Acoustic Assessment

SGCH Flowerdale Road

127-129 Flowerdale Road, Liverpool

Prepared for SGCH
Report Reference: 18SYA0061 R01_2

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.

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Revision Record

No.	Author	Reviewed/Approved	Description	Date
A	K Dhayam	-	DRAFT A – Issued to client	18/10/2018
B	K Dhayam	-	DRAFT B – Issued to client	12/11/2018
0	K Dhayam	J Fox	Final Issue	1/02/2019
1	K Dhayam	J Fox	Revision 1	11/02/2019
2	K Dhayam	J Fox	Revision 2 – Minor Changes	7/03/2019

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Executive Summary

TTM Consulting conducted an acoustic assessment for the proposed residential development at 127-129 Flowerdale Road, Liverpool for SGCH.

Noise monitoring of existing ambient and road traffic noise levels was conducted in the area. Noise impact levels of the proposed development were assessed. Road traffic noise impact onto the development from Hoxton Park Road and Flowerdale Road was also assessed.

The development is predicted to comply with Liverpool Development Control Plan (DCP) 2008 and relevant standards and guidelines, with the inclusion of acoustic treatments to the windows, walls and roof, and upgrade to the balustrade around the rooftop communal space.

The northern area of the ground floor has also been recommended as the preferred communal outdoor open space area.

Additional road traffic generated by the development will not cause a significant noise impact on the local community.

Overall, the assessment shows that the development is feasible while keeping an appropriate acoustic amenity and controlled noise impact onto the local community.

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1 Introduction

TTM was engaged by SGCH to undertake an acoustic assessment of the proposed residential development at 127-129 Flowerdale Road, Liverpool. The assessment addresses the impact of the development on the local community, and the impact of the local environment onto the development. 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 (DCP) 2008
- NSW Road Noise Policy[1]
- NSW SEPP Infrastructure[2]
- Architectural plans by DKO Architecture, dated 6/03/2019, Revision A, as presented in Appendix A.

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

[2] NSW Department of Planning, State Environmental Planning Policy (SEPP) (Infrastructure) 2007

2 Site Description

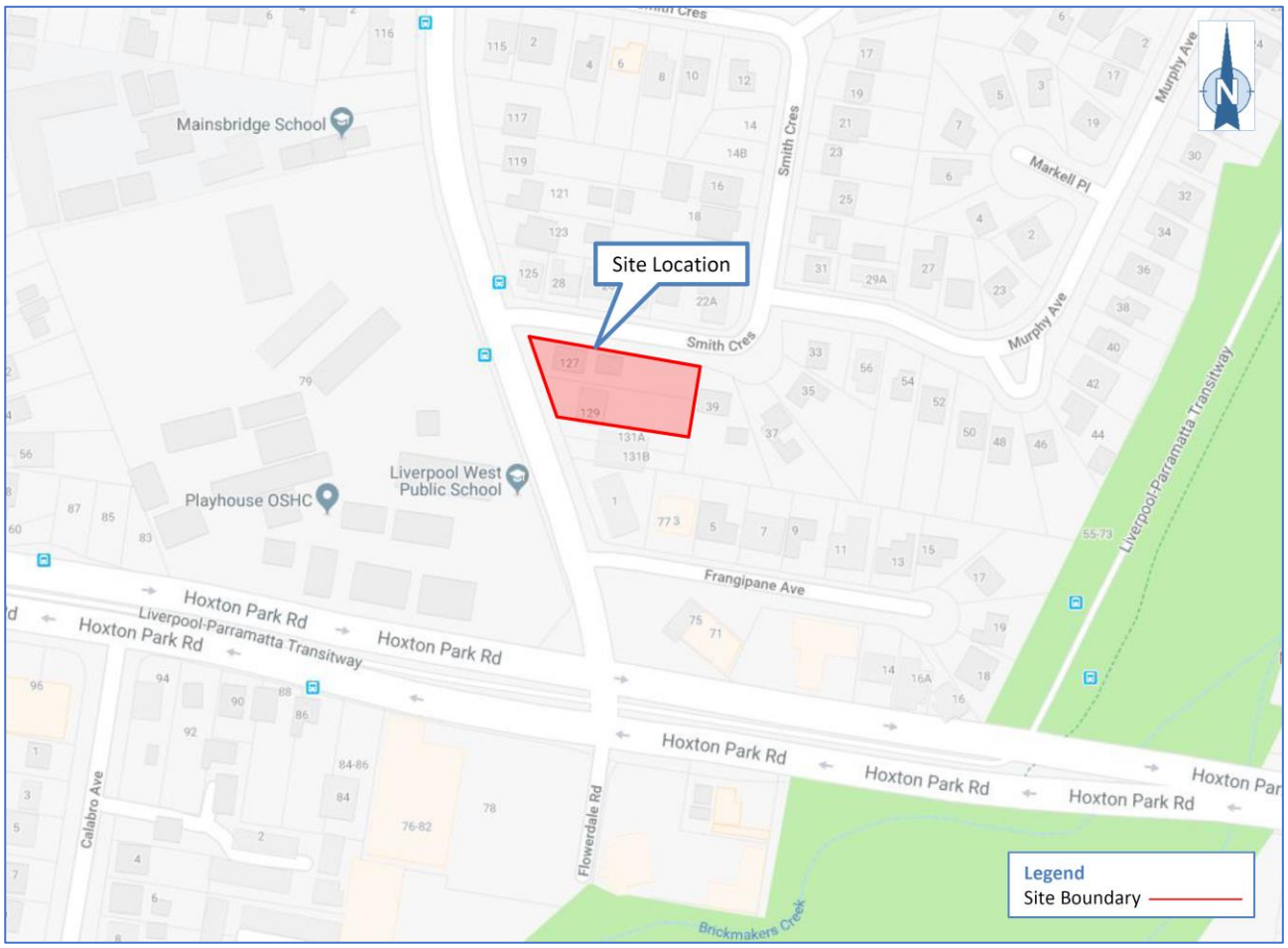
The subject site is located at 127-129 Flowerdale Road, Liverpool in a typical suburban residential area, at the corner of Flowerdale Road and Smith Crescent. There are currently residential dwellings on the site.

To the west of the site, across Flowerdale Road is Liverpool West Public School. To the north, across Smith Crescent are existing residential properties. Further northwest of the site is Mainsbridge School. There are also existing residential properties sharing the southern and eastern boundaries of the site.

Flowerdale Road leads to Hoxton Park Road to the south, which is an arterial road.

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

Figure 1: Site Locality



2.1 Noise Sensitive Receivers (NSRs)

The closest residential properties which may be adversely impacted by the proposed development have been identified, as shown in Figure 2 and are as follows:

- R1 – East of site: Residential property at 39 Smith Crescent
- R2 – South of site: Residential property at 131A Flowerdale Road
- R3 – North of site: Residential properties at 125 Flowerdale Road & at 22, 24, 26 Smith Crescent

Should the derived noise limits in this report be predicted to 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.

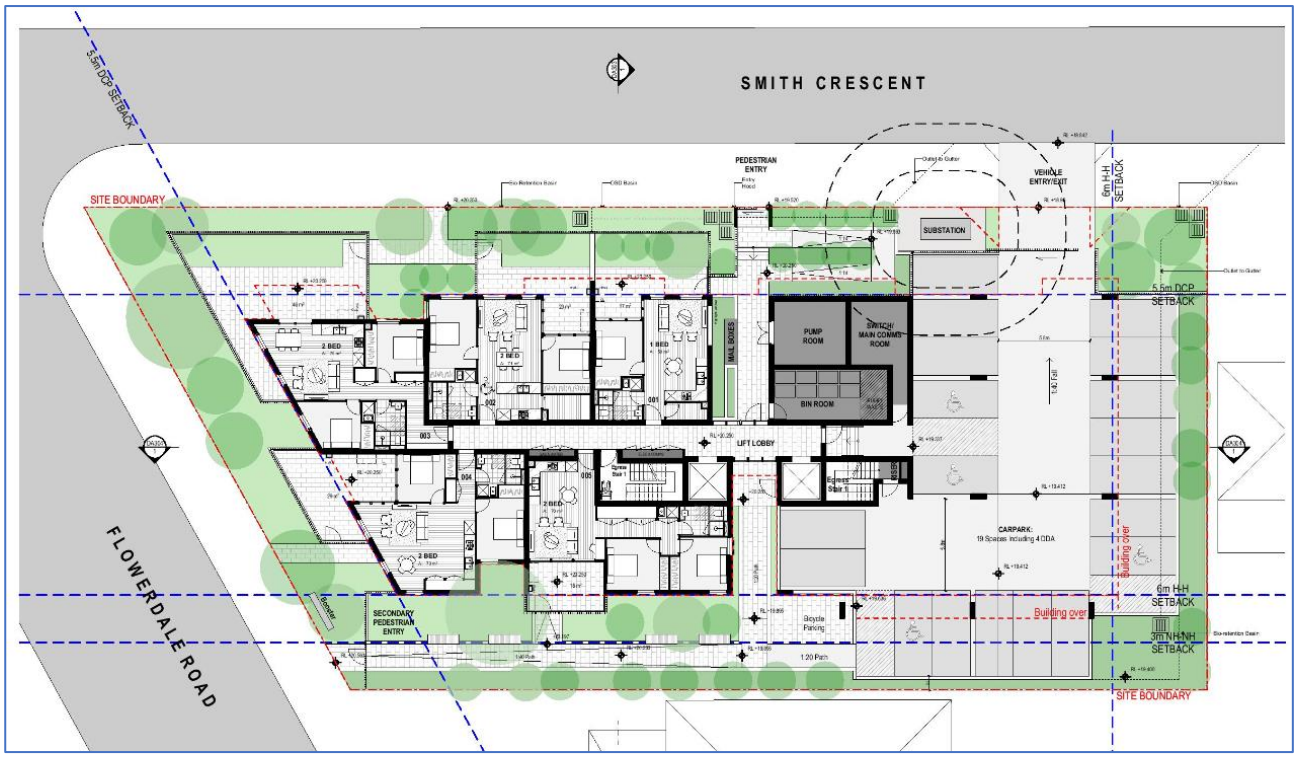
Figure 2: Noise Sensitive Receivers

3 Proposed Development

The proposed development involves the demolition of the existing structures and the construction of a five-storey residential apartment building with car parking on ground floor 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 3.

Figure 3: Development Site Plan



4 Noise Survey

TTM conducted a site inspection on the 24th September 2018 at 129 Flowerdale Road, Liverpool. During the site inspection, existing environmental noise sources and noise sensitive receivers were identified.

The area was observed to be typical of a suburban residential area with an acoustical environment dominated by local intermittent traffic flows on Flowerdale Road.

Unattended ambient noise monitoring was conducted between the 24th and 30th September 2018 to capture representative noise levels at the identified noise sensitive receivers (NSRs). Noise levels were captured generally in accordance with the recommendations of Australian Standard AS 1055[3].

The noise monitoring location relative to the NSRs are shown in Figure 4.

Figure 4: Noise Monitoring Location

[3] AS 1055.1:1997. Acoustics - Description and measurement of environmental noise - General procedures

4.1 Observations

The equipment used to measure existing ambient noise levels at the site are presented in Table 1. All measurements were recorded in average, maximum and statistical noise parameters at 15-minute intervals using fast response.

Table 1: Measurement Equipment and Observations

Type of Measurement	Equipment Model, Type and Serial Number	Comments and Observations
Attended – On-site noise	Brüel & Kjær Model 2250 Type 1 Sound Level Meter (S/N 3004473)	Microphone was positioned at approximately 1.5 metres above ground level in a free-field position. One 15-minute measurement was recorded to verify and complement long-term monitoring results from unattended noise logger. Noise environment was dominated by local road traffic. Intermittent and low road traffic activity with low heavy vehicle percentage were observed. Noise from a couple of buses pass-bys were also captured. At the time of the measurement, children from Liverpool West Public School were leaving the school. Measurement also includes noise from children playing in Liverpool West Public School and one instance of an electronic school bell.
Unattended – Long term ambient noise	Brüel & Kjær Model 2250 Light Noise Logger (S/N 3006261)	To ensure the security of noise logger and considering access restrictions, the logger was installed in the front yard of the property at 129 Flowerdale Road with the microphone positioned at approximately 1.5 metres above ground level in a free-field position at the location shown in Figure 4. The noise logger was used to capture long-term existing ambient noise levels representative of the identified noise sensitive areas to the future development on the site.
Calibration – Check equipment	Brüel & Kjær Model 4231 Sound Calibrator (S/N 3009809)	Noise logger and sound level meter were both calibrated on-site before and after measurements/monitoring and no significant drift was observed.

4.2 Weather Conditions

During the noise monitoring period, adverse weather conditions were reported on the Bureau of Meteorology website on Wednesday 26th September from 5.30am to 9.00am in the area. Data recorded during the adverse weather conditions were excluded from the noise monitoring results.

4.3 Monitoring Results

Table 2 and Table 3 present the statistical noise levels measured by the unattended noise logger installed on site. The daily noise monitoring results are represented graphically in Appendix B. The monitoring results are used to derive the environmental noise targets applicable to the proposed development, and to calibrate the road traffic noise model.

Table 2: Noise Monitoring Results – Ambient Noise Descriptors

Period	Existing Noise Levels in dB(A)			
	Rating Background Noise Levels, RBL L_{90}	L_{eq}	L_{10}	L_1
Day	47	60	63	72
Evening	44	59	61	73
Night	38	54	60	71

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)

Table 3: Noise Monitoring Results – Road Traffic Noise Descriptors

Period (T)	Noise level in dB(A)		
	NSW RNP descriptor – $L_{eq,T}$	NSW RNP descriptor – $L_{eq,1h}$ (Average maximum 1 hour)	CoRTN (For noise modelling purposes) – $L_{10,18h}$ (6am to 12am)
Day (7am - 10pm)	60	64	60.7
Night (10pm - 7am)	53	57	

The measured noise levels are typical of a suburban residential area, as expected.

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

5.1 Liverpool Development Control Plan (DCP) 2008

Liverpool DCP 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 DCP 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 from freeway/arterial/sub-arterial roads, and 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	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 NSW SEPP Infrastructure

The NSW State Environmental Planning Policy (SEPP) has been used to investigate the impact of road traffic noise onto the proposed development.

The relevant criteria for road traffic noise impact are contained in *Division 17 Roads and traffic, Subdivision 2 Development in or adjacent to road corridors and road reservations, Paragraph 102 Impact of road noise or vibration on non-road development*.

Relevant noise criteria contained in The NSW Department of Planning, *Development near Rail Corridors and Busy Roads – Interim Guideline* also refers to NSW SEPP Infrastructure.

The criteria are summarised as follows:

- For the development that is on land in or adjacent to the road corridor with an annual average daily traffic (AADT) volume of more than 40,000 vehicles, the development is likely to be adversely affected by road noise or vibration.
- Appropriate measures are required to be taken to ensure that the following L_{Aeq} noise levels are not exceeded for road traffic noise impact:
  - in any bedroom in the building—35 dB(A) at any time between 10 pm and 7am, and
  - anywhere else in the building (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.
- Typically, a maximum of 10dB noise attenuation is achieved internally for noise entering through open windows/doors. Therefore, when windows/doors of the apartments are open, L_{Aeq} noise levels greater than 45 dB(A) (for bedrooms) and 50 dB(A) (for living areas) are predicted to exceed the internal noise criteria.

6 Noise Assessment

This section of the report addresses the following:

- Road traffic noise impact from the surrounding road network onto the development
- Noise from the communal roof terrace to identified noise sensitive areas, and
- Road traffic noise impact from additional road traffic generated by the development to the local community.

6.1 Road Traffic Noise Intrusion

The proposed development is subject to road traffic noise intrusion from Hoxton Park Road and Flowerdale Road.

Hoxton Park Road is a dual carriageway with two lanes in each direction with a signed speed zone of 60km/h eastbound and 70km/h westbound, with the addition of a transitway between the eastbound and westbound lanes.

Flowerdale Road is a collector road linking local traffic to the arterial roads. The site is located within a school zone with a speed limit of 40km/h during school hours, and 60km/h outside school hours.

6.1.1 Noise Prediction Model

Road traffic noise levels were predicted using the CoRTN[4] 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 6.

Table 6: Parameters used in SoundPLAN model

Parameter		Value
Façade correction		+2.5dB
Façade receiver heights	Ground floor	1.5m above ground level
	Other floors	1.5m above floor level
Speed limit	Hoxton Park Road	60 km/h (Posted limit) – Eastbound 70 km/h (Posted limit) – Westbound
	Flowerdale Road	60km/h (Outside school hours) 40 km/h (School hours)
Road surface correction		None

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

The model has been designed to predict road traffic noise from Hoxton Park Road and Flowerdale Road. Elevation contours of the site and the road used in the model were extracted from the drawings provided by DKO Architecture and Google Earth, where required.

The traffic volume and growth rate information used in the SoundPLAN model were obtained from traffic counts data previously conducted by TTM Consulting (Report Ref.: 18SYD0091 *Hoxton Park Rd, between Gillespie St & William St, counted from 22nd to 28th August 2018*) 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 Hoxton Park Road was conservatively assumed to be 2%. No growth was applied to Flowerdale Road.

The growth rate was used to predict ultimate traffic volumes for Year 2028. The traffic volumes, growth rate and percentage of heavy vehicles (HV) used in the model are summarised in Table 7.

Table 7: Traffic Data used in SoundPLAN Model

Road name	Existing – Year 2018		Growth rate (%)	% HV	Ultimate – Year 2028	
	AADT	18-hour traffic (94%)			AADT	18-hour traffic (94%)
Hoxton Park Road – Westbound	14680	13800	2	1	17900	16820
Hoxton Park Road – Eastbound	15990	15030	2	1	19490	18320
Flowerdale Road	5000	4700	0	1	5000	4700

6.1.1.1 Verification of Road Traffic Noise Model

The measured and predicted free-field noise levels at the noise monitoring location for the existing situation are shown in Table 8.

Table 8: Comparison of measured and predicted free-field noise levels – Existing situation

Measurement Location (Refer to Figure 4)	Sound Pressure Levels, $L_{10,18h}$ in dB(A)		
	Measured	Predicted	Difference
Noise Monitoring Location	60.7	59.7	-1.0

The predicted road traffic noise level using SoundPLAN is 1.0dB lower than the measured noise level. The model is within the accepted model variance of ±2 dB and is therefore validated.

A +1.0dB correction factor will be added to the predicted modelling results to represent a conservative model.

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, as shown in Table 3, have been determined. The offsets are summarised in Table 9.

Table 9: 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)	-0.7	+3.3
Night (10pm – 7am)	-7.7	-3.3

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 (including +1dB model correction), 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 9 have been applied to determine the façade-corrected L_{eq}. The predicted results are summarised in Table 10.

Table 10: Future Road Traffic Noise Predictions

Receiver Ref. & Façade direction – Refer to Appendix C	Floor level	Predicted $L_{10,18h}$ dB(A)	Noise levels in dB(A)			
			$L_{eq\ Day}$	$L_{eq,1h\ Day}$	$L_{eq\ Night}$	$L_{eq,1h\ Night}$
SGCH Flowerdale Road E	GF	56	56	60	49	53
SGCH Flowerdale Road E	F 1	59	58	62	51	55
SGCH Flowerdale Road E	F 2	60	59	63	52	56
SGCH Flowerdale Road E	F 3	61	60	64	53	57
SGCH Flowerdale Road E	F 4	61	61	65	54	58
SGCH Flowerdale Road N	GF	51	51	55	44	48
SGCH Flowerdale Road N	F 1	54	53	57	46	51
SGCH Flowerdale Road N	F 2	56	55	59	48	52
SGCH Flowerdale Road N	F 3	57	56	60	49	53
SGCH Flowerdale Road N	F 4	58	57	61	50	55
SGCH Flowerdale Road SE	GF	56	55	59	48	53
SGCH Flowerdale Road SE	F 1	59	59	63	52	56
SGCH Flowerdale Road SE	F 2	63	63	67	56	60
SGCH Flowerdale Road SE	F 3	65	64	68	57	61
SGCH Flowerdale Road SE	F 4	66	65	69	58	62
SGCH Flowerdale Road SW	GF	62	62	66	55	59
SGCH Flowerdale Road SW	F 1	65	64	68	57	61
SGCH Flowerdale Road SW	F 2	66	65	69	58	63
SGCH Flowerdale Road SW	F 3	66	66	70	59	63
SGCH Flowerdale Road SW	F 4	67	66	70	59	63

Receiver Ref. & Façade direction – Refer to Appendix C	Floor level	Predicted $L_{10,18h}$ dB(A)	Noise levels in dB(A)			
			$L_{eq\ Day}$	$L_{eq,1h\ Day}$	$L_{eq\ Night}$	$L_{eq,1h\ Night}$
SGCH Flowerdale Road W	GF	65	64	68	57	62
SGCH Flowerdale Road W	F 1	67	66	70	59	64
SGCH Flowerdale Road W	F 2	67	66	70	59	64
SGCH Flowerdale Road W	F 3	67	66	70	59	64
SGCH Flowerdale Road W	F 4	67	66	70	59	63
Rooftop Communal Space (Free-field) E	F 4	63	62	66	55	60
Communal Open Space (Free-field) SW	GF	60	59	63	52	57
Communal Open Space (Free-field) N	GF	49	48	52	41	45

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 60dB(A) $L_{eq,1hr\ Day}$ and 55dB(A) $L_{eq,1hr\ Night}$. Acoustic treatment to the building is therefore required to meet the internal design sound levels of 40dB(A) $L_{eq\ Night}$ for bedrooms, and 45dB(A) L_{eq} 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[5] to meet the internal noise levels for each type of occupancy.

The acoustic performance requirements for the building envelope are summarised in Table 11. Alternative construction methods meeting the minimum acoustic rating are also acceptable.

Table 11: 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

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

Building element	Minimum acoustic performance required, R_W	Typical construction details
	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 12. It is strongly recommended to obtain a glazing certificate from the manufacturer stating the acoustic rating of any alternative glazing system.

Table 12: Glazing acoustic performance requirements

Floor level	Façade	Occupancy Type	Minimum acoustic performance required, R_W
Ground	North	Bedroom	No acoustic requirements
		Living	
	South	Bedroom	25
		Living	27
	East	Bedroom	No acoustic requirements
		Living	
	West	Bedroom	25
		Living	34
Level 1-3	North	Bedroom	21
		Living	21
	South	Bedroom	27
		Living	29
	East	Bedroom	25
		Living	27
	West	Bedroom	27
		Living	34
Level 4	North	Bedroom	21
		Living	21
	South	Bedroom	27
		Living	29
	East	Bedroom	25
		Living	27
	West	Bedroom	27
		Living	34

6.2 Communal Open Space Ground Floor

The communal open space on ground floor will experience noise levels from 48-59dB(A) $L_{eq,Day}$. In accordance with NSW Road Noise Policy criteria given in Table 5, some areas, typically the southern area of the space, will exceed 55 dB(A) $L_{eq,15hour}$.

However, the open space area to the north of the development can be used as the communal open space on the ground floor, as the predicted road traffic noise in that area will be less than 55 dB(A) $L_{eq,15hour}$.

6.3 Rooftop Communal Space

A rooftop communal space is proposed on Level 4 of the development. The roof terrace is located in proximity to existing residential properties.

The communal roof terrace will generally be used for barbeques and outdoor gatherings. Noise generated from the use of the roof terrace may cause an adverse impact on the neighbouring noise sensitive receivers. To ensure the acoustic amenity of the local community is preserved, it is suggested to:

- Restrict use of terrace to the day-time and evening assessment periods only, which is from 7am to 10pm, or 8am to 10pm on Sundays and public holidays.
- Restrict number of people on the terrace.
- Position outdoor speakers, if any, strategically away from noise sensitive receivers.
- Implementation of noise control treatments such as acoustic balustrades, partial roofs and/or amplified music limits.

6.3.1 Road Traffic Noise Impact

The rooftop space will experience noise levels of 62dB(A) $L_{eq,Day}$. In accordance with NSW Road Noise Policy criteria given in Table 5, the area is predicted to exceed 55 dB(A) $L_{eq,15hour}$ by 8dB.

It is recommended to upgrade the balustrade surrounding the rooftop communal space by a solid concrete or glass wall with a minimum height of 1.5 metres to ensure road traffic noise levels do not exceed 55 dB(A) $L_{eq,15hour}$.

6.4 Road Traffic Generated by Development

Additional traffic is expected to be generated from the new development. However, additional traffic generated from the development is not expected to cause any significant increase in road traffic noise to other residences. Based on additional peak hour traffic generated by the development, road traffic noise levels are not expected to increase by more than 0.5 dB.

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

Typical construction details have been provided as a guide. Should alternative construction methods be required, the minimum acoustic rating is still required to 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. 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 by referring to the 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 while referring to the recommended glazing thickness. If the glazing thickness does not achieve the recommended R_W rating, thicker glass should be considered.

It is recommended that a glazing certificate be obtained demonstrating that the installed glazing system meets the minimum R_W requirements.

7.2 Communal Open Space Ground Floor

Based on the predicted road traffic noise impact on the communal open space areas, it is recommended to assign the northern area of the development as the preferred outdoor communal open space.

7.3 Rooftop Communal Space

It is recommended to upgrade the balustrade around the rooftop communal space to a solid concrete or glass wall with a minimum height of 1.5 metres.

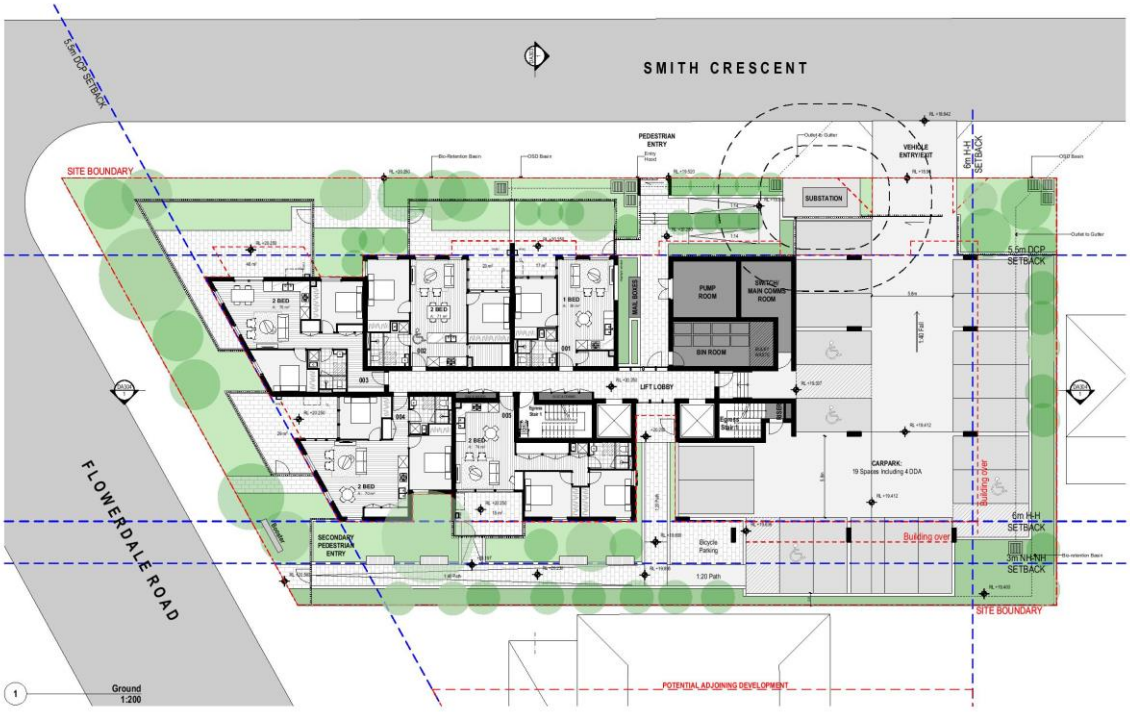
8 Conclusion

Following a noise impact assessment conducted by TTM Consulting for SGCH for the proposed residential development at 127-129 Flowerdale Road, Liverpool, TTM concludes the following:

- Acoustic treatments to the windows, walls and roof are required to meet the internal acoustic design targets of the development.
- The noise emissions from the plant room and substation, including corrections for tonal and impulsive noise characteristics, must not exceed 69 dB(A) measured at one metre from the plant room and the substation.
- The northern area of the ground floor should be assigned as the preferred communal outdoor open space area.
- The balustrade around the rooftop communal space is recommended to be upgraded to a solid concrete or glass wall with a minimum height of 1.5 metres.
- Additional road traffic generated by the development will not cause a significant noise impact on the local community.

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

Appendix A Relevant Development Plans



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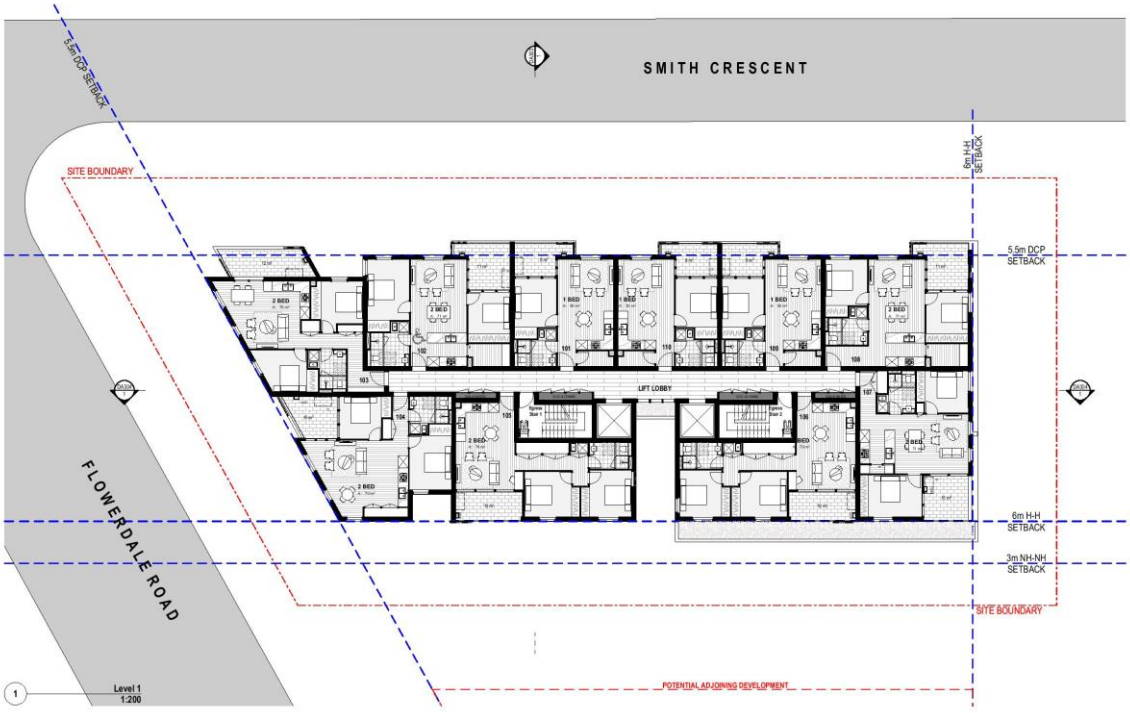
Rev.	Date	By	Ckd	Description
TP2	27/09/2018	PP	IL	Issue for Information
TP3	31/10/2018	PP	IL	Issue for Coordination
TP4	5/12/2018	PP	IL	Issue for Coordination
TP5	15/02/2019	PP, RY	IL	Issue for Coordination
A	6/03/2019	PP	IL	Issue for Development Application

Project Name / Project Address: SGCH Flowerdale Road, 127-129 Flowerdale Rd, Liverpool, NSW, 2170
Client: SGCH

Project Number: 00012087
Drawing Name: Ground Floor Plan
Scale: 1:200@A3
Date Commenced: September 2018
Drawing Number: DA200
Revision: A



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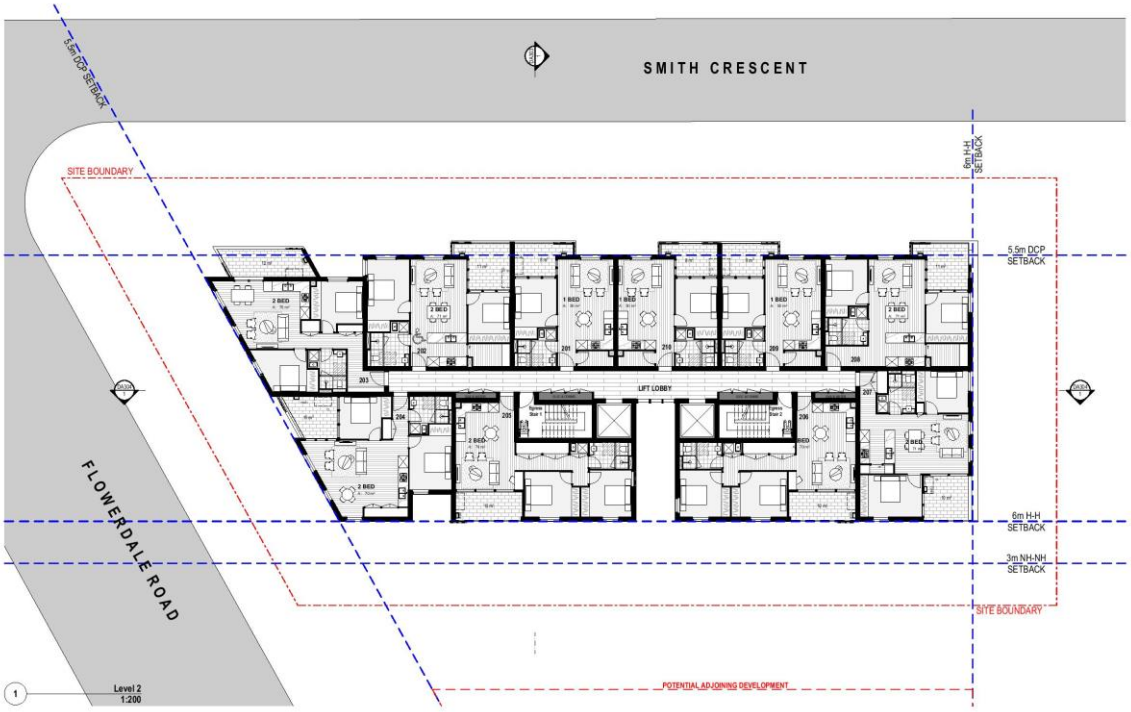
TP3	31/10/2018	PP	IL	Issue for Coordination
TP4	5/12/2018	PP	IL	Issue for Coordination
TP5	15/02/2019	PP, RY	IL	Issue for Coordination
A	6/03/2019	PP	IL	Issue for Development Application

Project Name / Project Address: SGCH Flowerdale Road, 127-129 Flowerdale Rd, Liverpool, NSW, 2170
Client: SGCH

Project Number: 00012087
Drawing Name: Level 1
Scale: 1:200@A3
Date Commenced: September 2018
Drawing Number: DA201
Revision: A



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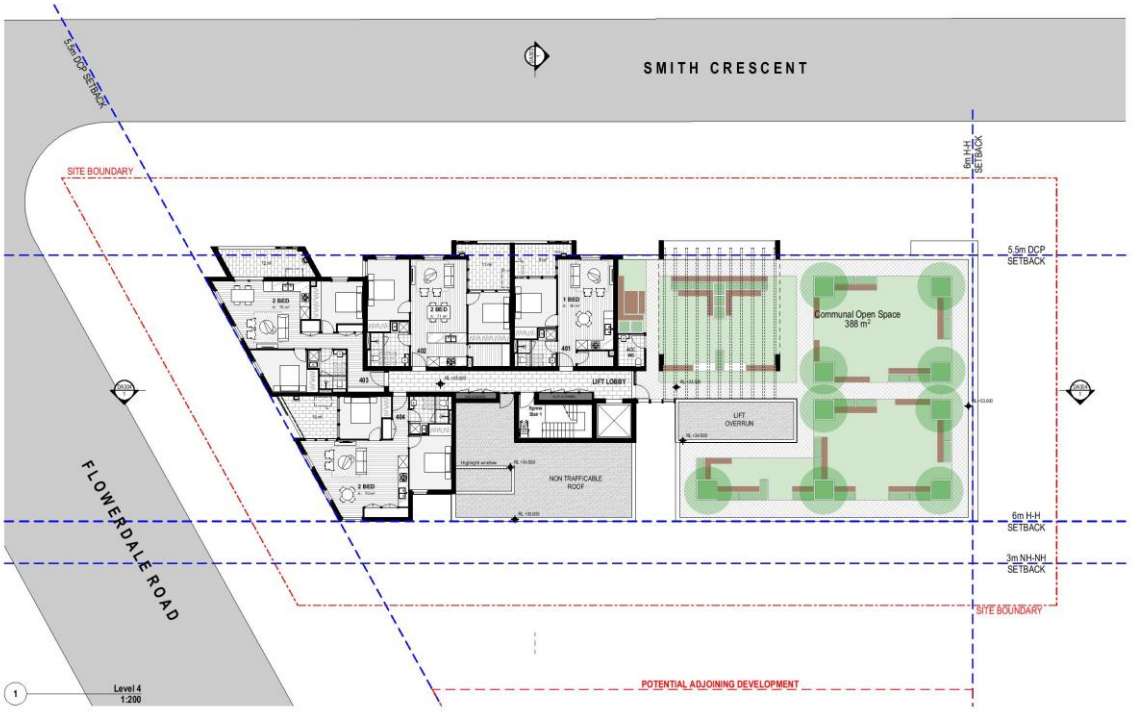
Rev.	Date	By	Ckd	Description
TP3	15/02/2019	PP, RY	IL	Issue for Coordination
A	6/03/2019	PP	IL	Issue for Development Application

Project Name	SGCH Flowerdale Road
Project Address	127-129 Flowerdale Rd, Liverpool, NSW, 2170
Client	SGCH
Project Number	00012087
Drawing Name	Level 2-3 Typical
Scale	1:200@A3
Date Commenced:	September 2018
Drawing Number	DA202
Revision	A



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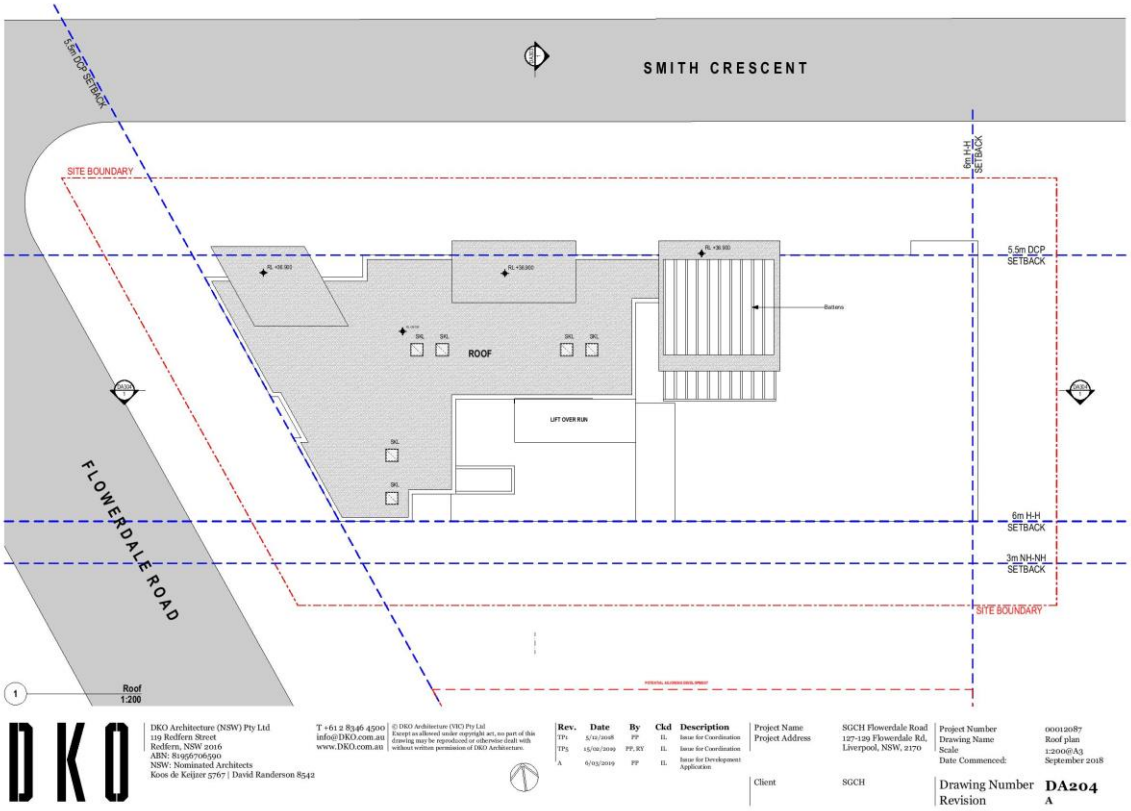
Rev.	Date	By	Ckd	Description
TP0	27/09/2018	PP	IL	Issue for Information
TP3	31/10/2018	PP	IL	Issue for Coordination
TP4	5/12/2018	PP	IL	Issue for Coordination
TP5	15/02/2019	PP, RY	IL	Issue for Coordination
A	6/03/2019	PP	IL	Issue for Development Application

Project Name	SGCH Flowerdale Road
Project Address	127-129 Flowerdale Rd, Liverpool, NSW, 2170
Client	SGCH
Project Number	00012087
Drawing Name	Level 4
Scale	1:50, 1:200@A3
Date Commenced:	September 2018
Drawing Number	DA203
Revision	A


SMITH CRESCENT
5.5m DCP SETBACK
SITE BOUNDARY
6m H-H SETBACK
5.5m DCP SETBACK
ROOF
LIFT OVER RUN
Battens
FLOWERDALE ROAD
6m H-H SETBACK
3m NH-NH SETBACK
SITE BOUNDARY
1
Roof
1:200
DKO
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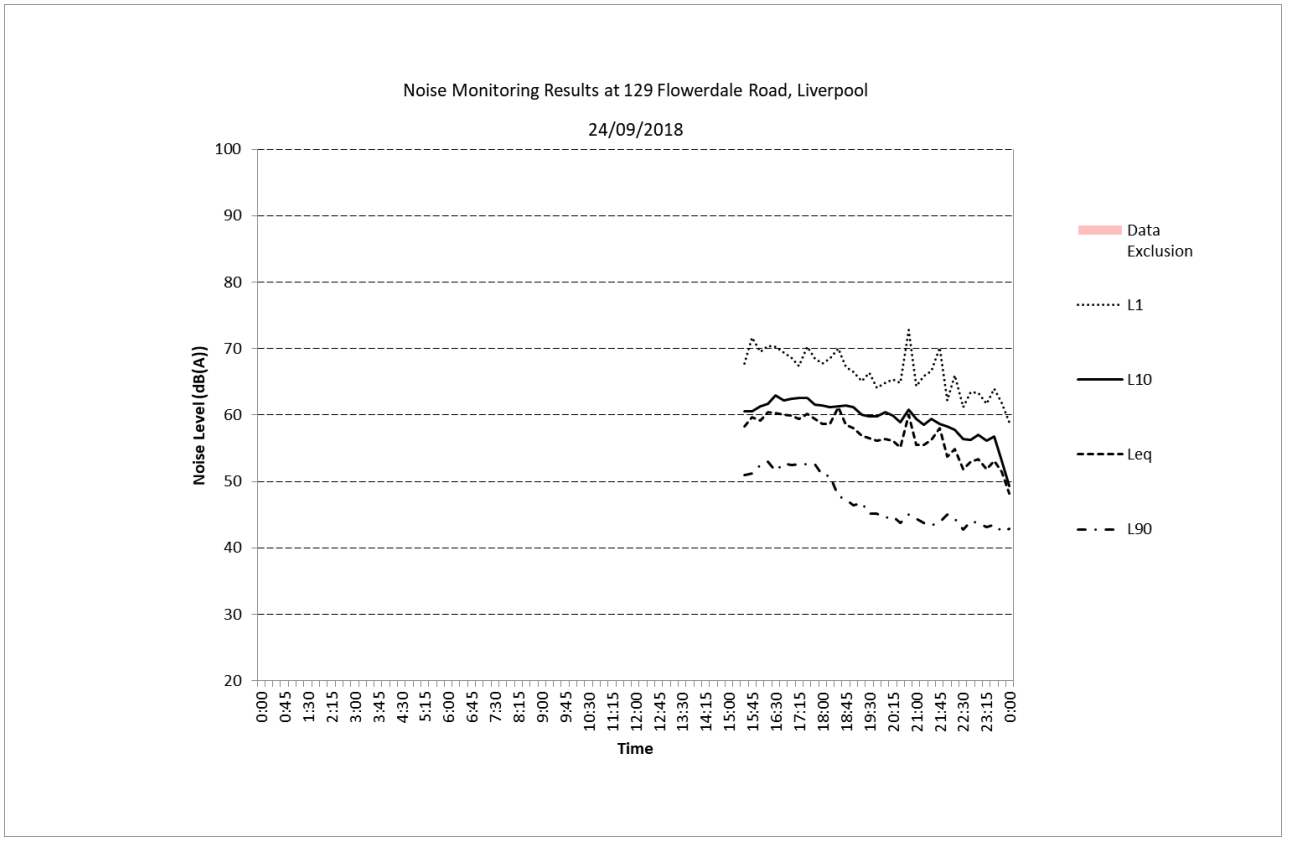
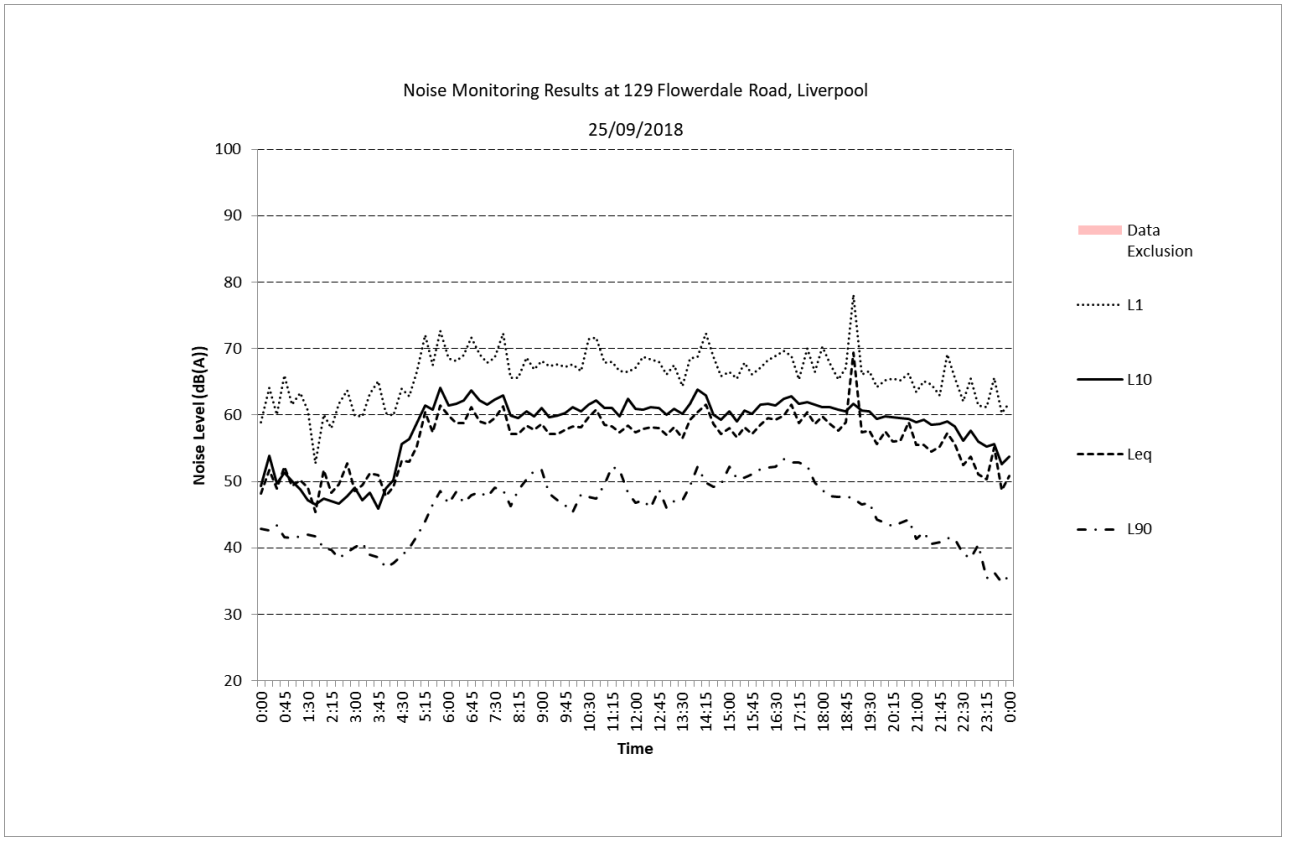
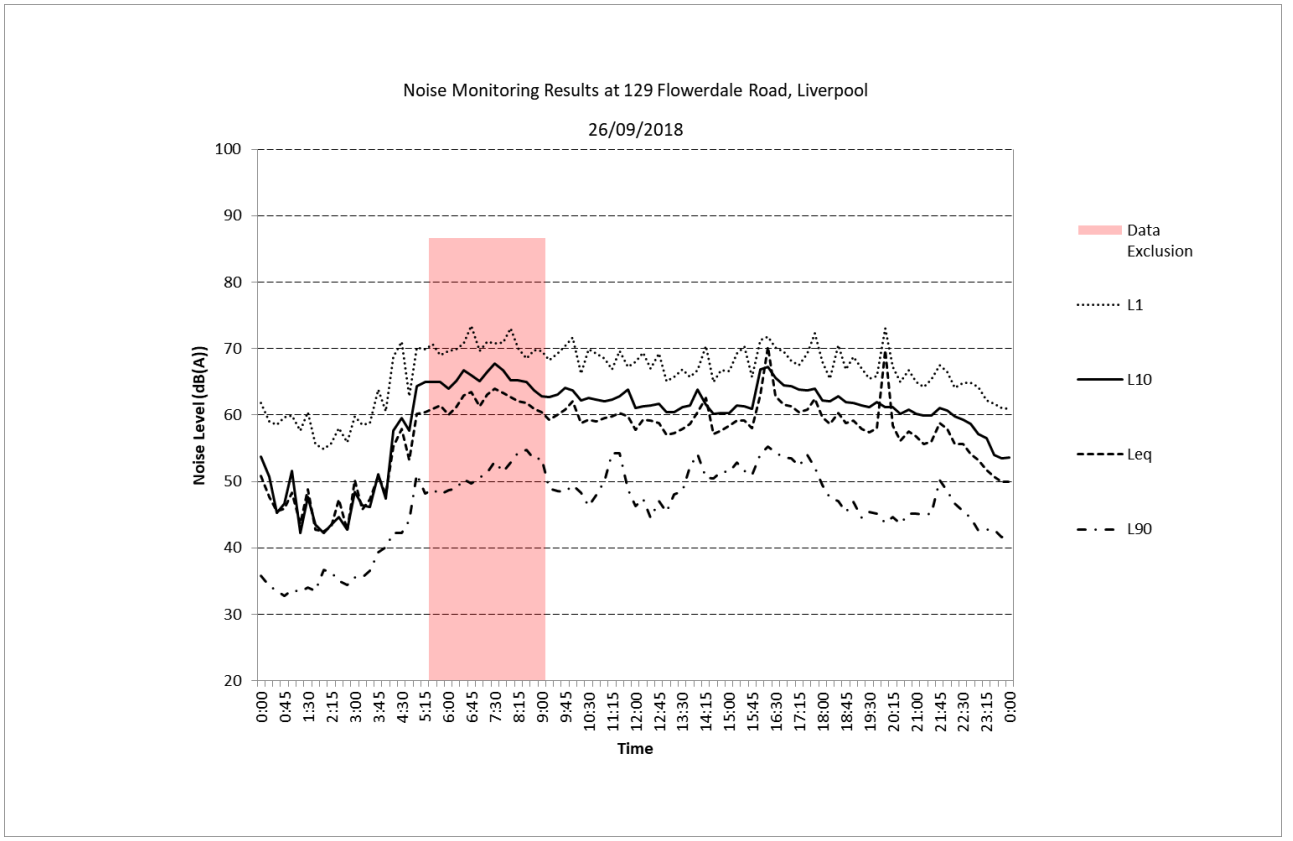
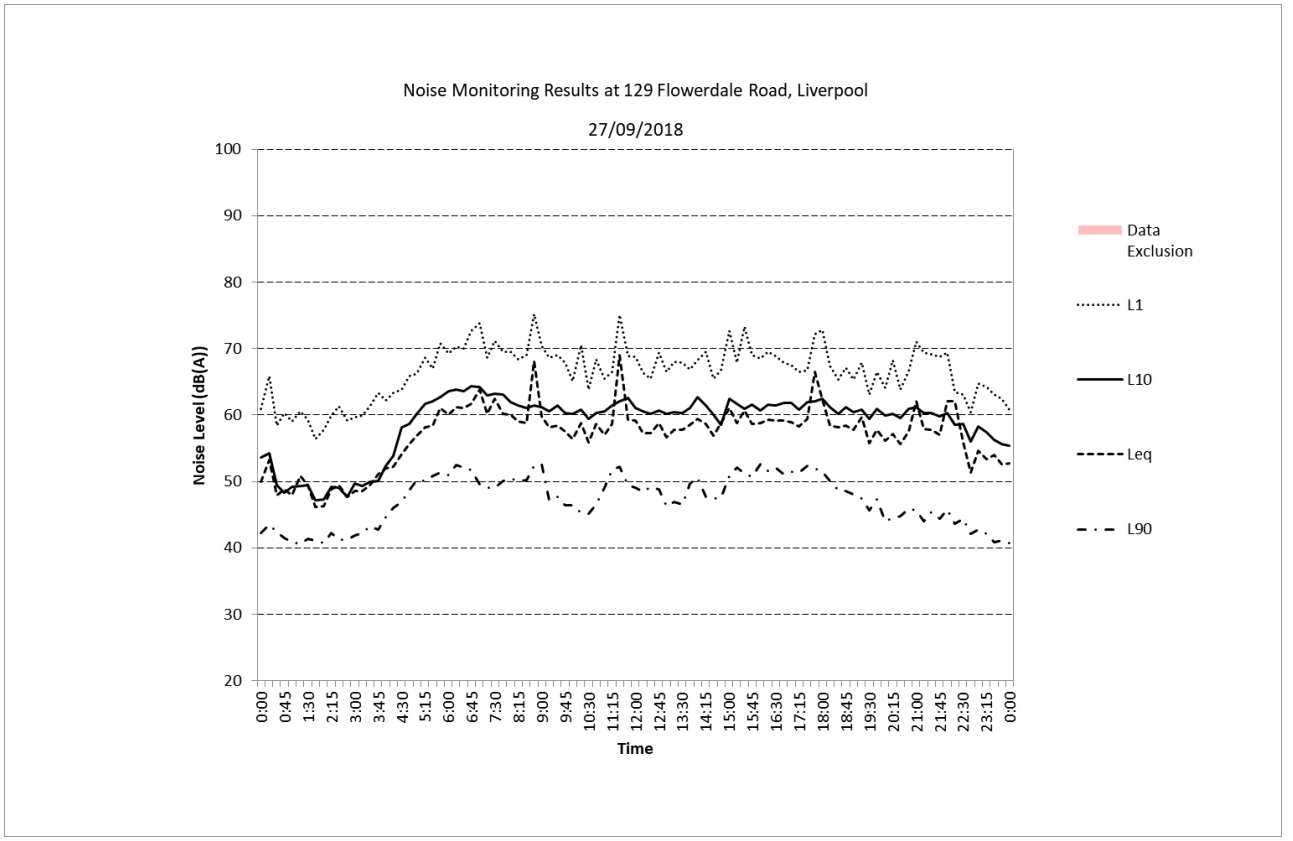
Rev. Date By Ckd Description
TP1 5/11/2018 PP IL Issue for Coordination
TP3 15/01/2019 PP, RY IL Issue for Coordination
A 6/03/2019 PP IL Issue for Development Application
Project Name SGCH Flowerdale Road
Project Address 127-129 Flowerdale Rd, Liverpool, NSW, 2170
Client SGCH
Project Number 00012087
Drawing Name Roof plan
Scale 1:200@A3
Date Commenced: September 2018
Drawing Number DA204
Revision A

Appendix B Noise Monitoring Graphs


Noise Monitoring Results at 129 Flowerdale Road, Liverpool
24/09/2018
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 Results at 129 Flowerdale Road, Liverpool
25/09/2018
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 Results at 129 Flowerdale Road, Liverpool
26/09/2018
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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27/09/2018
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
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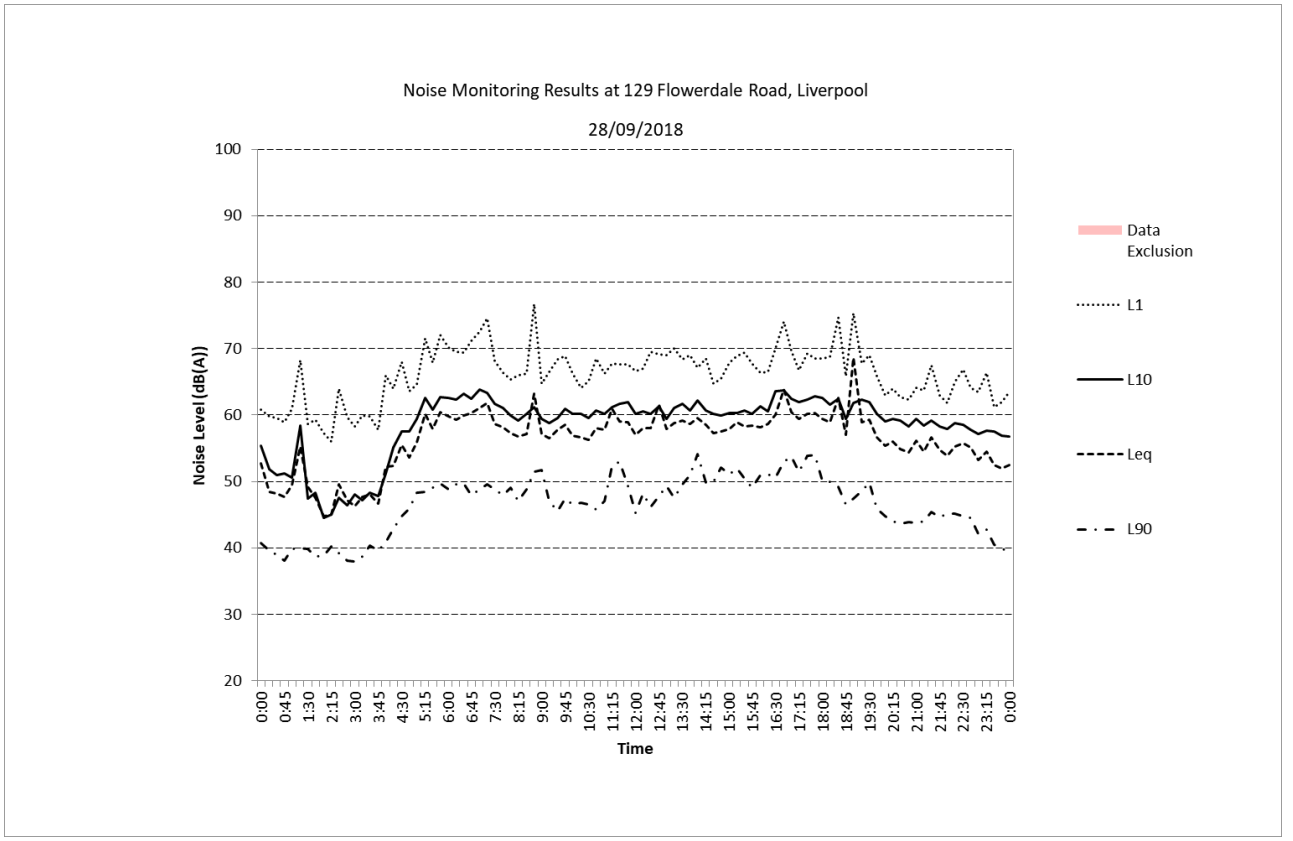
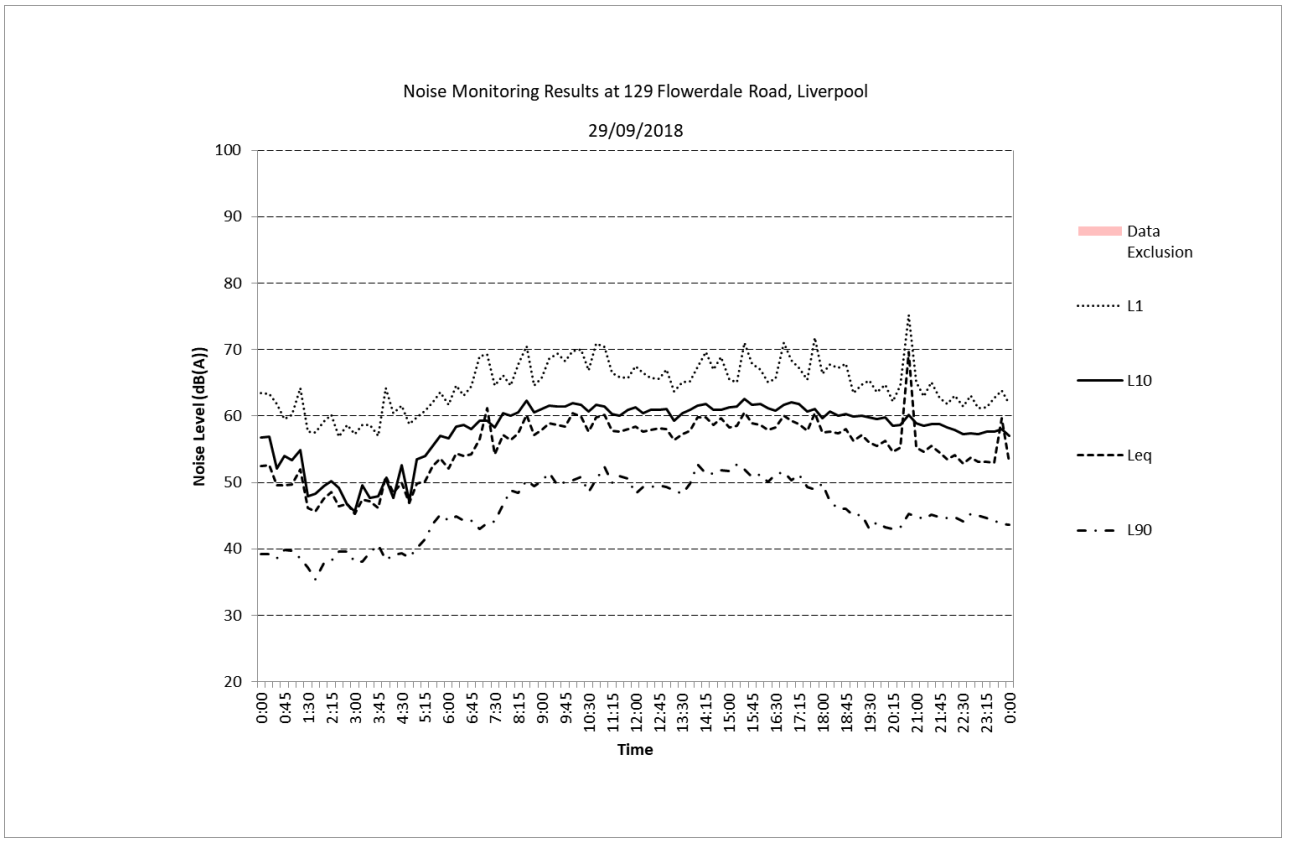
0:00
Time
Data Exclusion
L1
L10
Leq
L90


Noise Monitoring Results at 129 Flowerdale Road, Liverpool
28/09/2018
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90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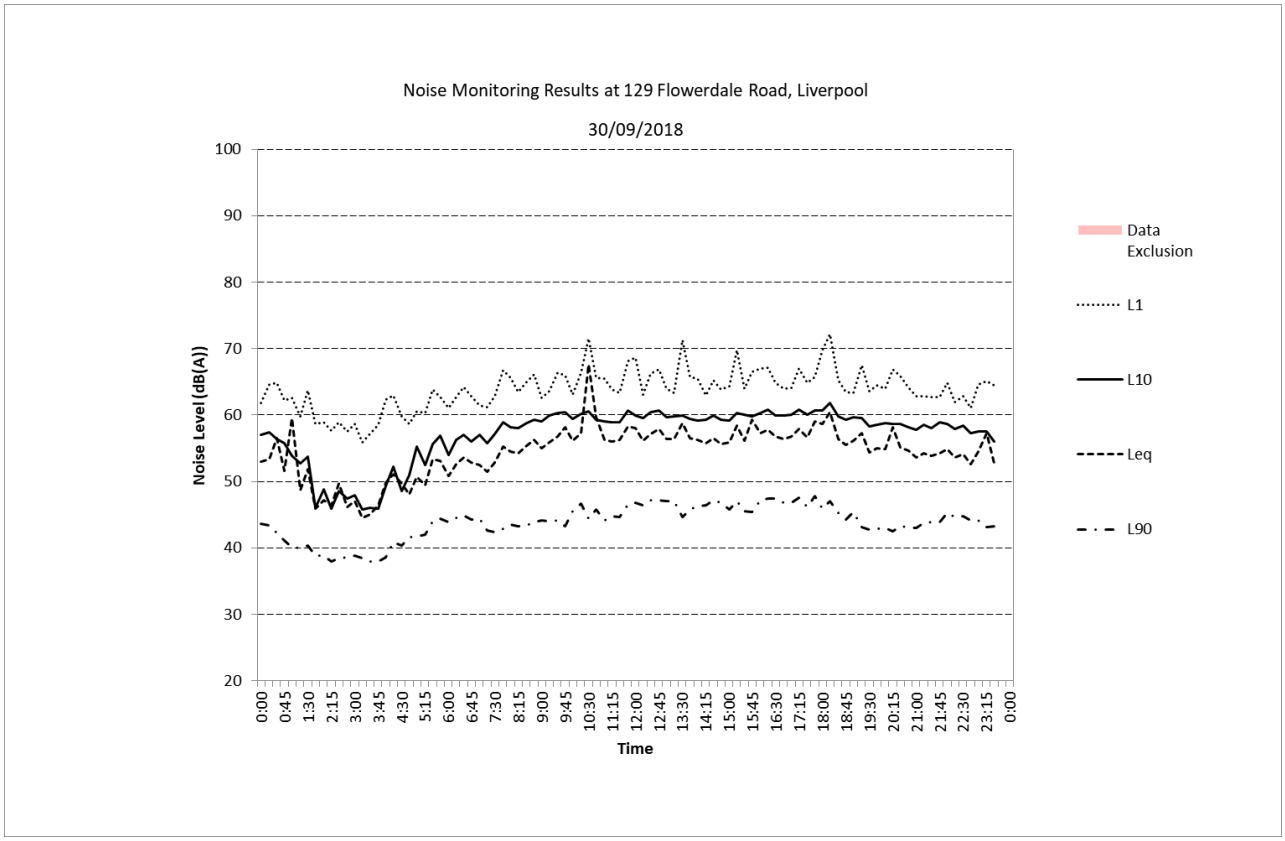
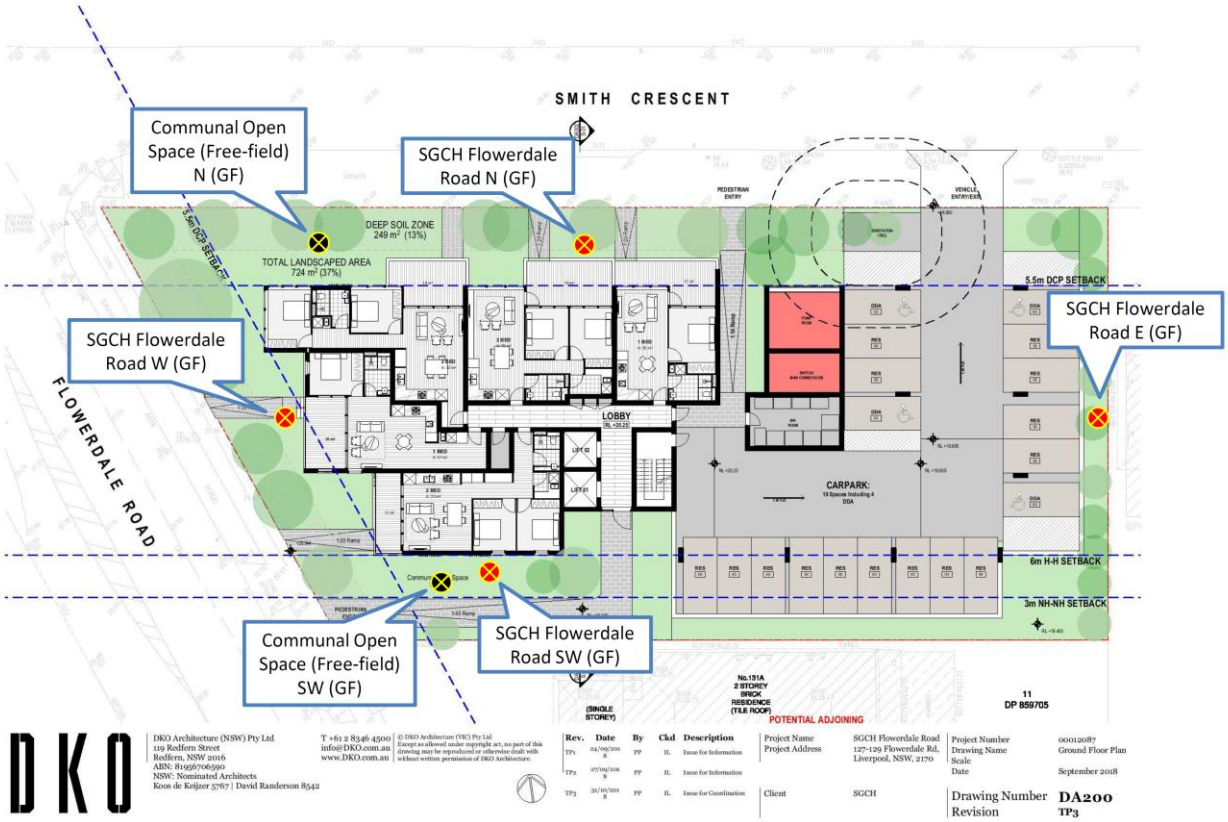
29/09/2018
Noise Level (dB(A))
Time
Data Exclusion
L1
L10
Leq
L90


Noise Monitoring Results at 129 Flowerdale Road, Liverpool
30/09/2018
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 Model – Receivers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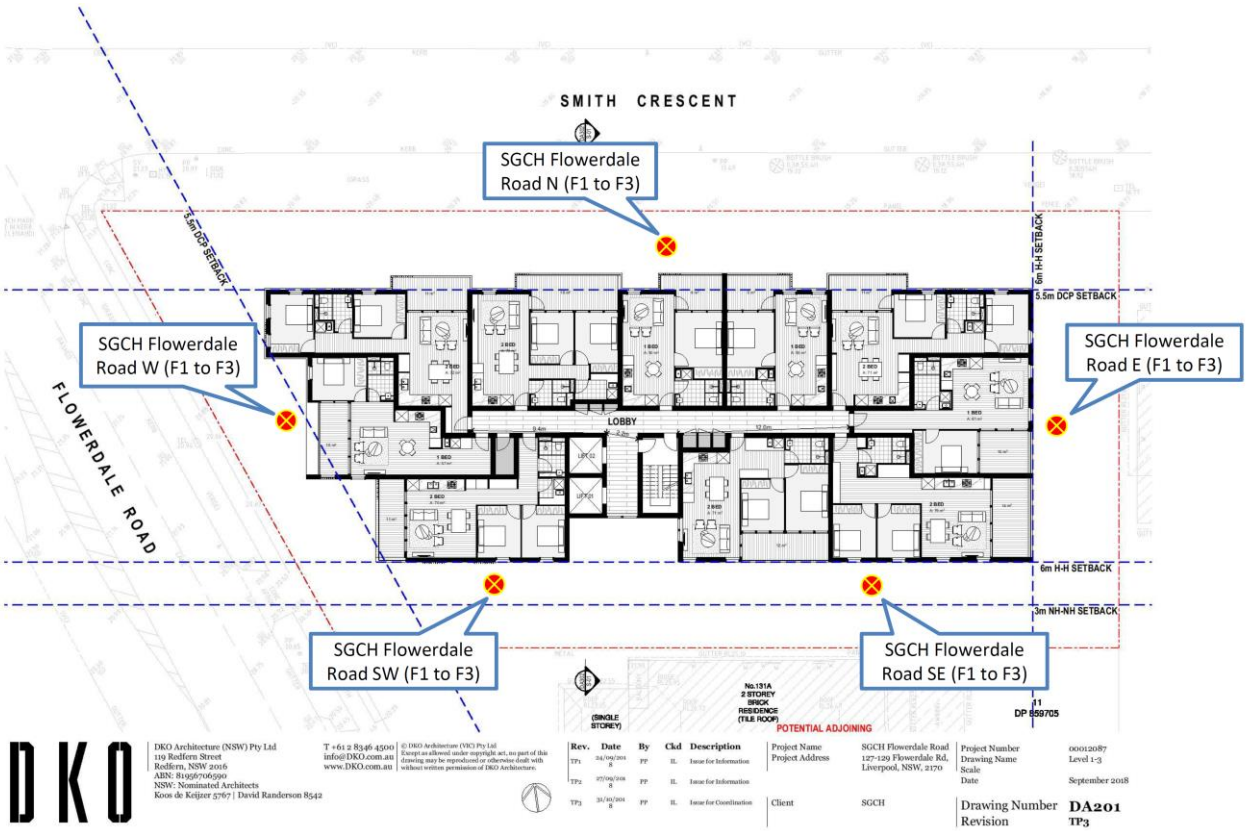
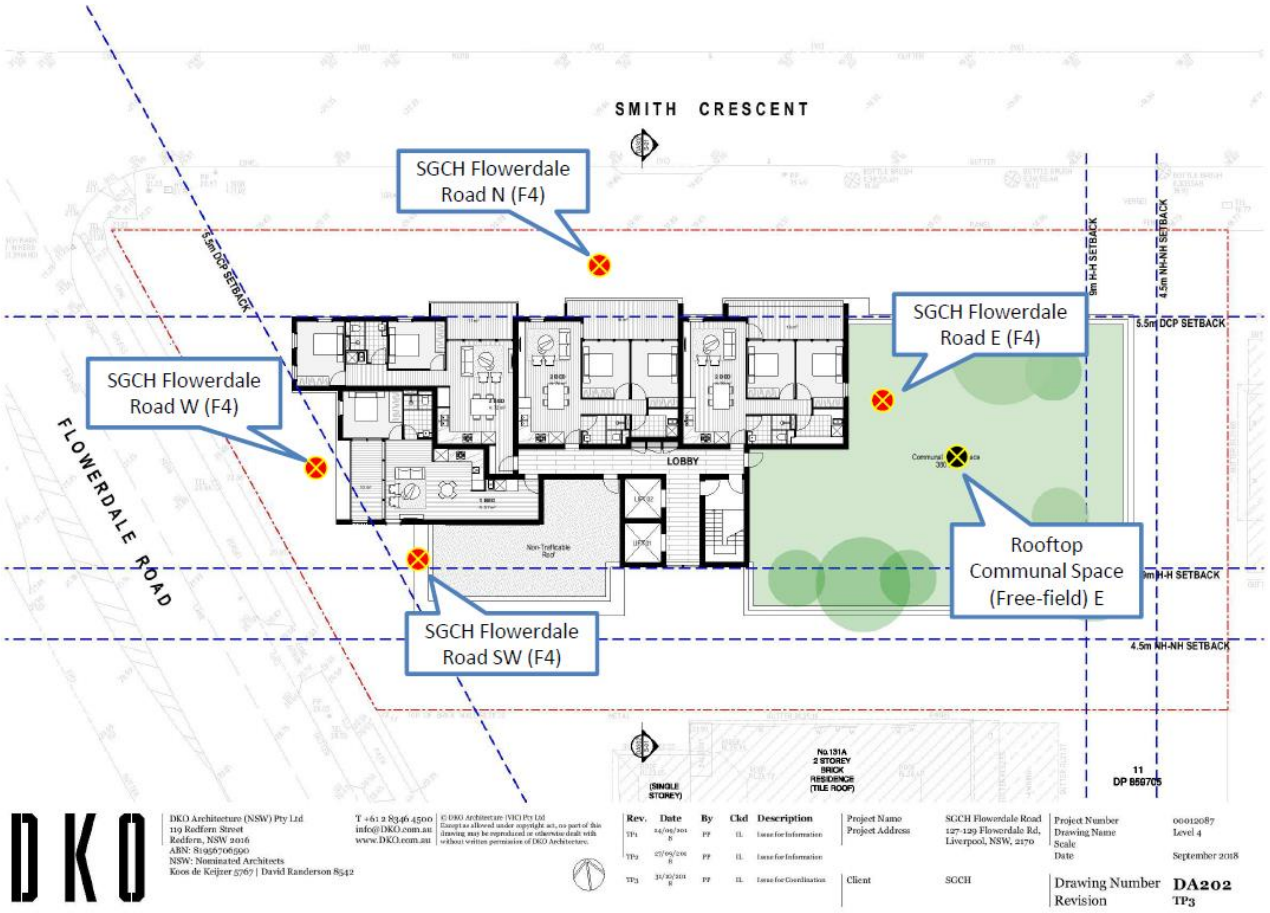
Communal Open Space (Free-field) N (GF)
SGCH Flowerdale Road N (GF)
SGCH Flowerdale Road W (GF)
SGCH Flowerdale Road E (GF)
SGCH Flowerdale Road SW (GF)
Communal Open Space (Free-field) SW (GF)
FLOWERDALE ROAD
DEEP SOIL ZONE 249 m² (13%)
TOTAL LANDSCAPED AREA 724 m² (37%)
5.5m DCP SETBACK
6m H-H SETBACK
3m NH-NH SETBACK
LOBBY
CARPARK:
POTENTIAL ADJOINING
DKO
DA200
TP3


SMITH CRESCENT
SGCH Flowerdale Road N (F1 to F3)
SGCH Flowerdale Road W (F1 to F3)
SGCH Flowerdale Road E (F1 to F3)
SGCH Flowerdale Road SW (F1 to F3)
SGCH Flowerdale Road SE (F1 to F3)
FLOWERDALE ROAD
5.5m DCP SETBACK
6m H-H SETBACK
3m NH-NH SETBACK
LOBBY
POTENTIAL ADJOINING
DKO
DA201
TP3


SMITH CRESCENT
SGCH Flowerdale Road N (F4)
SGCH Flowerdale Road E (F4)
SGCH Flowerdale Road W (F4)
SGCH Flowerdale Road SW (F4)
Rooftop Communal Space (Free-field) E
FLOWERDALE ROAD
5.5m DCP SETBACK
5m H-H SETBACK
4.5m NH-NH SETBACK
LOBBY
No.131A 2 STOREY BRICK RESIDENCE (TILE ROOF)
(SINGLE STOREY)
11 DP 859705
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Rev. Date By Chkd Description
TP1 14/09/2018 PF IL Issue for Information
TP2 27/09/2018 PF IL Issue for Information
TP3 31/10/2018 PF IL Issue for Coordination
Project Name
Project Address
SGCH Flowerdale Road
127-129 Flowerdale Rd,
Liverpool, NSW, 2170
Client
SGCH
Project Number 00012087
Drawing Name Level 4
Scale
Date September 2018
Drawing Number DA202
Revision TP3

Appendix D 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

TERM	DEFINITION
	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.
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.
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.
One-Third Octave Bands	One-Third Octave Bands are frequency ranges where each octave is divided into one-third octaves with the upper frequency limit being 1.26 times the lower frequency. They are identified by the geometric mean frequency of each band, or centre frequency.

TERM	DEFINITION
Project-Specific Noise 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 Industrial Noise 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.
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.
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.
Tonality	Noise containing a prominent frequency and characterised by a definite pitch.