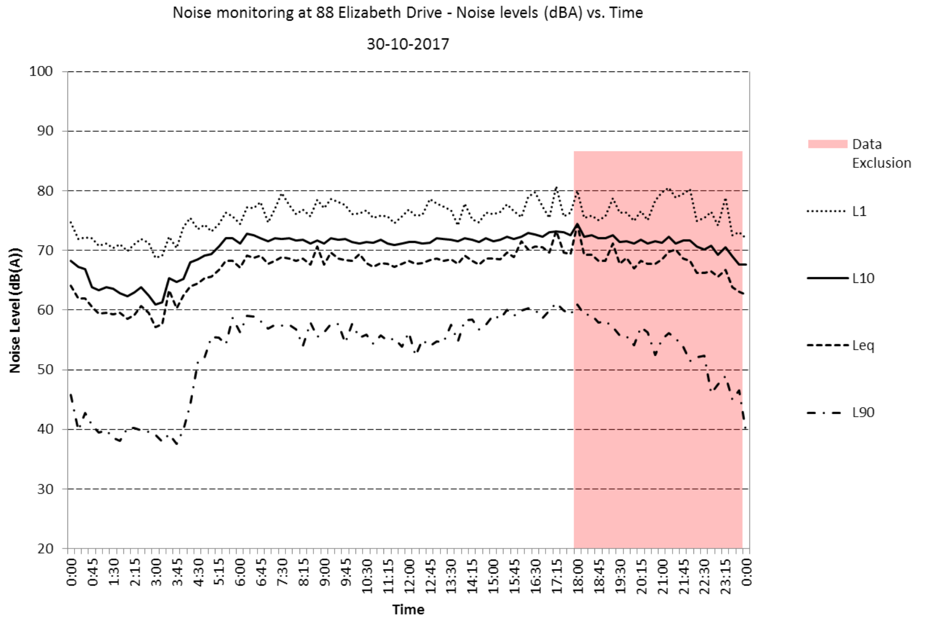
Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
27-10-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90



Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
28-10-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90



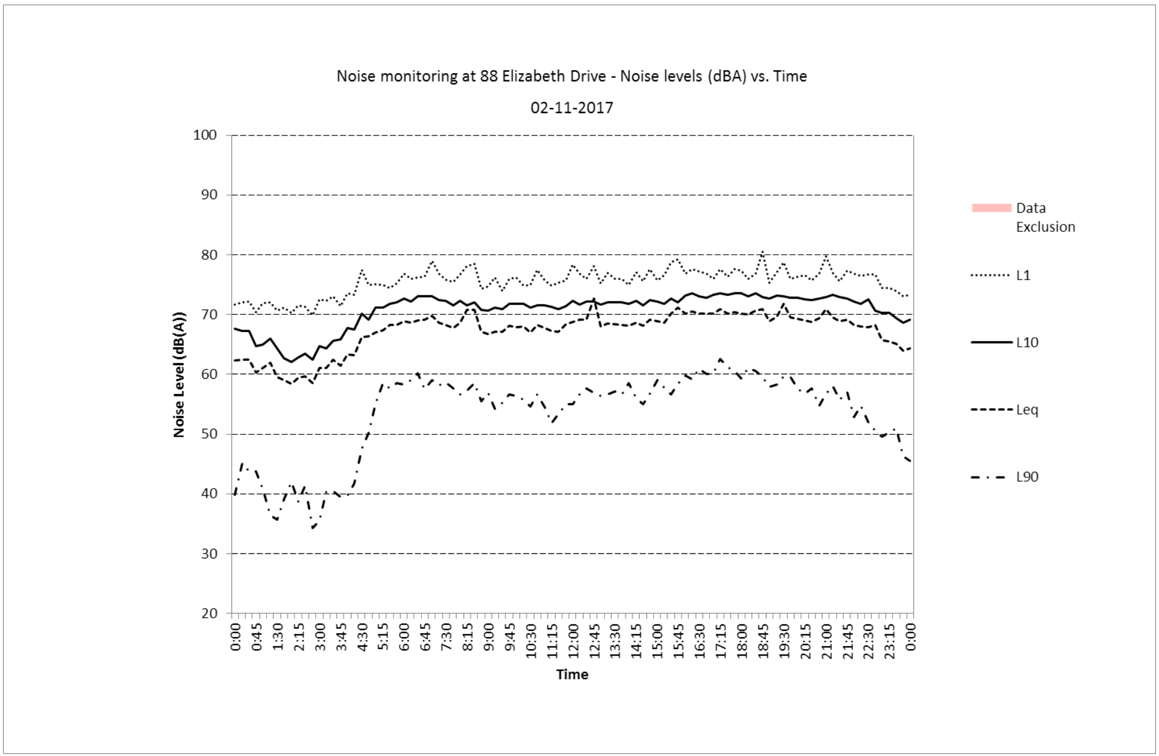
Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
29-10-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90



Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
30-10-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90


Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
31-10-2017
Noise Level (dB(A))
100
90
80
70
60
50
40
30
20
0:00
0:45
1:30
2:15
3:00
3:45
4:30
5:15
6:00
6:45
7:30
8:15
9:00
9:45
10:30
11:15
12:00
12:45
13:30
14:15
15:00
15:45
16:30
17:15
18:00
18:45
19:30
20:15
21:00
21:45
22:30
23:15
0:00
Time
Data Exclusion
L1
L10
Leq
L90

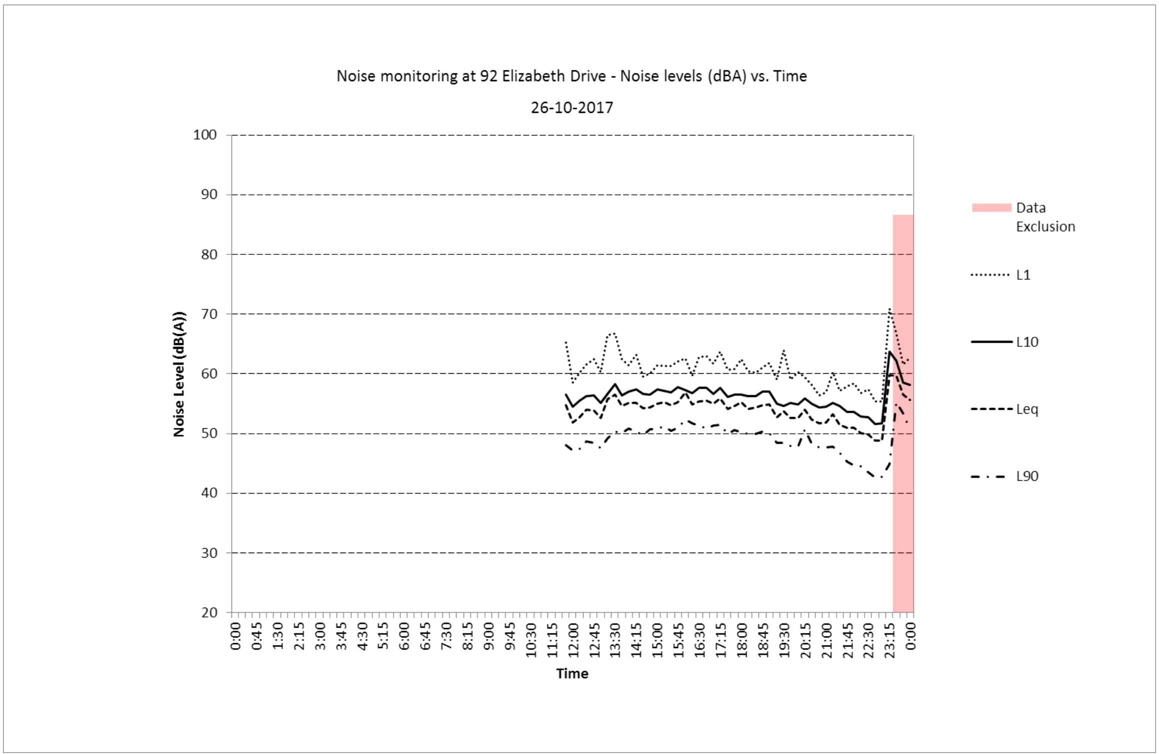

Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
01-11-2017
Noise Level (dB(A))
100
90
80
70
60
50
40
30
20
0:00
0:45
1:30
2:15
3:00
3:45
4:30
5:15
6:00
6:45
7:30
8:15
9:00
9:45
10:30
11:15
12:00
12:45
13:30
14:15
15:00
15:45
16:30
17:15
18:00
18:45
19:30
20:15
21:00
21:45
22:30
23:15
0:00
Time
Data Exclusion
L1
L10
Leq
L90

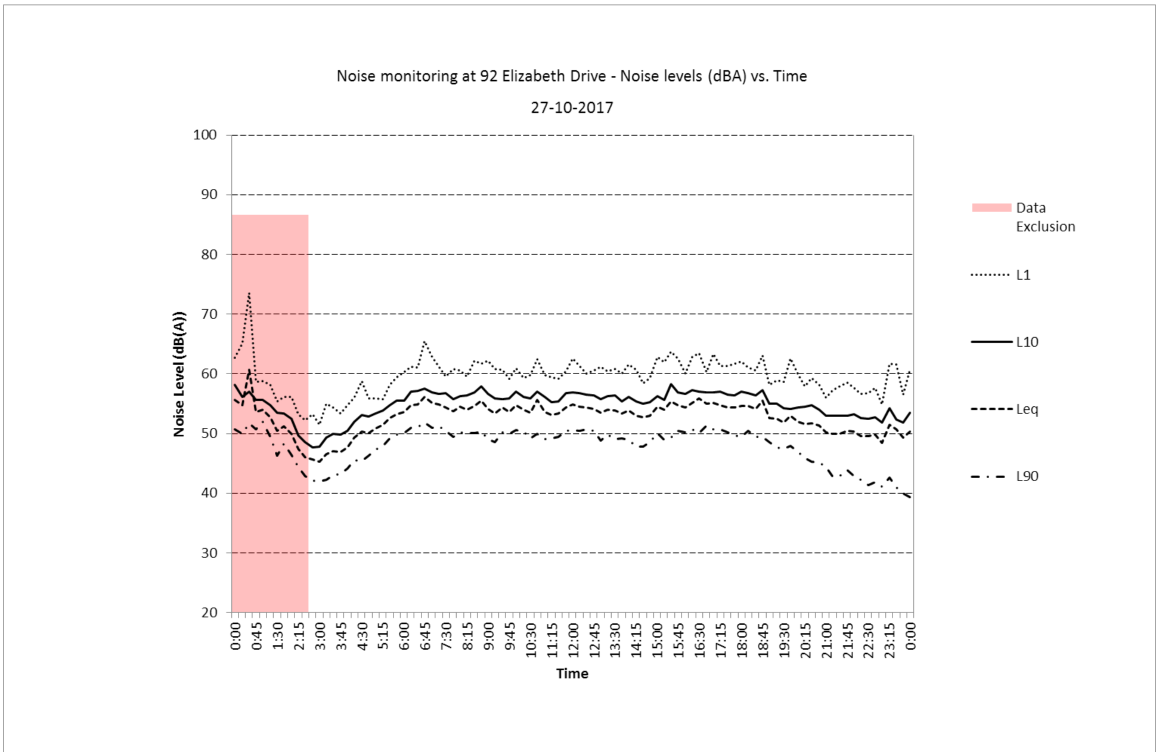


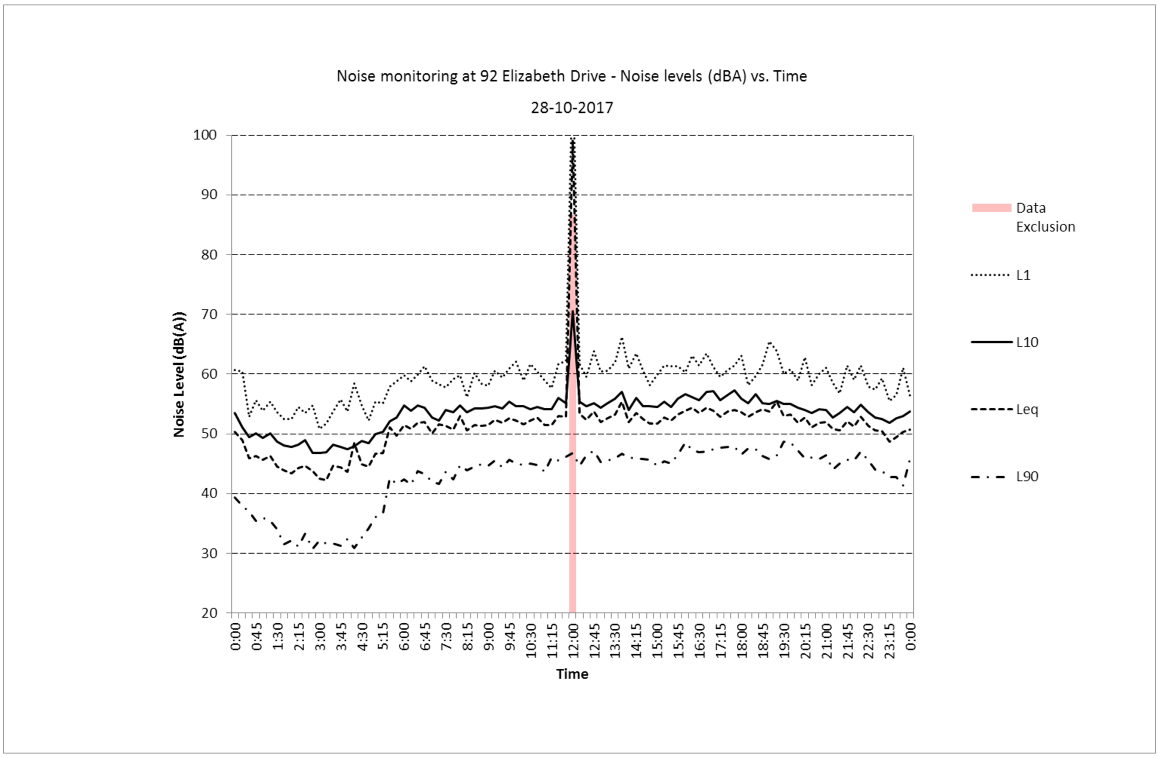
Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
02-11-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90

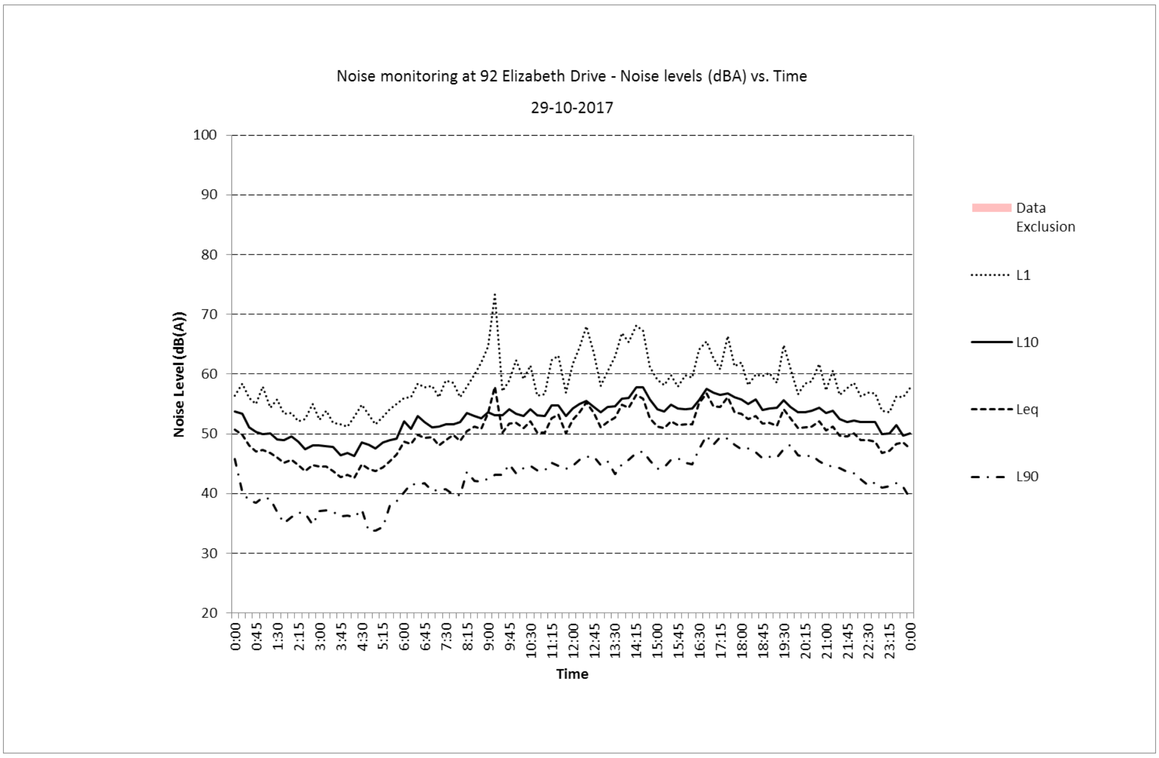
Noise monitoring at 88 Elizabeth Drive - Noise levels (dBA) vs. Time
03-11-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90

Location 2 – 92 Elizabeth Drive – Ambient Noise






Noise monitoring at 92 Elizabeth Drive - Noise levels (dBA) vs. Time
28-10-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90


Noise monitoring at 92 Elizabeth Drive - Noise levels (dBA) vs. Time
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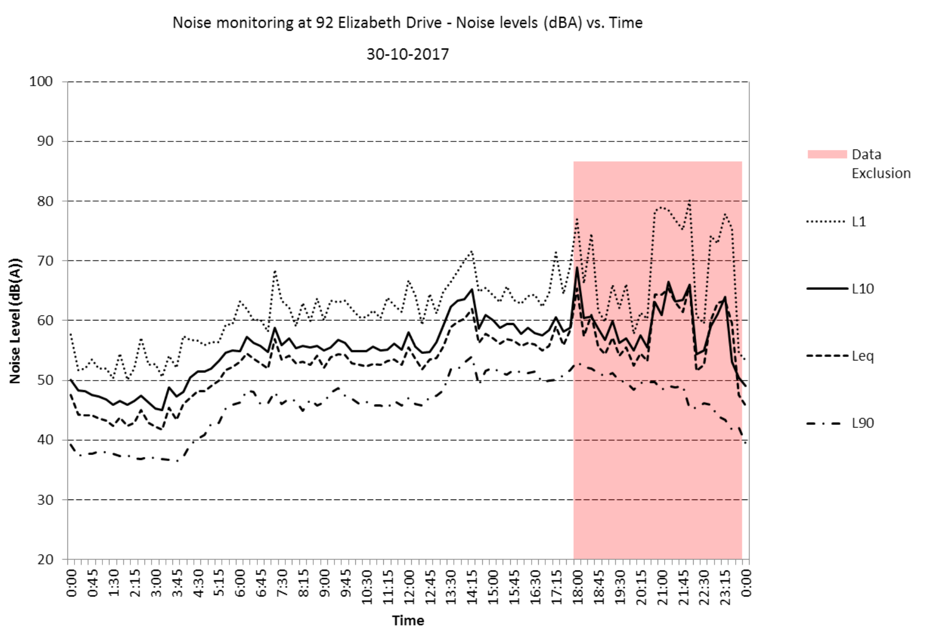
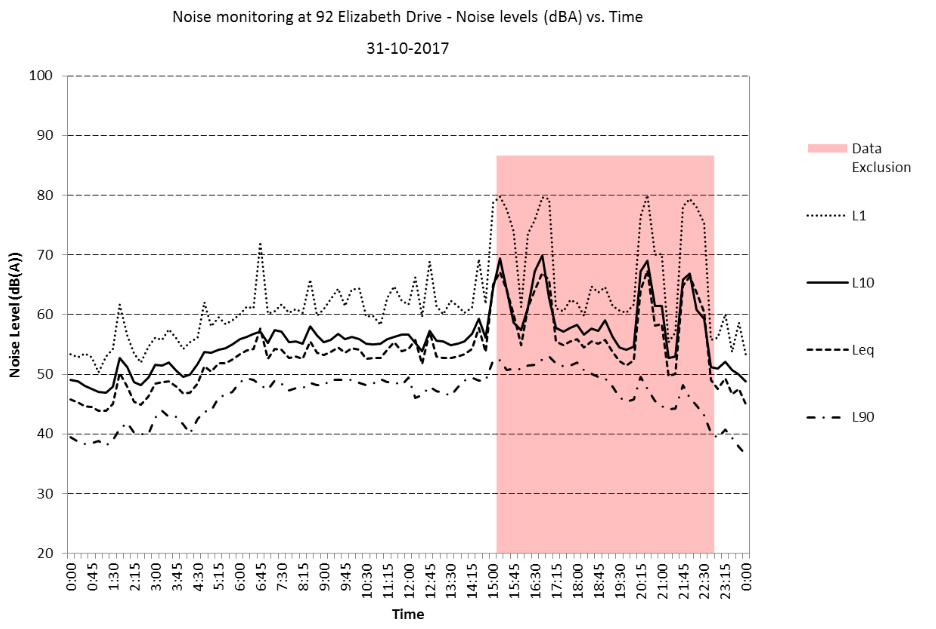
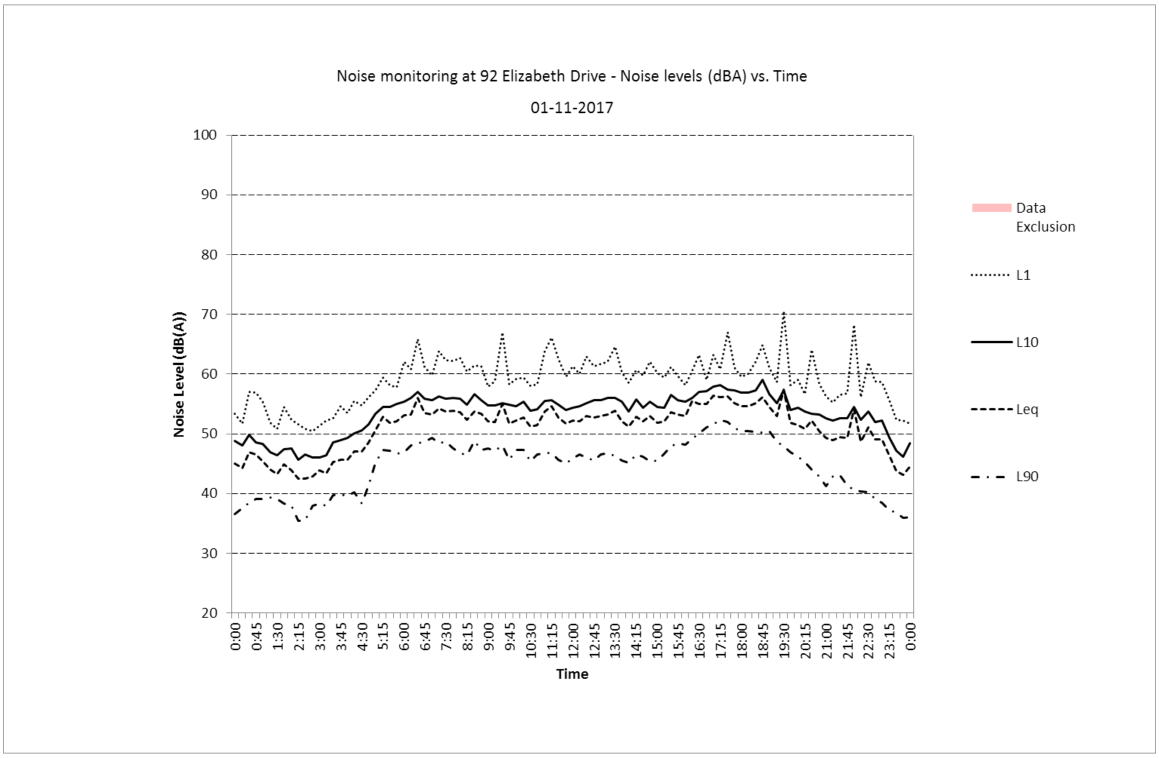
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90



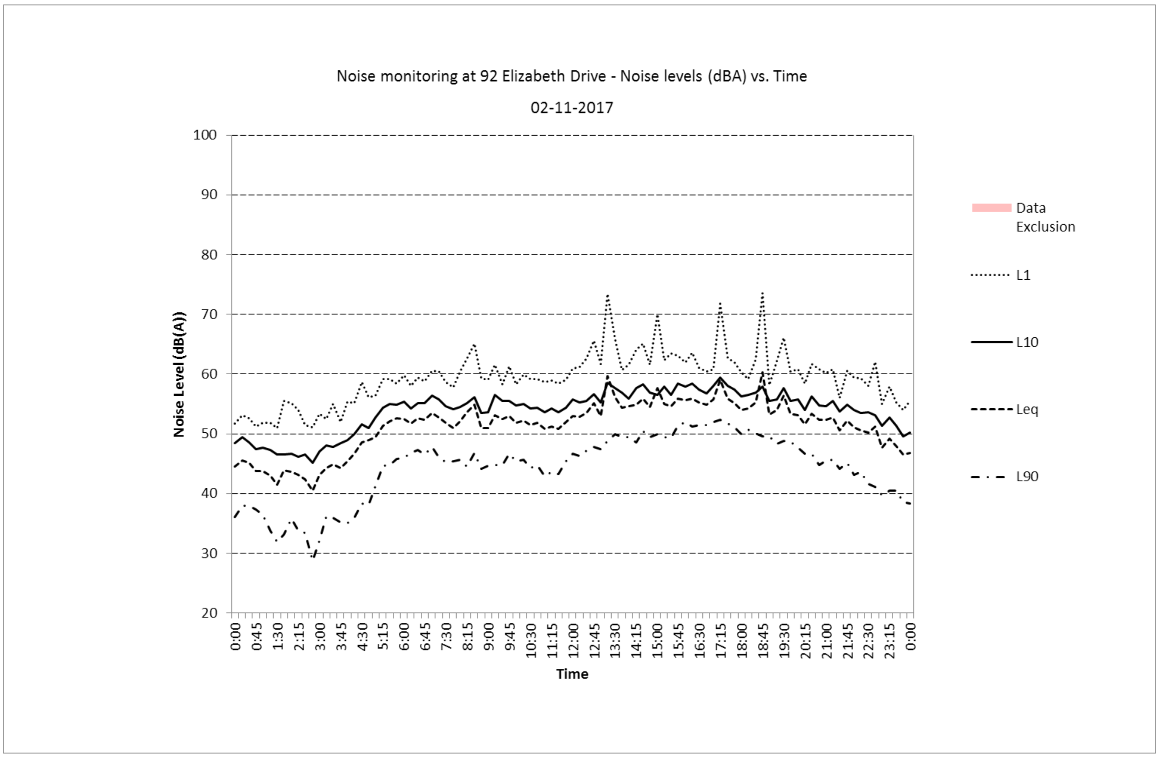
Noise monitoring at 92 Elizabeth Drive - Noise levels (dBA) vs. Time
30-10-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90



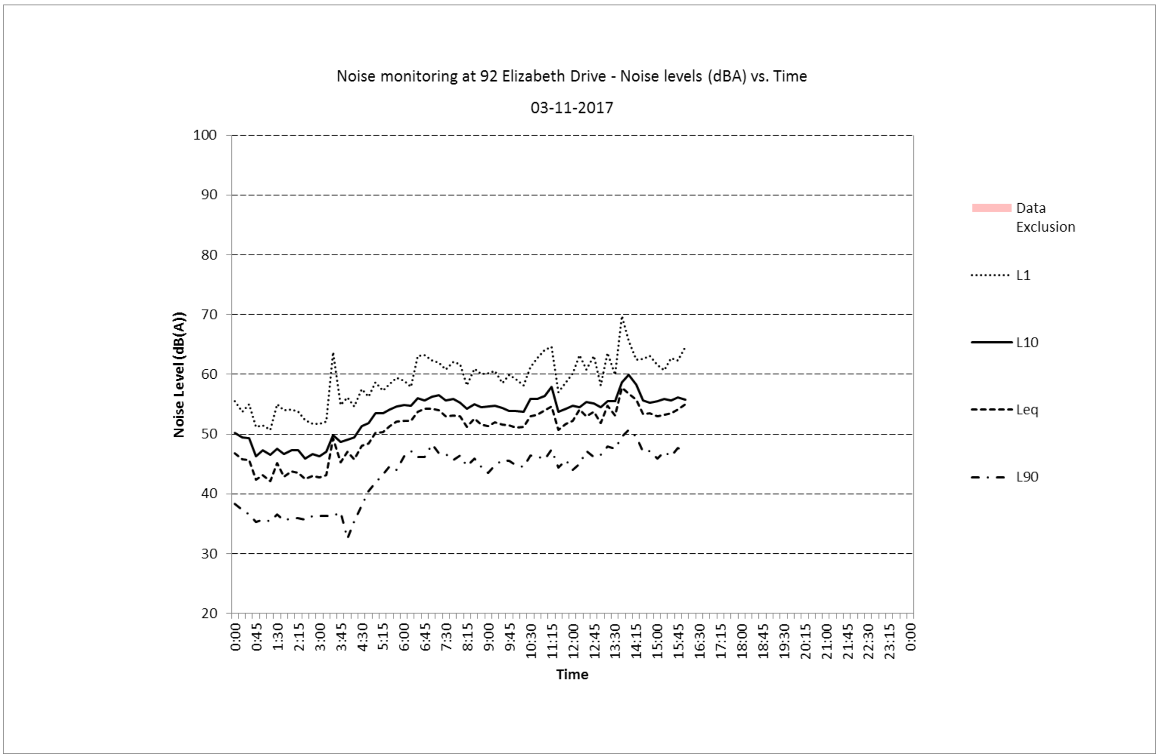
Noise monitoring at 92 Elizabeth Drive - Noise levels (dBA) vs. Time
31-10-2017
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90



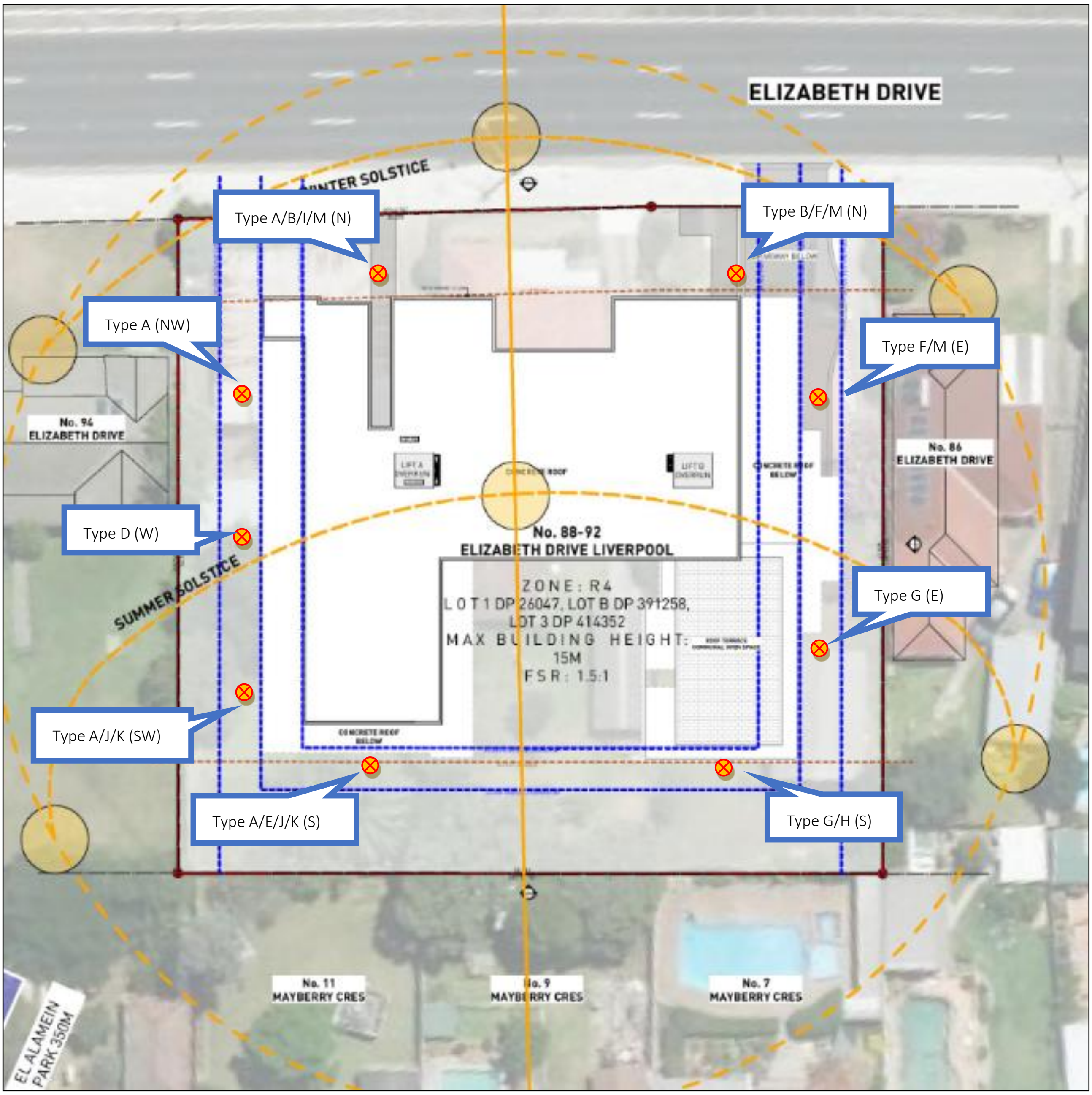
Noise monitoring at 92 Elizabeth Drive - Noise levels (dBA) vs. Time
01-11-2017
Noise Level (dB(A))
100
90
80
70
60
50
40
30
20
0:00
0:45
1:30
2:15
3:00
3:45
4:30
5:15
6:00
6:45
7:30
8:15
9:00
9:45
10:30
11:15
12:00
12:45
13:30
14:15
15:00
15:45
16:30
17:15
18:00
18:45
19:30
20:15
21:00
21:45
22:30
23:15
0:00
Time
Data Exclusion
L1
L10
Leq
L90



Noise monitoring at 92 Elizabeth Drive - Noise levels (dBA) vs. Time
02-11-2017
Noise Level (dB(A))
100
90
80
70
60
50
40
30
20
0:00
0:45
1:30
2:15
3:00
3:45
4:30
5:15
6:00
6:45
7:30
8:15
9:00
9:45
10:30
11:15
12:00
12:45
13:30
14:15
15:00
15:45
16:30
17:15
18:00
18:45
19:30
20:15
21:00
21:45
22:30
23:15
0:00
Time
Data Exclusion
L1
L10
Leq
L90


Noise monitoring at 92 Elizabeth Drive - Noise levels (dBA) vs. Time
03-11-2017
Noise Level (dB(A))
100
90
80
70
60
50
40
30
20
0:00
0:45
1:30
2:15
3:00
3:45
4:30
5:15
6:00
6:45
7:30
8:15
9:00
9:45
10:30
11:15
12:00
12:45
13:30
14:15
15:00
15:45
16:30
17:15
18:00
18:45
19:30
20:15
21:00
21:45
22:30
23:15
0:00
Time
Data Exclusion
L1
L10
Leq
L90

Appendix C SoundPLAN – Location of Receivers


ELIZABETH DRIVE
WINTER SOLSTICE
SUMMER SOLSTICE
Type A/B/I/M (N)
Type B/F/M (N)
Type A (NW)
Type F/M (E)
Type D (W)
Type G (E)
Type A/J/K (SW)
Type A/E/J/K (S)
Type G/H (S)
No. 94
ELIZABETH DRIVE
No. 86
ELIZABETH DRIVE
No. 88-92
ELIZABETH DRIVE LIVERPOOL
ZONE: R4
LOT 1 DP 26047, LOT B DP 391258,
LOT 3 DP 414352
MAX BUILDING HEIGHT:
15M
FSR: 1.5:1
No. 11
MAYBERRY CRES
No. 9
MAYBERRY CRES
No. 7
MAYBERRY CRES
EL ALAMEIN
PARK 350M

Appendix D Glossary

GLOSSARY

In this acoustic report unless the context of the subject matter otherwise indicates or requires, a term has the following meaning:

TERM	DEFINITION
ABL	The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night-time (for each day). It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.
Adverse Weather	Weather effects that increases noise (i.e. wind and temperature inversion) that occurs at a site for a significant period of time (i.e. wind occurring more than 30% of the time in any assessment period in any season and / or temperature inversion occurring more than 30% of the nights in winter).
Ambient Noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources both near and far.
Assessment Period	The period in a day over which assessments are made: day (0700 to 1800h), evening (1800 to 2200h) or night (2200 to 0700h) or actual operating period if only a part of a period(s).
A – Weighting Filter	A-weighting is the most commonly used of a family of curves defined in the International standard IEC 61672:2003 and various national standards relating to the measurement of sound

	pressure level. A-weighting is applied to instrument-measured sound levels in effort to account for the relative loudness perceived by the human ear, as the ear is less sensitive to low audio frequencies.
Background Noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is excluded. Usually described using the L90 measurement parameter.
C – Weighting Filter	The C-weighting approximates the sensitivity of human hearing at industrial noise levels (above about 85 dB(A)). The C-weighted sound level (i.e., measured with the C-weighting) is more sensitive to sounds at low frequencies than the A-weighted sound level and is sometimes used to assess the low-frequency content of complex sound environments and entertainment noise.
Decibel	The ratio of sound pressures which we can hear is a ratio of 106 (one million:one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (Lp) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.
dB(A)	The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a sound level meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.
Equivalent Continuous Sound Level (L_{eq})	Another index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period, similar to the average. Hence fluctuating levels can be described in terms of a single figure level.
Extraneous Noise	Noise resulting from activities that are not typical of the area. Atypical activities may include construction, and traffic generated during holiday periods and during special events such as concert or sporting events.
Fast Time Weighting	125 ms integration time while the signal level is increasing and decreasing.
Frequency	The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kHz, e.g. 2 kHz = 2000 Hz. Human hearing ranges approximately from 20 Hz to 20 kHz. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.
Impulse Time Weighting	35 ms integration time while the signal level is increasing and 1.5s integration time while the signal level is decreasing.
L_{Aeq}	See equivalent continuous sound level definition above. This is the A-weighted energy average of the varying noise over the sample period and is equivalent to the level of a constant noise

	which contains the same energy as the varying noise environmental. This measure is also a common measure of environmental noise and road traffic noise.
$L_{Aieq,T}$	Equivalent continuous A-weighted sound pressure level over the measurement period T with impulse time weighting.
$L_{Ceq,T}$	The equivalent continuous C-weighted sound pressure level (integrated level) that, over the measurement period T, has the same mean square sound pressure (referenced to 20 µPa) as the fluctuating sound(s) under consideration.
$L_{C, Peak}$	The C-weighted Peak sound pressure level during a designated time interval or a noise event.
Low Frequency	Noise containing major components in the low-frequency range (20Hz to 250Hz) of the frequency spectrum.
Maximum Noise Levels L_{max}	The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.
Minimum Noise Levels L_{min}	The minimum noise level over a sample period is the minimum level, measured on fast response, during the sample period.
Noise Sensitive Receiver (NSR)	A noise sensitive receiver is any person or building or outside space in which they reside or occupy that has the potential to be adversely impacted by noise from an outside source, or noise not generated by the noise sensitive receiver.
Octave Bands	Octave bands are frequency ranges in which the upper limit of each band is twice the lower limit. Octave bands are identified by their geometric mean frequency, or centre frequency.
Project Noise Trigger Levels	They are target noise levels for a particular noise generating facility. They are based on the most stringent of the intrusive or amenity criteria derived from the NSW Noise for Industry Policy.
RBL	The Rating Background Level for each period is the median value of the ABL values for the period over all the days measured. There is a therefore an RBL value for each period – daytime, evening and night-time.
Shoulder Periods	Where early morning (5 am to 7 am) operations are proposed, it may be unduly stringent to expect such operations to be assessed against the night-time criteria (especially if existing background noise levels are steadily rising in these early morning hours). In these situations, appropriate noise level targets may be negotiated with the regulatory/consent authority on a case-by-case basis.
Slow Time Weighting	1 second integration time while the signal level is increasing and decreasing.
Sound Level Difference (D)	The sound insulation required between two spaces may be determined by the sound level difference needed between them. A single figure descriptor, the weighted sound level difference, D_w, is sometimes used (see BS EN ISO 717-1).
Sound Power	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level varies as a function of distance from a source. However, the

	sound power level is an intrinsic characteristic of a source (analogous to its volume or mass), which is not affected by the environment within which the source is located.
Sound Reduction Index (R)	The sound reduction index (or transmission loss) of a building element is a measure of the loss of sound through the material, i.e. its attenuation properties. It is a property of the component, unlike the sound level difference which is affected by the common area between the rooms and the acoustic of the receiving room. The weighted sound reduction index, R_w, is a single figure description of sound reduction index which is defined in BS EN ISO 717-1: 1997. The R_w is calculated from measurements in an acoustic laboratory. Sound insulation ratings derived from site (which are invariably lower than the laboratory figures) are referred to as the R'_w ratings.
Statistical Noise Levels	For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for ten per cent of the time period under consideration, has been adopted in this country for the assessment of road traffic noise. The L_{90}, the level exceeded for ninety per cent of the time, has been adopted to represent the background noise level. The L_1, the level exceeded for one per cent of the time, is representative of the maximum levels recorded during the sample period. A-weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, e.g. $dBL_{A10,\ 5min}$ or $dBL_{A90,\ 8hr}$.
L_{A1}	The L_{A1} level is the A-weighted noise level which is exceeded for 15 of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.
L_{A10}	The L_{A10} level is the A-weighted noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.
L_{A50}	The L_{A50} level is the A-weighted noise level which is exceeded for 50% of the sample period.
L_{A90}	The LA90 level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the LA90 level for 10% of the time. This measure is a commonly referred to as the background noise level.
Structureborne Noise	The L_{A90} level is the A-weighted noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is a commonly referred to as the background noise level.
Temperature Inversion	An atmospheric condition in which temperature increases with height above the ground.
Tonality	Noise containing a prominent frequency and characterised by a definite pitch.