ACOUSTICS AND AIR

SCEGGS DARLINGHURST
MASTERPLAN & STAGE 1 PROJECT APPLICATION
CONSTRUCTION & OPERATIONAL NOISE REPORT

REPORT NO. 18180
VERSION C

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PREPARED FOR

SCECGS DARLINGHURST
C/- SANDRICK PROJECT DIRECTIONS
SUITE 412, NEXUS NORWEST
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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% 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 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.

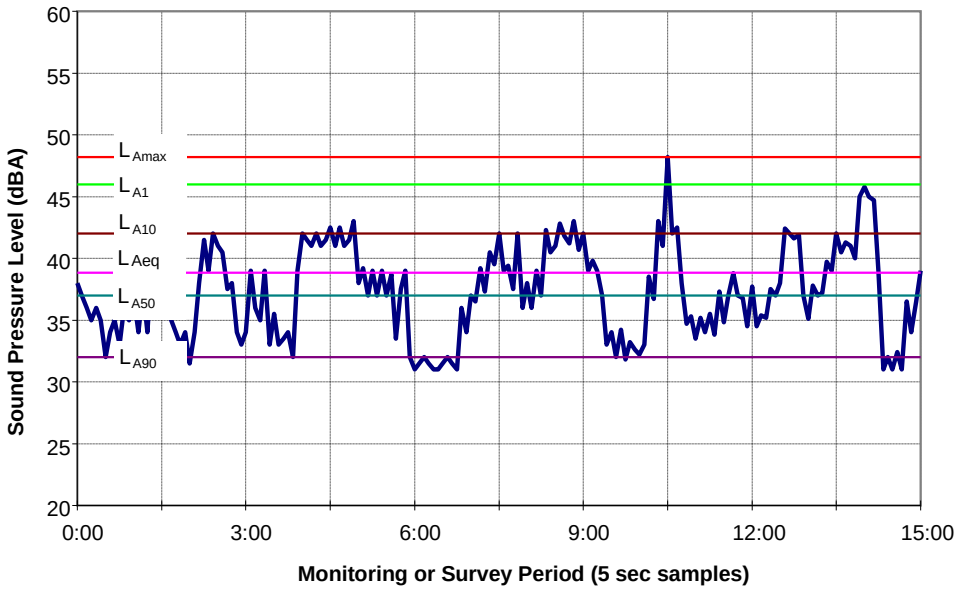
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the 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 environment. This measure is also a common measure of environmental noise and road traffic noise.

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.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

This Noise Impact Assessment (NIA) has been prepared to accompany a State Significant Development Application for the proposed masterplan and redevelopment of the Sydney Church of England Girls' Grammar School, Darlinghurst (SCEGGS) site at 215 Forbes Street, Darlinghurst. It accompanies an Environmental Impact Statement (EIS) prepared in support of State Significant Development Application SSD 8993 for the staged development of the SCECGS Darlinghurst Campus.

The State Significant Development is for:

– a Masterplan Concept Development Application for building envelopes, building locations and land uses across the campus, to guide development over the next 20 years, and;

– a Stage 1 Detailed Design Proposal for the first stage of works, comprising the replacement of Wilkinson House with a new building. Details of the project are described in the following sections.

This assessment responds to the issue raised in item 8 of the SEARs as follows:

8. Noise and Vibration

Identify and provide quantitative assessment of the main noise and vibration generation sources during construction and operation, including consideration of public address system, school bell and the use of the school hall for concerts etc. (both during and outside school hours) Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.

Relevant Policies and Guidelines:

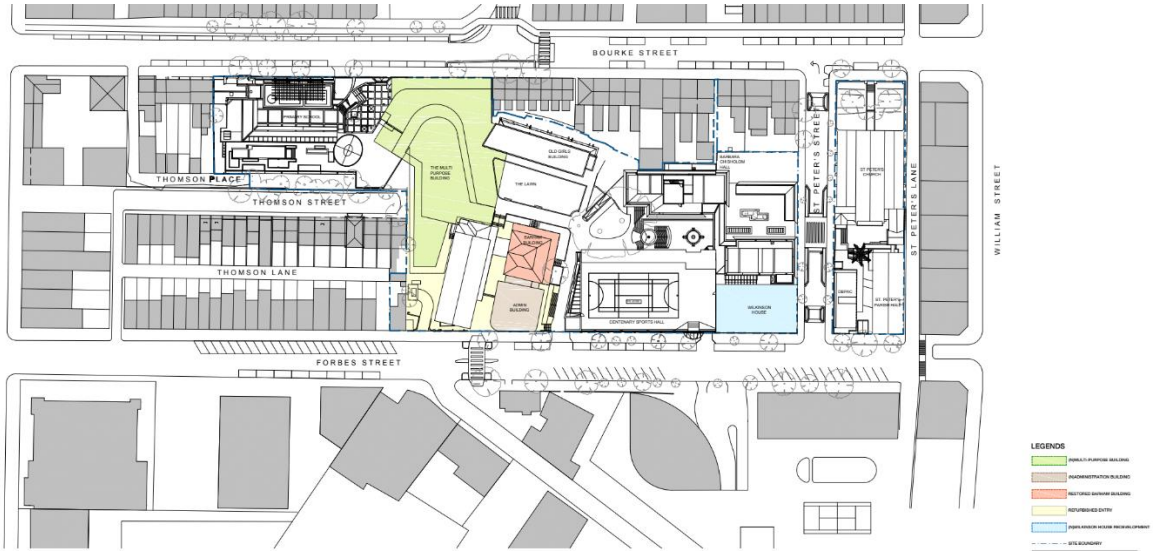
- *Noise Policy for Industry 2017 (EPA)*
- *Interim Construction Noise Guideline (DECC)*
- *Assessing Vibration: A technical Guideline 2006*
- *Development Near Rail Corridors and Busy Roads - Interim Guideline (Department of Planning 2008)*

This report consists of the original NIA that was submitted to the Department of Planning along with Appendix B which includes a response to submissions that relate to noise and vibration.

Appendix C includes a draft construction noise and vibration management plan prepared to be included in contact documentation so that specific mitigation measures can be adopted by the successful builder . This has been included as a specific request by Council and the DPIE.

Figure 1-1 shows the Masterplan site.

Figure 1-1 2040 Masterplan Site



Wilkinson House

The redevelopment of Wilkinson House will involve the demolition of the existing structure and the construction of a new building maximising the potential of the site.

The design for a new building will provide the opportunity to:

- reconfigure the planning to provide large open spaces through a more efficient location of the circulation core and the provision of a column free structure;
- align the floor levels with Joan Freeman Building;
- provide an additional floor level to the current number of levels;
- efficiently integrate services;
- improve the accessibility and amenity of the building; and
- improve security for the building.

The design is for flexible learning spaces, specialised learning areas, student facilities, and administration areas.

New Multi-Purpose Building

The design will remain as a Masterplan concept. The Masterplan will allow the school options for the final use and facilities to be provided in the building. This includes an option to provide an indoor swimming pool or to use the space for another educational use. A Child Car Centre will

form one of the uses. It is envisaged that the new multi-purpose building will be air-conditioned, and it will be designed to meet a 4-Greenstar rating or equivalent.

2 AMBINET NOISE MONITORING

2.1 Ambient Noise Levels at the Site

Residential receivers surrounding the site that may be affected by construction and operational noise have been identified in four areas and are detailed in Table 2-1 and shown in Figure 2-1.

Figure 2-1 Aerial showing Noise Monitoring Locations

Table 2-1 Surrounding Receivers

Receivers	Comments
A – Thomson Street & Lane Residences	Terrace residences
B – Bourke Street	Terrace residences and Commercial receivers
C – Forbes Street	Mix of single and multi-storey residential buildings
D – St Peters Street	Church on the opposite of St Peters Street

In order to quantify the existing noise environment, long-term ambient noise levels were monitored at two (2) locations surrounding the site, selected to cover the range of environments in the potentially affected areas.

The locations are presented in Table 2-2. The noise logger locations are shown in Figure 2-1.

Table 2-2 Long-Term Noise Monitoring Locations

Logger	Location	Monitoring Period
1	Thomson Street boundary	14 – 24 September 2018
2	Horizon Apartments Forbes Street	14 – 24 September 2018

The noise monitoring equipment used for the Wilkinson Murray noise measurements consisted of ARL Type EL-215 environmental noise loggers set to A-weighted, fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Glossary for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle. The L_{A90} level is normally taken as the background noise level during the relevant period.

Detailed results for each monitoring location are shown in graphical form in Appendix A. The graphs show measured values of L_{Aeq}, L_{A90}, L_{A10} and L_{A1} for each 15-minute monitoring period.

Table 2-3 summarises the noise results, for daytime, evening and night time periods as defined in the EPA's *Interim Construction Noise Guidelines (ICNG)* and the NSW *Noise Policy for Industry (NPfI)*.

Table 2-3 Summary of Measured Ambient Noise Levels

Noise Logging Site	RBL (dBA)				$L_{Aeq,period}$ (dBA)			
	Daytime 7am-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 8am-1pm	Daytime 7am-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 8am-1pm
1	47	45	44	47	56	52	49	57
2	50	49	47	50	55	55	53	54

Background noise levels at all locations were free of the influence of extraneous noise sources, such as plant or construction activities. Noise data measured during inclement weather was excluded in accordance with EPA procedures.

Results of noise monitoring are presented in Appendix A.

3 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

This section of the assessment relates to Stage 1 works, whereby other stages of the development will be assessed when applications are made for these works. It should be noted that the noise and vibration criteria detailed in the following sections is applicable to all stages of the Masterplan.

3.1 Construction Noise Criteria

The following sections detail the applicable site-specific noise and vibration criteria based on the EPA *Interim Construction Noise Guideline*.

3.1.1 Construction Noise Management Levels

The EPA released the *Interim Construction Noise Guideline (ICNG)* in July 2009. The guideline provides noise goals that assist in assessing the impact of construction noise.

For residences, the basic daytime construction noise goal is that the $L_{Aeq,15min}$ noise management level should not exceed the background noise by more than 10dBA. This is for standard hours: Monday to Friday 7.00am-6.00pm, and Saturday 8.00am-1.00pm. Outside the standard hours, where construction is justified, the noise management level would be background + 5dBA. Table 3-1 details the *ICNG* noise management levels.

Table 3-1 Construction Noise Management Levels at Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq,(15min)}$	How to Apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Time of Day	Management Level $L_{Aeq,(15min)}$	How to Apply
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see Section 7.2.2.

In addition, the following construction noise management levels $L_{Aeq,15\ min}$ are recommended for other receivers and areas:

- Active recreation areas (such as parks): external $L_{Aeq,15min}$ 65dBA
- Industrial premises: external $L_{Aeq,15min}$ 75dBA
- Offices, retail outlets: external $L_{Aeq,15min}$ 70dBA
- Classrooms at schools and other educational institutions: internal $L_{Aeq,15min}$ 45dBA

Based on the above, Table 3-2 presents the applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications.

Table 3-2 Site-Specific Construction Noise Management Levels

Area	Construction Noise Management Level, L_{Aeq} – dBA				Highly noise affected Noise Level, L_{Aeq} dBA
	Day	Evening	Night	Saturday*	
A – Thomson Street & Lane Residences	57	50	49	57	75
B – Bourke Street	57	50	49	57	75
C – Forbes Street	60	54	52	60	75
D – St Peters Street	60	54	52	60	75

* Standard Saturday construction hours.

3.2 Hours of Operation & Programme

The proposed working hours for this project are as follows:

- Monday to Friday 7.00am to 7.00pm
- Saturday 8.00am to 1.00pm
- Sunday and Public Holidays No work

If required, after hours permits will be sought from the relevant authorities.

3.3 Vibration Criteria

Criteria for assessment of the effects of vibration on human comfort are set out in British Standard 6472-1992. Methods and criteria in that Standard are used to set "preferred" and "maximum" vibration levels in the document *Assessing Vibration: A Technical Guideline* (2006) produced by the NSW DECCW.

Acceptable values of human exposure to continuous vibration, such as that associated with drilling, are dependent on the time of day and the activity taking place in the occupied space (e.g. workshop, office, residence, or a vibration-critical area). Guidance on preferred values for continuous vibration is set out in Table 3-3.

Table 3-3 Criteria for Exposure to Continuous Vibration

Place	Time	Peak Particle Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (e.g. hospital operating theatres precision laboratories)	Day or Night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices	Day or Night time	0.56	1.1
Workshops	Day or Night time	1.1	2.2

In the case of intermittent vibration, which is caused by plant such as rock breakers, the criteria are expressed as a Vibration Dose Value (VDV) and are presented in Table 3-4.

Table 3-4 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime		Night Time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Calculation of VDV requires knowledge of the number of events, and their duration in the relevant time period.

3.3.1 Building Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 *"Explosives – Storage and Use – Part 2: Use of Explosives"* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"*, as they "are applicable to Australian conditions".

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 3-5.

Table 3-5 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Un-reinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

The Standard states that the guide values in Table 3-5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Note that rock breaking / hammering, and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.

The British Standard goes on to state that "*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity*". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

In addition to the British Standard, for the case of nearby heritage buildings, guidance for structural damage is derived from the German Standard DIN 4150 -3 *Structural Vibration Part 3 – Effects of Vibration on Structures*. Table 3-6 details these recommendations for heritage buildings.

Figure 3-1 Graph of Transient Vibration Guide Values for Cosmetic Damage

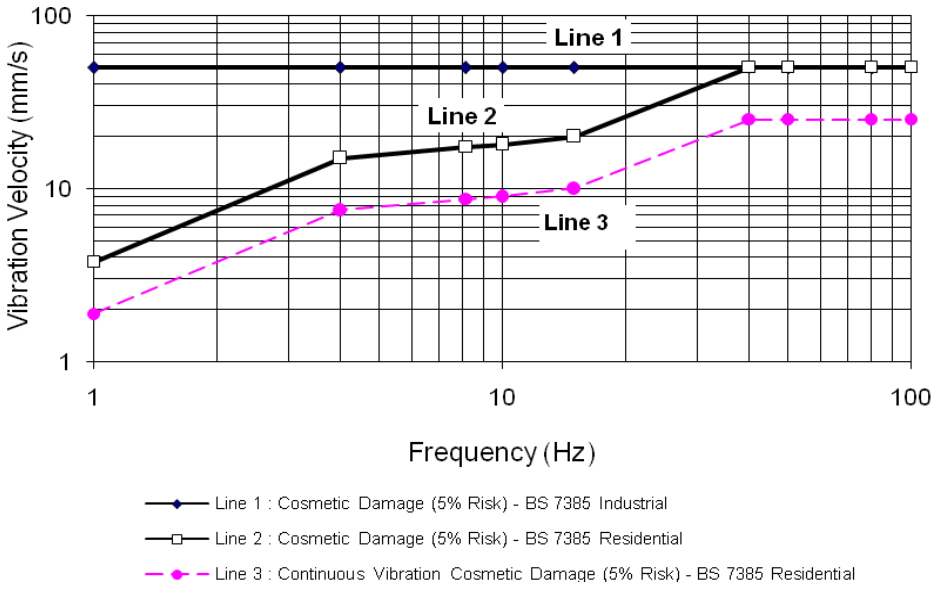


Table 3-6 DIN 4150 recommended PPV Vibration Level for Heritage Buildings

Guideline Values for Velocity – mm/s		
1-10 Hz	10 to 15 Hz	40 to 50 Hz
3	3 to 8	8-10

3.4 Construction Equipment & Noise Source Levels

Sound Power Levels (SWLs) for typical construction plant are identified in Table 3-7. These SWLs have been measured at other similar construction sites. The table gives both Sound Power Level and Sound Pressure Levels (SPL) at 7m for the equipment. Sound Power Level is independent of measurement position.

Table 3-7 Typical Construction Plant Sound Levels – dBA

Plant	Sound Power Level	Sound Pressure Level at 7m
Concrete Truck	109	84
Angle Grinder	109	84
Concrete Pump – 120 mm diameter / 50 bar	112	87
Concrete Saw	116	91
Mobile Crane	98	73
Dump Truck	108	83
Compressor	100	75
Bobcat	103	78
Hand Tools	90	65

Plant	Sound Power Level	Sound Pressure Level at 7m
Excavator	108	83
Crawler Cranes	98	73
Tower Crane	104	79
Front End Loader	112	87
Excavator	107	82
Hammer Hydraulic	122	97
Bored Pile Rig	112	87

3.5 Construction Noise Predictions

Assessment of likely construction noise at surrounding receivers has been undertaken for the proposed construction works for stage 1 works at Wilkinson House. Assessment has been based on the construction of a new school building on the Wilkinson House site.

Site-related noise emissions were modeled with the "CadnaA" noise prediction program, using the ISO 9613 noise prediction algorithms. Factors that are addressed in the noise modeling are:

- equipment sound level emissions and location;
- screening effects from buildings;
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

Modelling has been conducted for a number of construction scenarios. The three works scenarios considered are summarised in Table 3-8.

Table 3-8 Construction Scenarios for Construction Works

Scenario	Description	Works
A	Demolition	Removal of existing structure from behind the facade of the existing building using excavators fitted with jaw crushers and hammers. Truck Movements – loaded into trucks sent off site.
B	Building Construction	This scenario includes concreting and lifting. 1 concrete pump, 2 forklifts, 1 compressor, 1 crane, a boom truck and tower crane are assumed to operate in 15 minutes. Also, concrete trucks and normal delivery trucks assumed to be two movements in 15 minutes.
C	Facade / Fitout	In the event that the construction of the facade occurs in isolation. Forklift, truck, tower crane and power tools assumed. Two truck movements in 15 minutes assumed.

Noise modelling has been conducted for each of the above scenarios, with plant located across the Wilkinson House construction site.

The modelling assumes a "typical worst-case" scenario whereby all plant, is running continuously. As such, the modelling represents likely noise levels that would occur during intensive periods of construction. Therefore, the presented noise levels can be considered in the upper range of noise levels that can be expected at surrounding receivers when the various construction scenarios occur.

Once noise sources have been applied to the model, the resultant noise levels at identified surrounding receivers are predicted. These results are then compared with established site-specific noise criteria.

Table 3-9 details results of construction noise modelling for each scenario.

Table 3-9 Predicted Construction Noise Levels at Residence – $L_{Aeq(15\ min)}$ – dBA

Residential Receiver	Predicted Noise Level	NML	Exceedance
Scenario A – Demolition			
A – Thomson Street & Lane Residences	42	57	0
B – Bourke Street	51	57	0
C – Forbes Street	72	60	12
D – St Peters Street	71	60	11
Scenario B – Building Construction			
A – Thomson Street & Lane Residences	33	57	0
B – Bourke Street	51	57	0
C – Forbes Street	65	60	5
D – St Peters Street	68	60	8
Scenario C – Façade / Fitout			
A – Thomson Street & Lane Residences	27	57	0
B – Bourke Street	34	57	0
C – Forbes Street	60	60	0
D – St Peters Street	60	60	0

A review of results of construction noise indicates that these may be well above construction noise management levels at nearby residences particularly in Forbes Street (which are the residences immediately adjacent to the construction site), during demolition and construction stages.

3.6 Discussion of Results

Exceedances of noise management levels of up to 12dBA at residences to the east of the site may be expected during demolition period when major equipment is located on site. This magnitude of exceedance is consistent with similar sites where residences overlook development sites.

During the structure and fitout stages, the magnitude of exceedance will reduce due to the nature of construction activities.

Based on these findings, the adoption of reasonable and feasible noise management and mitigation will be required. These measures should be determined in detail when a contractor, with defined construction techniques, has been engaged on the project. However, "in-principle" mitigation measures are detailed in the following sections.

3.7 Construction Vibration Assessment

Operation of rock breakers and the like generate ground vibration that has the potential to transmit to nearby buildings.

Table 3-10 sets out the typical ground vibration levels at various distances for safe working distances.

Table 3-10 Recommended Safe Working Distances for Vibration Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Small Hydraulic Hammer	(300kg – 5 to 12t Excavator)	2m	7m
Medium Hydraulic Hammer	(900kg – 12 to 18t Excavator)	7m	23m
Large Hydraulic Hammer	(1600kg – 18 to 34t Excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Pile Boring	≤ 800mm	2m (nominal)	N/A
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

- Construction Noise Strategy, 2012, Transportation Construction Authority

The highest vibration levels will occur when construction equipment is located on the eastern side of the site near residences on the eastern boundary.

A review of the site plant and surrounding receivers indicates that the minimum distance between the vibration generating activities and surrounding buildings will be in the order of 10 metres. Therefore, the use of medium to large rock-breakers in the ground should be carefully managed at distances closer than 20 metres from residences.

It is recommended that trial testing of vibration levels be conducted where identified equipment having the potential to exceed the human comfort criteria is proposed.

Structural damage vibration criteria in residential buildings are much higher than human comfort criteria and predicted vibration levels are within these criteria under most circumstances. The exception, should heavy rock-breakers be used, is for areas near eastern residences on Forbes Street. Therefore, the uses of alternative excavation measures, such as rock-saws on excavators are recommended. If hammers are required, test vibration monitoring is recommended to ensure that vibration levels at residences are not excessive.

3.8 Construction Noise & Vibration Mitigation Measures

Without mitigation, noise levels from construction activities have been predicted to exceed the noise management levels nominated in the guidelines at some surrounding receivers. Therefore, noise control measures are recommended to ensure that noise is reduced where feasible.

The following project specific mitigation measures are recommended;

- Installation a 2.4 metre plywood hoarding around the construction site;
- Selection of quietest feasible construction equipment;
- Use of jaw crushers in preference to rock-breakers where feasible;
- Localised treatment such as barriers, shrouds, and the like around fixed plant such as pumps, generators, and concrete pumps; and
- Provision of respite periods.

In addition, the following measures should be included in a Noise and Vibration Management Plan.

- *Plant Noise Audit* – Noise emission levels of all critical items of mobile plant and equipment should be checked for compliance with noise limits appropriate to those items prior to the equipment going into regular service. To this end, testing should be established with the contractor.
- *Operator Instruction* – Operators should be trained in order to raise their awareness of potential noise problems and to increase their use of techniques to minimise noise emission.
- *Equipment Selection* – All fixed plant at the work sites should be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures, and other noise attenuation measures in order to ensure that the total noise emission from each work site complies with EPA guidelines.
- *Site Noise Planning* – Where practical, the layout and positioning of noise-producing plant and activities on each work site should be optimised to minimise noise emission levels.

The adoption of the above measures is aimed at working towards achieving the noise management levels established at surrounding receivers.

3.9 Community Liaison & General Approaches to Mitigation

An effective community relations programme should be put in place to keep the community that has been identified as being potentially affected appraised of progress of the works, and to forewarn potentially affected groups (e.g. by letterbox drop, meetings with surrounding owners/tenants, etc) of any anticipated changes in noise and vibration emissions prior to critical stages of the works, and to explain complaint procedures and response mechanisms. This programme should include a *Community and Stakeholder Engagement Strategy* developed specifically for the Project.

Close liaison should be maintained between the communities overlooking work sites and the parties associated with the construction works to provide effective feedback in regard to perceived emissions. In this manner, equipment selections and work activities can be coordinated where necessary to minimise disturbance to neighbouring communities, and to ensure prompt response to complaints, should they occur.

3.10 Noise & Vibration Management Plan

A Construction Noise and Vibration Management Plan for the site is recommended which should be prepared by the successful contractor. The plan should reference the findings of this assessment. Areas that should be addressed in plan include:

- noise and vibration mitigation measures;
- noise and vibration monitoring;
- response to complaints**;**
- responsibilities;
- monitoring of noise emissions from plant items;
- reporting and record keeping;
- non-compliance and corrective action; and
- community consultation and complaint handling.

3.11 Management of Construction Noise & Vibration to the School

Noise and vibration levels from construction are likely to be similar to the levels predicted for receivers immediately surrounding the site. Accordingly, measures that will be adopted to manage the school which should are detailed in a Construction Management Plan.

Measures that can be adopted to manage noise and vibration impacts at the school will be managed between the school and the successful contractor and could include:

- closing of classroom windows;
- relocating classes during busy construction periods; and
- scheduling works during school holidays.

4 OPERATIONAL NOISE & VIBRATION

Operational noise from the proposed facilities will be from activities within the new buildings as well as mechanical plant located predominantly on roofs.

4.1 Operational Noise Criteria

The NSW *NPfI* provides a framework and process for deriving noise criteria for consents and licences that enable the EPA and others to regulate premises that are scheduled under the Protection of the Environment Operations Act 1997. Whilst specifically aimed at assessment and control of noise from industrial premises regulated by the EPA, the policy is also appropriate for use by the DP&E when assessing major development proposals.

Having been designed for large industrial and agricultural sources, the monitoring and assessment procedures may not be applicable to the smaller developments and noise sources regulated by local government. It is recognised however, that Councils may find the policy to be of assistance in noise assessment and land-use planning.

The *NPfI* documents a procedure for assessment and management of industrial noise which involves the following steps:

- Determining the project noise trigger levels for a development. The project noise trigger level is a benchmark level above which noise management measures are required to be considered. They are derived by considering short-term intrusiveness due to changes in the existing noise environment (applicable to residential receivers only) and maintaining noise level amenity for particular land uses for residents and other sensitive receivers;
- Predicting or measuring noise produced by the development (having regard to any associated annoying characteristics and prevailing meteorological effects);
- Comparing the predicted or measured noise level with the project noise trigger level and assessing impacts and the need for noise mitigation and management measures;
- Considering any residual noise impacts following the application of feasible and reasonable noise mitigation measures;
- Setting statutory compliance levels that reflect the best achievable and agreed noise limits for development; and
- Monitoring and reporting environmental noise levels from the development.

The project noise trigger level represents the level that, if exceeded, may indicate a potential noise impact upon a community. It is a benchmark or objective and is not intended for use as a mandatory requirement.

Intrusiveness Noise Level

For assessing intrusiveness, the background noise level (L_{A90}) is measured and the Rating Background Level (RBL) determined. The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous noise level (L_{Aeq}) of the source (measured over a 15-minute period) does not exceed the background noise level (RBL) by more than 5dBA.

Amenity Noise Level

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include transportation noise (when on public transport corridors), noise from motor sport, construction noise, community noise, blasting, shooting ranges, occupational workplace noise, wind farms, amplified music/patron noise.

The amenity noise level aims to limit continuing increases in noise levels which may occur if the intrusiveness level alone is applied to successive development within an area.

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

To prevent increases in industrial noise due to the cumulative effect of several developments, the project amenity noise level for each new source of industrial noise is set at 5dBA below the recommended amenity nose level.

The following exceptions apply to determining the project amenity noise level:

- For high-traffic areas the amenity criterion for industrial noise becomes the $L_{Aeq,period(traffic)}$ minus 15dBA.
- In proposed developments in major industrial clusters.
- If the resulting project amenity noise level is 10dB or lower than the existing industrial noise level, the project amenity noise level can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a consideration because no other industries are present in, or likely to be introduced into the area, the relevant amenity noise level is assigned as the project amenity noise level for the development.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess mitigation options and determine achievable noise requirements.

An extract from the NSW *NPfI* that relates to the amenity noise levels for surrounding receivers is given in Table 4-1.

Table 4-1 Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level L_{Aeq} (dBA)
Residence	Suburban	Day	55
		Evening	45
		Night	40

Note 1: Daytime 7.00am–6.00pm; Evening 6.00pm–10.00pm; Night 10.00pm-7.00am.

Maximum Noise Level Events

Noise sources of short duration and high level that may cause disturbance to sleep if occurring during the night time need to be considered.

The approach recommended by the *NPfI* is to apply the following initial screening noise levels:

- $L_{Aeq,15min}$ 40dBA or the prevailing RBL + 5dB, whichever is the greater; and/or
- L_{AFmax} 52dBA or the prevailing RBL + 15dB, whichever is the greater.

The sleep disturbance screening noise levels apply outside bedroom windows during the night time period.

Where the screening noise levels cannot be met, a detailed maximum noise level event assessment should be undertaken. It may also be appropriate to consider other guidelines including the NSW *Road Noise Policy (RNP)* which contains additional guidance relating to potential sleep disturbance impacts.

A review of research on sleep disturbance in the *RNP* indicates that in some circumstances, higher noise levels may occur without significant sleep disturbance. Based on currently available research results, the *RNP* concludes that:

- "Maximum internal noise levels below 50dBA to 55dBA are unlikely to cause awakening reactions."
- "One or two noise events per night, with maximum internal noise levels of 65dBA to 70dBA, are not likely to affect health and wellbeing significantly."

4.2 Project Noise Trigger Levels

The amenity and intrusiveness noise levels and resulting project trigger levels (shown in **bold**) applicable to sources of continuous operational noise associated with the project (i.e. mechanical plant and equipment) are shown in Table 4 2.

Table 4-2 Project Noise Trigger Levels

Receiver	Period	Intrusiveness Noise Level[1] $L_{Aeq,15min}$ (dBA)	Project Amenity Noise Level[2] $L_{Aeq,15min}$ (dBA)
A – Thomson Street & Lane Residences	Day	**52**	58
	Evening	50	**48**
	Night	49	**43**
B – Bourke Street	Day	**52**	58
	Evening	50	**48**
	Night	49	**43**
C – Forbes Street	Day	**55**	58
	Evening	54	**48**
	Night	52	**43**
D – St Peters Street	Day	**55**	58
	Evening	54	**48**
	Night	52	**43**

Note 1: Intrusiveness noise level is $L_{Aeq,15min} \leq$ RBL +5. Minumum background is 35dBA in the day period whilst the minimum background in the evening and night is 30dBA.
Note 2: Project amenity noise level (ANL) is suburban ANL minus 5dBA plus 3dBA to convert from a period level to a 15-minute level.

For maximum noise level events (night time period only), the following screening noise levels apply.

Table 4-3 Sleep Disturbance Trigger Levels

Receiver	$L_{Aeq,15min}$	L_{AFmax}
A – Thomson Street & Lane Residences	49	59
B – Bourke Street	49	59
C – Forbes Street	52	52
D – St Peters Street	52	52

4.3 Mechanical Services

The major mechanical noise sources associated with the development will be exhaust fans and plant that will be located on the roof of the new buildings. These will consist of roof mounted condensers or plant that have yet to be determined.

Noise from most major plant, such fan coil units and pumps will be contained by the building structure. Therefore, it is the roof condensers and air handling units that may require noise mitigation to achieve the established site-specific noise criteria at surrounding receivers.

Detailed specifications of mechanical services equipment that would otherwise allow an acoustic assessment of noise emissions from the site are not available at this stage of the project as selection and design is conducted after project approval.

In line with the approvals for other developments, detailed assessment of operational noise emission should form a conditional requirement of the development, to be satisfied to the PCA, prior to the issue of the construction certificate.

To mitigate noise from mechanical plant, it is likely the some or all of the following noise control measures may need to be adopted at the design stage to meet noise objectives:

- Silencers on carpark and other fans,
- Acoustic louvres,
- Noise barriers, and;
- Variable speed controls on condenser fans.

The mechanical plant will be designed to meet the criteria presented in Table 4-3 at the identified nearby receivers.

4.4 Wilkinson Building Noise Emissions

The proposed use of the Wilkinson Building is for classes and, as such, noise generated within this area is expected to be general classroom noise which will be adequately contained by the facade of the building.

No special measures are required to protect the acoustic amenity of nearby residents.

4.5 New Multi-Purpose Building

The new multi-purpose building that will be subject to a separate project application in the future, will at times, generate significant internal noise levels due to sports and musical events. Therefore, adequate control of noise breakout will be required. Measures that will be adopted to ensure that compliance with established noise criteria include:

- Ceiling and wall treatments to improve the sound isolation of these elements;
- Laminated or double glazing of doors and windows;
- Acoustic treatment of mechanical services; and
- Sound system design and installation of sound limiters where deemed necessary.

Given that the design of the multi-purpose building has not been developed in any detail, the exact nature of these treatments cannot be specified, suffice to say that noise criteria has been established for the development, consistent with the SEARs, and can be adequately addressed at the appropriate point in time.

4.6 New Administration Building & Restoration of Barham

Noise generated by activities in these areas will be acoustically insignificant. Any noise will be contained within the facade of the buildings.

4.7 School Announcements & Bells

Announcements and school bells are typical activities associated with school operations. Typically, these are produced by the school PA system and can vary significantly depending on the final volume settings of the system.

At this stage, no design of the PA system has been determined. However, the following measures should be adopted to ensure that their impact at all surrounding residences is minimised:

- Speakers should be located and orientated to provide good coverage of the school areas whilst being directed away from residences. The coverage of the system should be subject of the detail design of the system.
- The volume of the system should be adjusted on site so that announcements and bells are clearly audible on the school site without being excessive. The system should initially be set so that noise at surrounding residences does not exceed the ambient noise levels by more than 5dBA.
- Once the appropriate level has been determined on site, the system should be limited to the acceptable level so that staff cannot increase noise levels.

The system bell should be set so that it only occurs on school days.

5 SUMMARY OF RECOMMENDATIONS

Based on Wilkinson Murray's acoustic assessment of the project, the following findings have been determined.

5.1 Construction Noise

Noise objectives for construction have been established based on EPA guidelines. The noise management levels should be adopted as objectives to work toward in minimising any noise impact at surrounding residences.

Table 5-1 presents applicable noise management levels at residential receivers in the vicinity of the site.

Table 5-1 Site-Specific Construction Noise Management Levels – dBA

Area	Construction Noise Management Level, L_{Aeq} – dBA				Highly noise affected Noise Level, L_{Aeq} dBA
	Day	Evening	Night	Saturday*	
A – Thomson Street & Lane Residences	57	50	49	57	75
B – Bourke Street	57	50	49	57	75
C – Forbes Street	60	54	52	60	75
D – St Peters Street	60	54	52	60	75

* 8.00am to 1.00pm.

It has been determined that noise from construction activities for the construction of Stage 1 (Wilkinson House) during the day period will potentially exceed established construction noise management levels. Therefore, the planning and management of construction activities must consider the sensitivities of surrounding residents so as to minimise the impact of construction activities at these receivers.

The control of construction noise and vibration should be addressed in a Noise & Vibration Management Plan developed when the successful contractor has been appointed for the project.

The following project-specific mitigation measures are recommended:

- Selection of quietest feasible construction equipment;
- A 2.4m plywood hoarding around the construction site and between the Healy Gym site and western residences;
- Use of jaw crushers or smaller rock breakers where feasible;
- Localised treatment, such as barriers, shrouds, and the like around fixed plant, such as pumps, generators, and concrete pumps; and
- Provision of respite periods, particularly on Saturdays.

5.2 Operational Noise

Site-specific noise criteria for the development have been established based on the lower of intrusive and amenity noise criteria.

The applicable operational noise levels at residential and commercial receivers in the vicinity of the site are presented in Table 5-2.

Table 5-2 Project Noise Trigger Levels – dBA

Receiver	Period	Intrusiveness Noise Level[1] $L_{Aeq,15min}$ (dBA)	Project Amenity Noise Level[2] $L_{Aeq,15min}$ (dBA)
A – Thomson Street & Lane Residences	Day	52	58
	Evening	50	48
	Night	49	43
B – Bourke Street	Day	52	58
	Evening	50	48
	Night	49	43
C – Forbes Street	Day	55	58
	Evening	54	48
	Night	52	43
D – St Peters Street	Day	55	58
	Evening	54	48
	Night	52	43

Note 1: Intrusiveness noise level is $L_{Aeq,15min} \leq$ RBL +5dBA. Minumum background is 35dBA in the day period whilst the minimum background in the evening and night is 30dBA.

Mechanical plant, such as rooftop exhausts and major plant associated with the development should be assessed at the time of detailed design and selection, having regard to nearby residential and commercial properties surrounding the development, and to future uses in the school area.

To mitigate noise from mechanical plant, silencers could be incorporated in the outlets of the exhaust fans. Silencers can be installed to the fans if required. The mechanical plant noise emission would be designed to meet the criteria present in Table 5-2 at the closest receivers.

Noise from Wilkinson House, the New Administration Building and restoration of Barham will not be acoustically significant and will be adequately contained by the building facade.

In the case of the proposed multi-function hall, noise will need to be contained by appropriate design of the facade and roof. Given that the design of the multi-purpose building has not been developed in any detail the exact nature of these treatments cannot be specified suffice to say that noise criteria has been established for the development, consistent with the SEARs, and can be adequately addressed at the appropriate point in time.

Noise from bells and announcements will be managed by design and adjustment techniques.

6 CONCLUSION

A construction and operational noise and vibration assessment of SCEGGS Darlinghurst Masterplan and Stage 1 (Wilkinson House) development has been conducted. Site-specific noise criteria that are applicable to this project have been presented.

A noise assessment has been conducted for the proposed construction activities associated with the Stage 1 development to determine the potential for noise and vibration impact at surrounding receivers. Exceedances of noise management levels are expected at surrounding receivers to the east of construction site on Forbes Street.

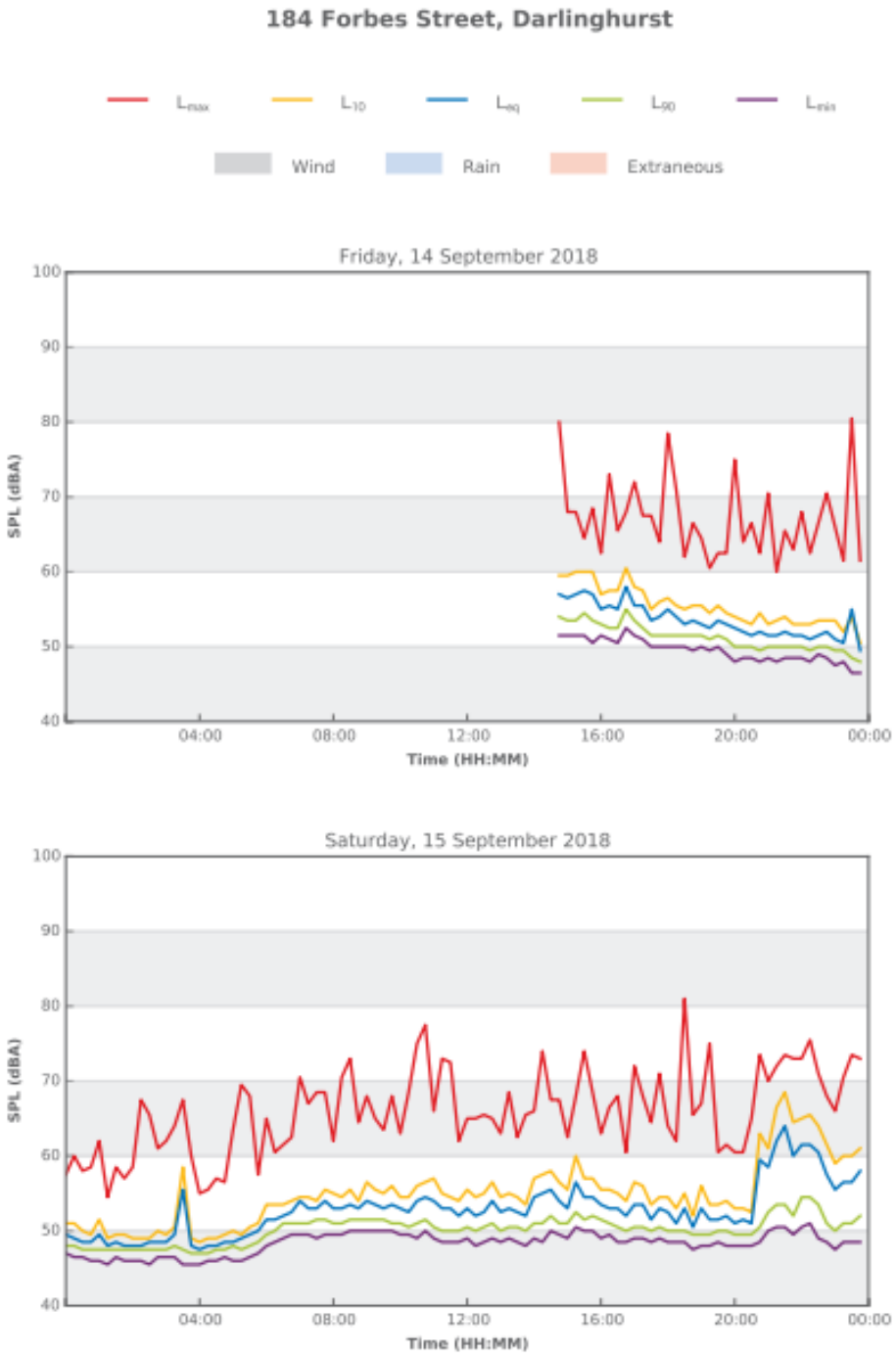
Vibration associated with on-site construction activities is unlikely to impact on surrounding receivers. Accordingly, management of noise from construction activities should be included in the Site Construction Environmental Management Plan.

Site-specific operational noise criteria have been determined for the project based on ambient noise monitoring. A review of likely major plant indicates that noise levels can comply with established noise criteria during proposed operation with the inclusion of acoustic treatment. A review of all plant with respect to site-specific noise criteria is required at detailed design stage.

Noise emissions from the proposed new multi-purpose building will be designed to achieve the site-specific assessment criteria under operation. Noise from other facilities associated with the Masterplan will be contained by standard facade design.

APPENDIX A

NOISE MEASUREMENT RESULTS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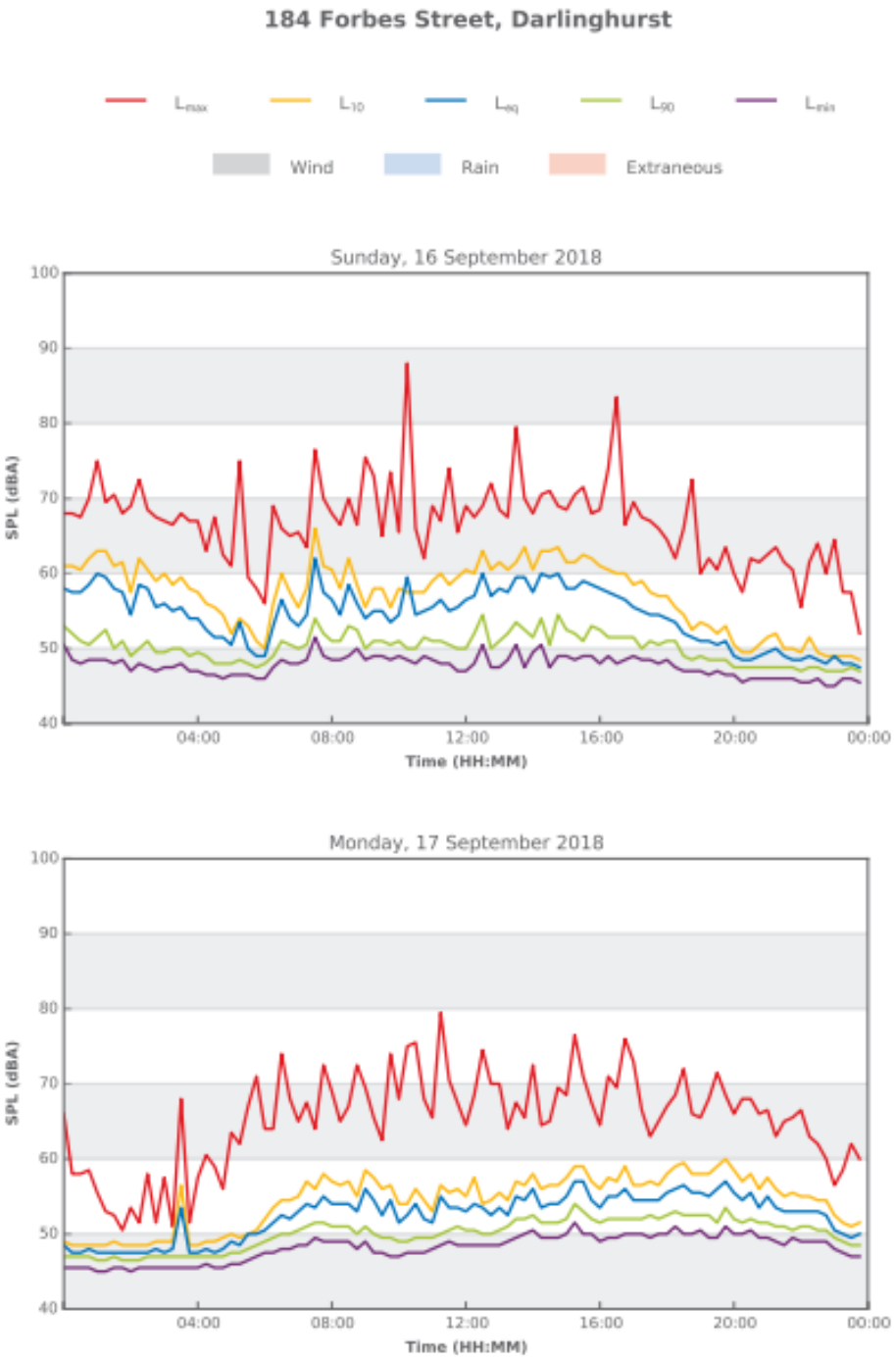
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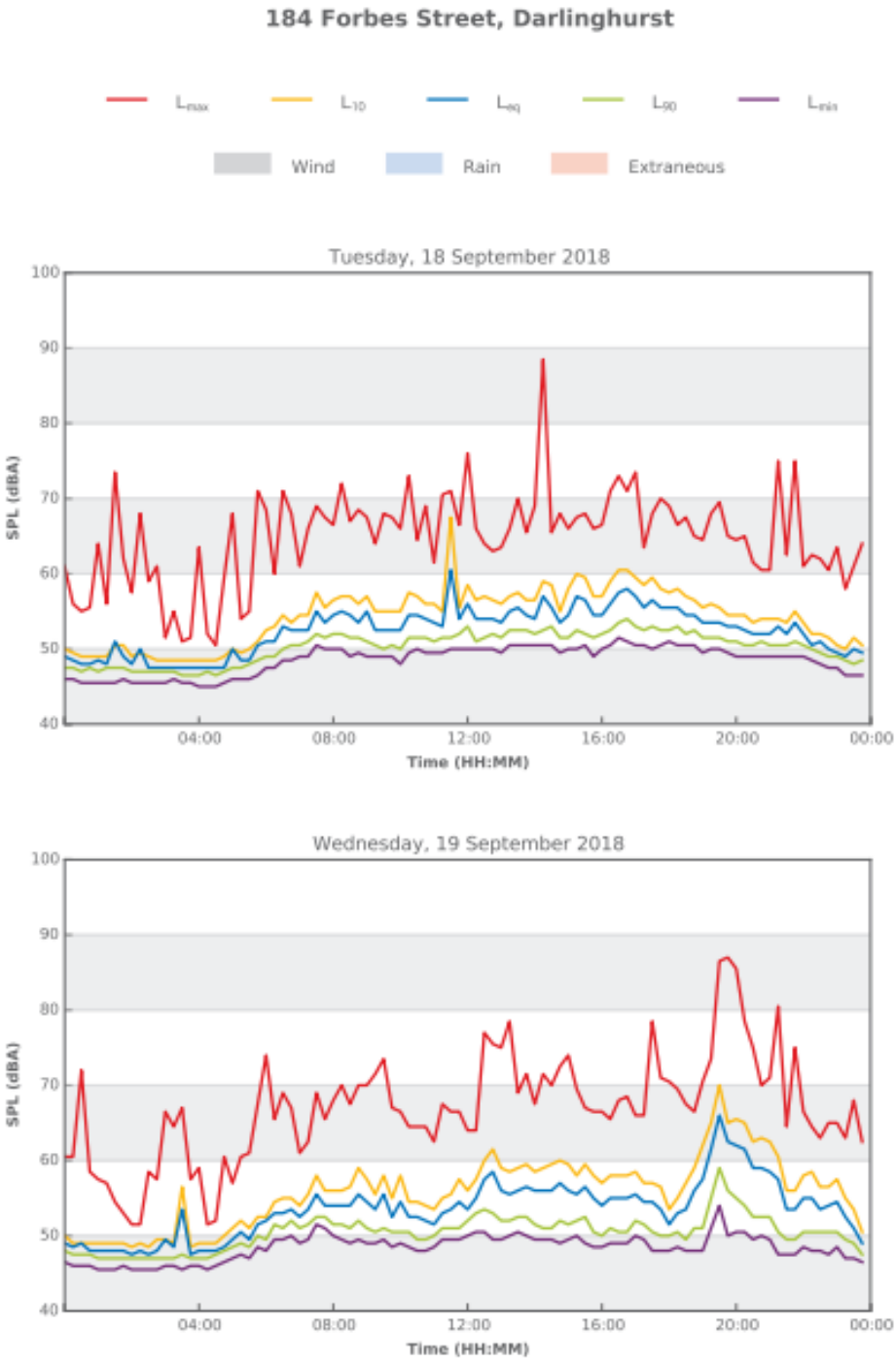
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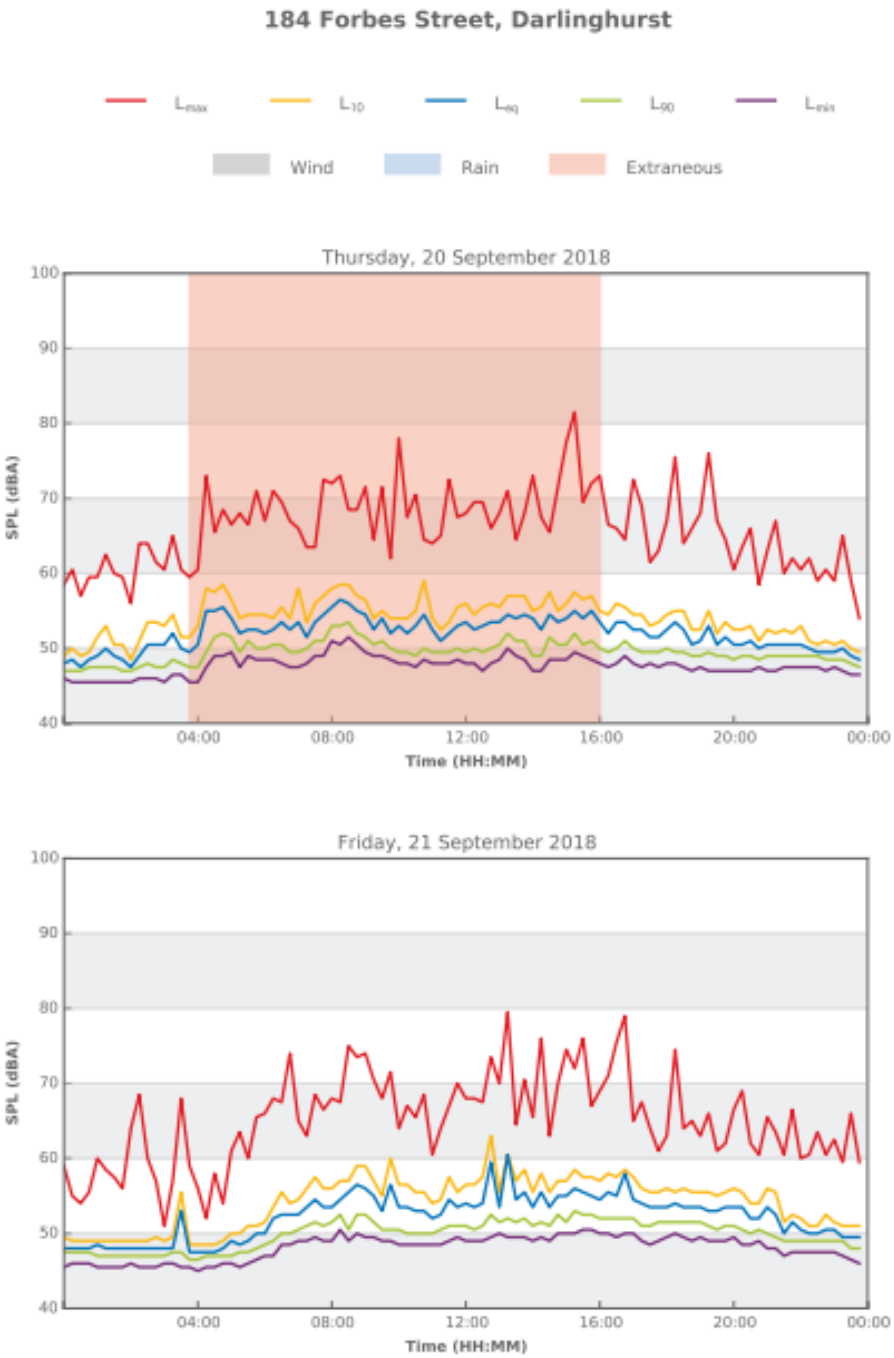
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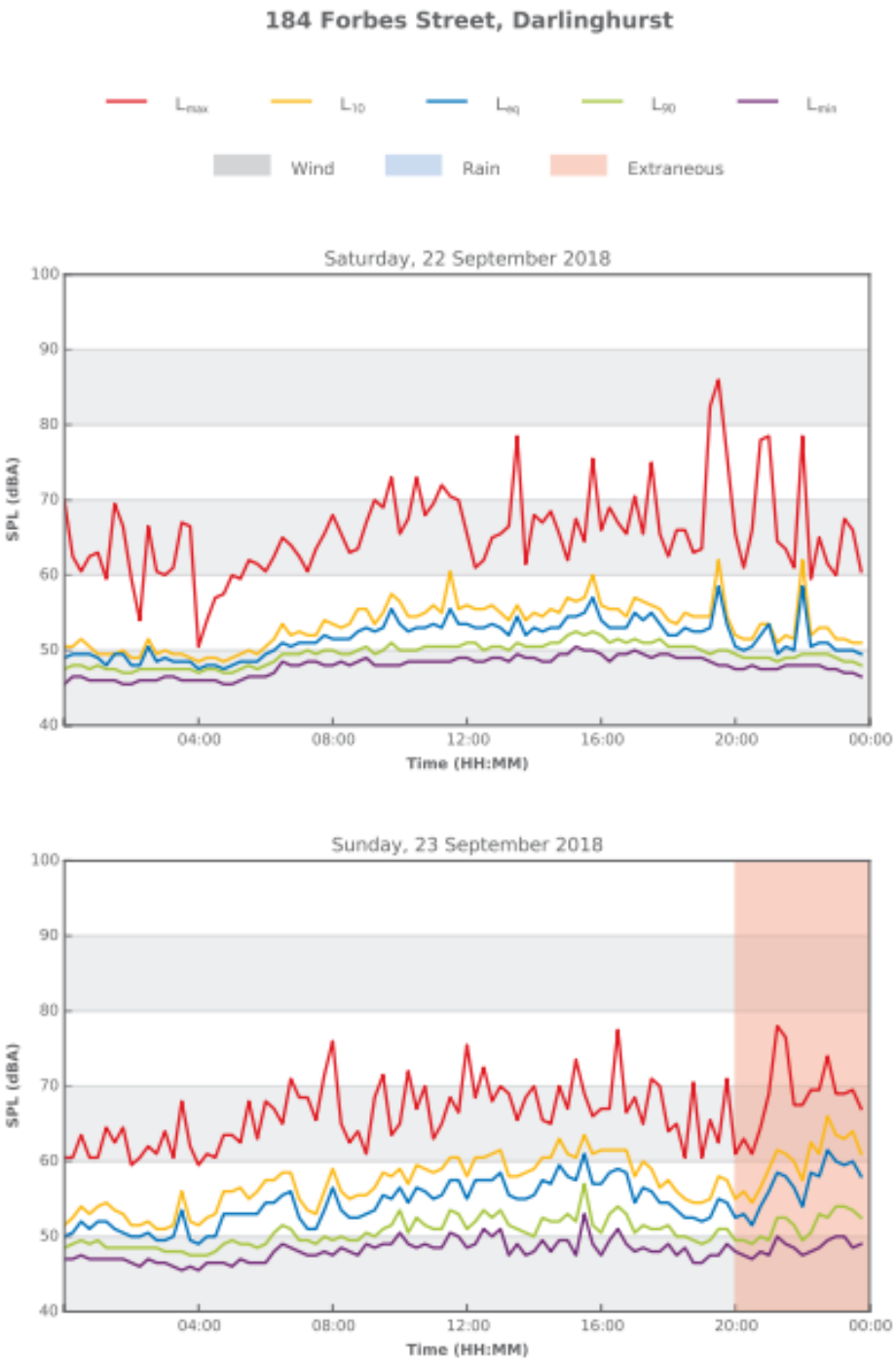
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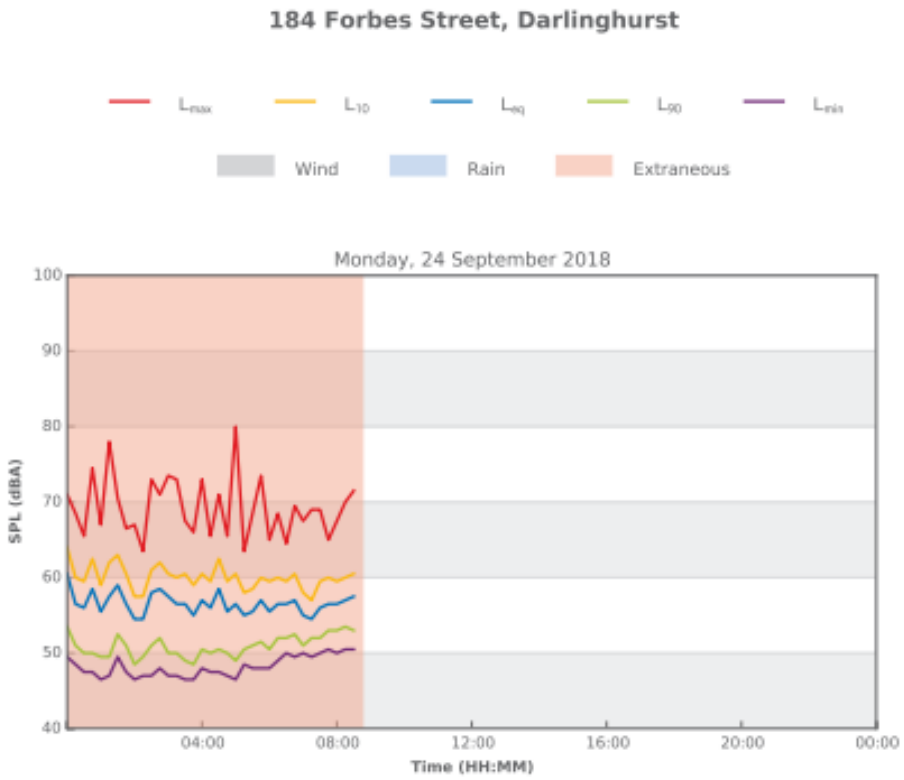
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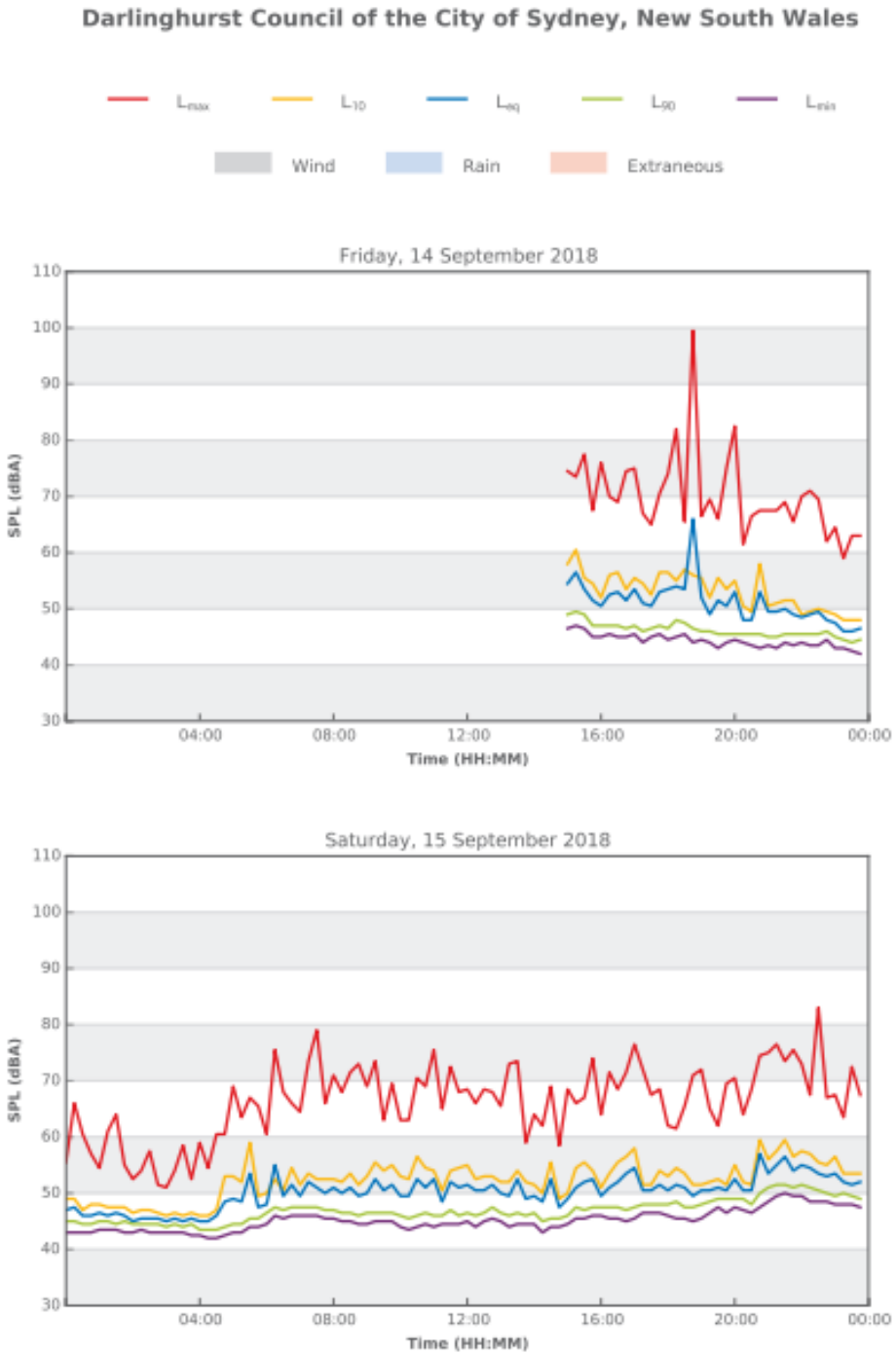
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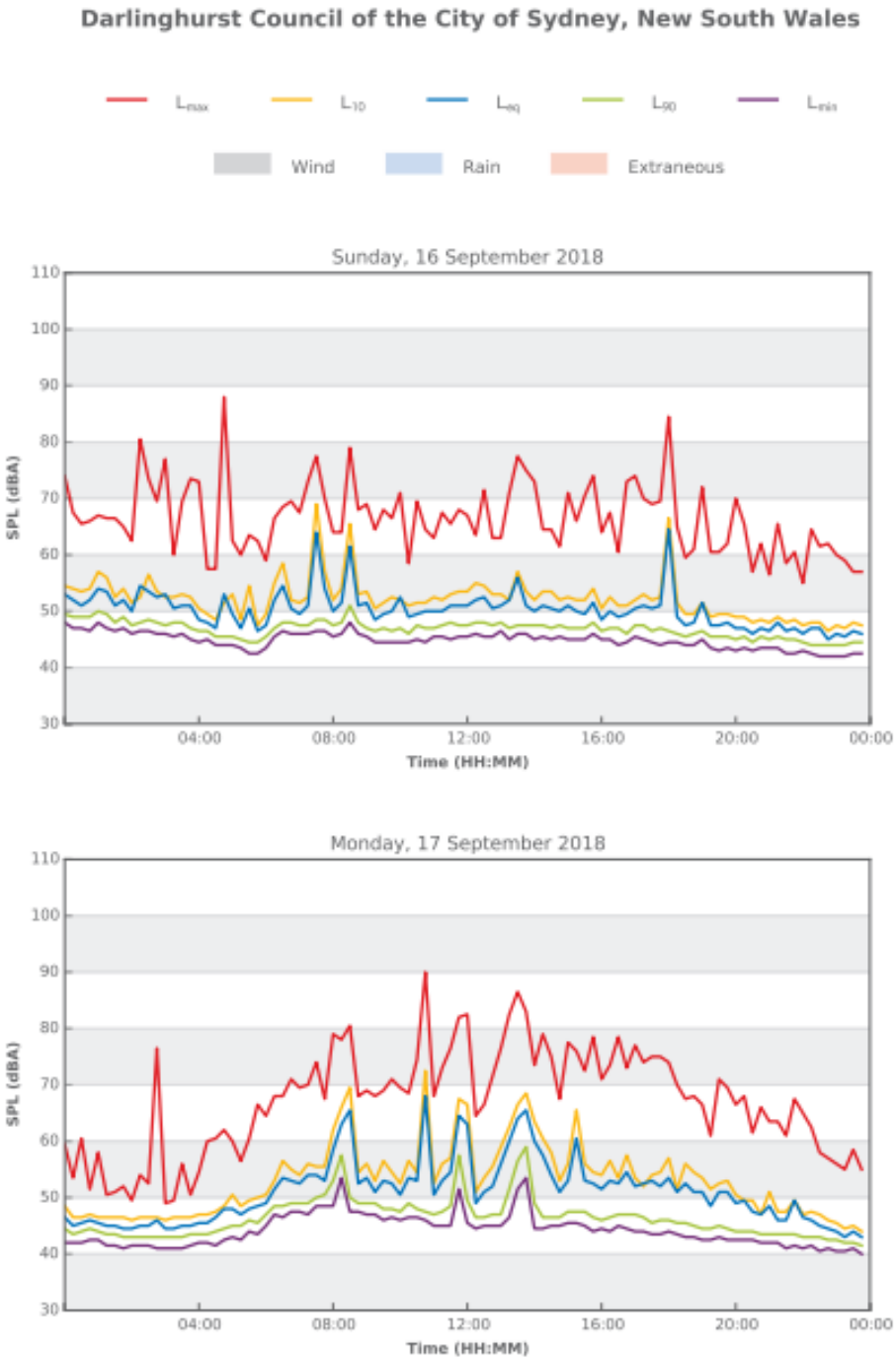
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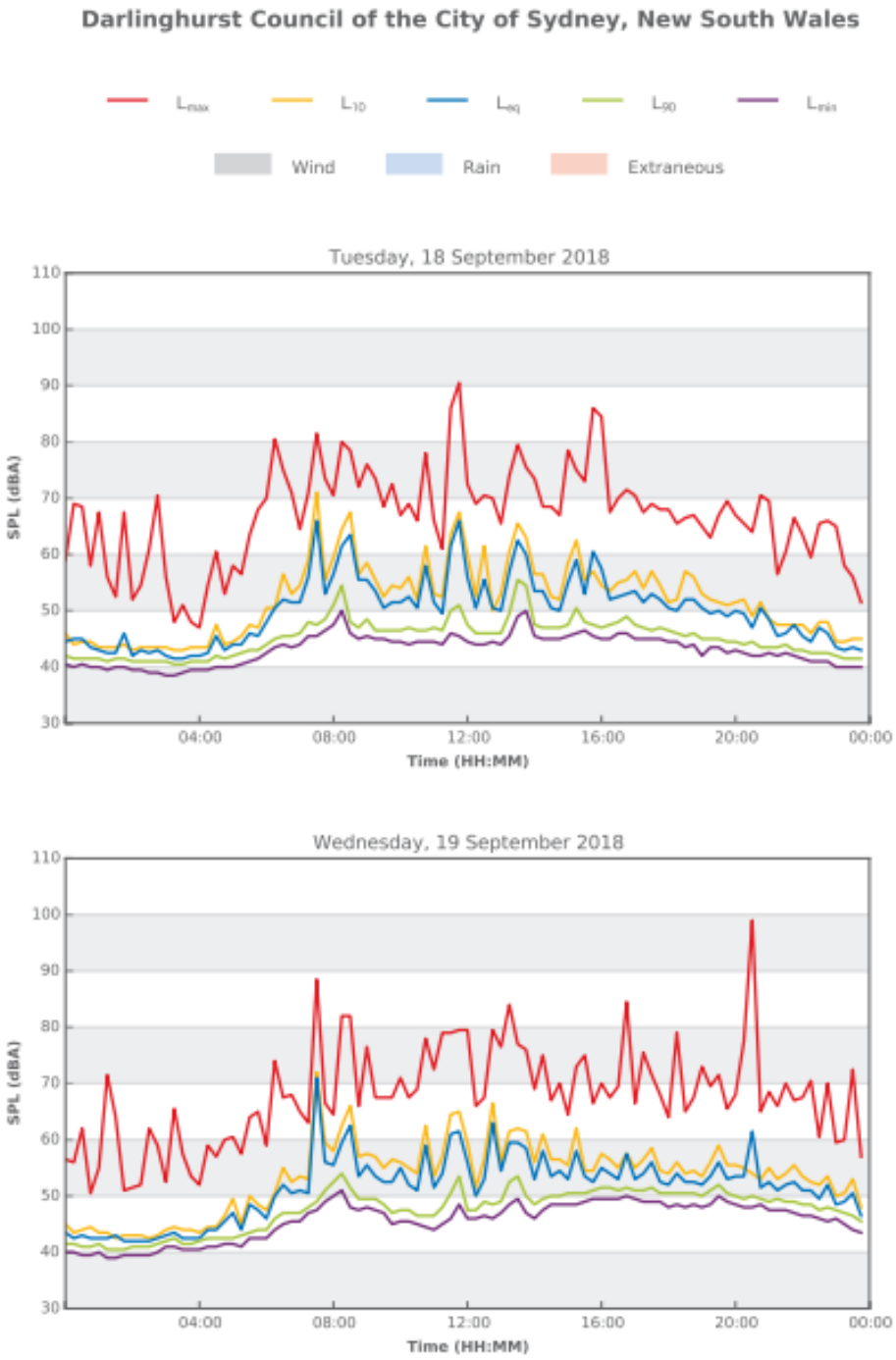
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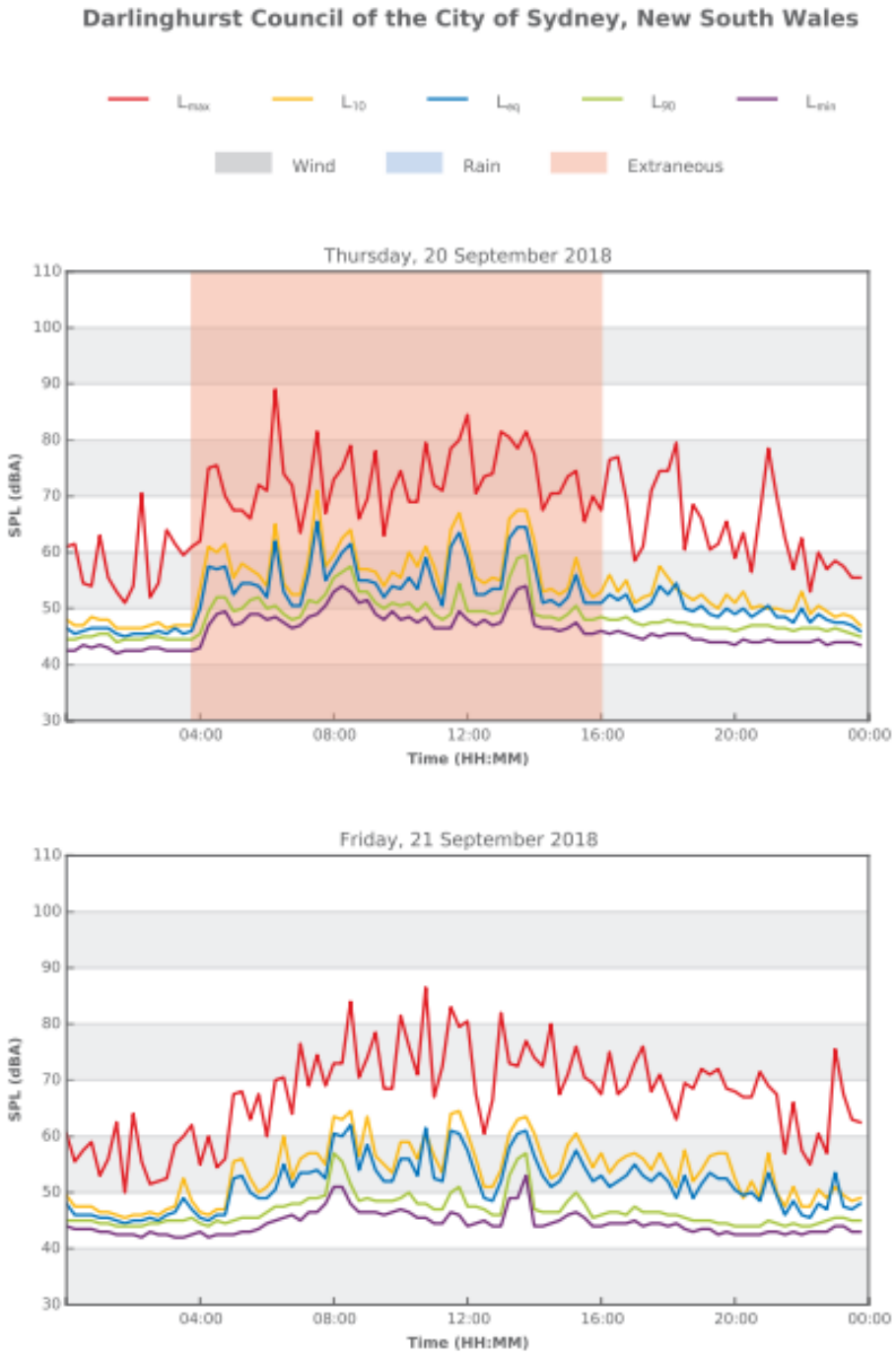
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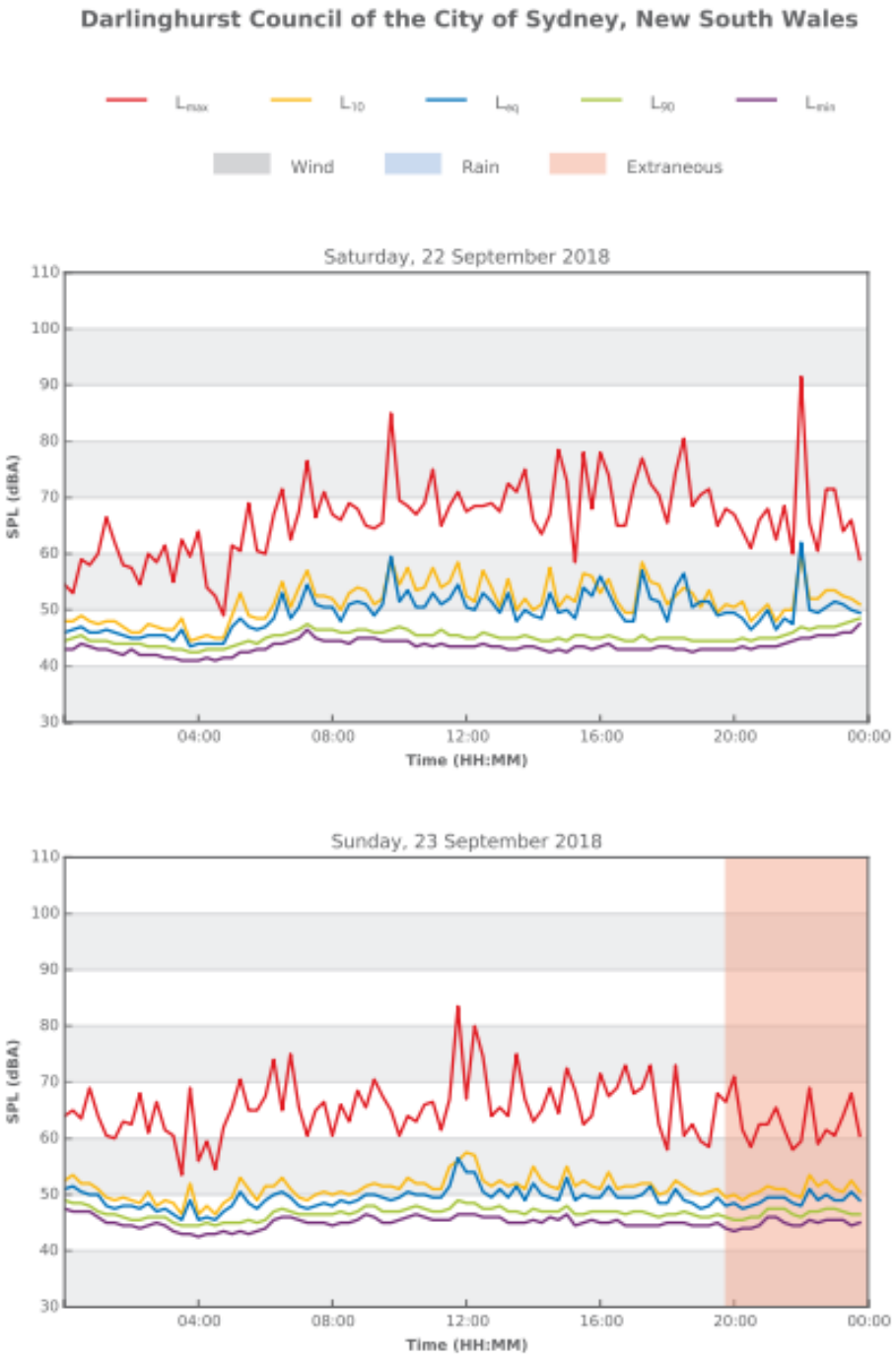
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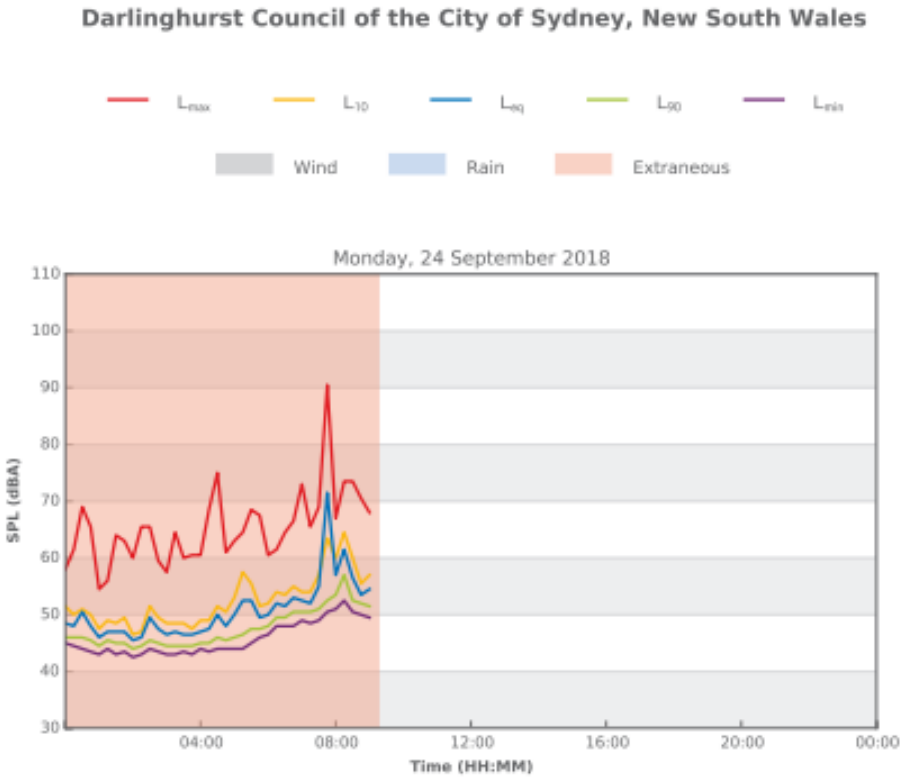
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APPENDIX B

RESPONSE TO SUBMISSIONS

The following items relate to issues regarding noise and vibration in the Project Application noise and vibration assessment. It should be noted that the description of operations contained in this report is not comprehensive whereby the assessment utilised descriptions contained in the EIS that accompanied the application.

As such, items that have been raised in submissions that were not deemed "acoustically significant" were not been included in in the initial report.

Item 1 – Construction Noise and Vibration Assessment.

Sydney City Council has raised the following:

Wilkinson House building is proposed to be demolished as part of this application, with noise management levels predicted to exceed the noise criteria by up to 12dB (i.e. background noise level +22dB.) An updated acoustic report should be provided that includes site-specific noise mitigation measures. If major exceedances are still predicted, alternative demolition methodologies need to be considered to ensure that all reasonable and feasible measures to reduce the noise level are fully explored.

Generic recommendations are inadequate. In addition, adequate respite periods must be nominated.

The Department should also ensure that a Construction Noise and Vibration Management Plan is submitted for approval prior to any construction certificate or demolition works commencing at Wilkinson House.

Response

A preliminary assessment of potential construction noise and vibration has been conducted to determine the likely impact on surrounding noise sensitive receivers. The predictions are based on indicative likely construction methods as the actual contractor will not be engaged until the project is approved and designed. At such time, the exact construction methodology will be known and therefore can be assessed, which is normal practice.

Site-specific Noise Management Levels have been established based on noise monitoring which are not noise criteria but rather objectives to work towards where reasonable and feasible measures can be adopted.

The DA report conducted an assessment of likely impacts from noise and vibration whereby the magnitude of predicted noise levels, which are typical worst case levels, are not unusual in the context of the Sydney Area. As such, measures to reduce impacts on surrounding receivers have been identified.

Consistent with the EPA's Interim Construction Noise Guideline noise mitigation measures have been recommended to be adopted where "reasonable and feasible". These have been included in the draft noise and vibration management plan in Appendix C.

Typically, where construction noise and vibration has been identified as an issue to manage, the project is conditioned so that a specific noise and vibration management plan is prepared prior to issue of the Construction Certificate. As specific equipment and program will not be know at this time, appropriate site-specific noise mitigation measures, including the need for respite can be determined.

As previously indicated the Draft Construction Noise and Vibration Management Plan can be

utilised in addressing Council's concerns and managing noise and vibration associated with construction.

Given that the assessment has been based on the EPA policy it is recommended that the hours are consistent with EPA guidelines being:

- Monday to Friday 7.00am to 6.00pm
- Saturday 8.00am to 1.00pm
- Sunday and Public Holidays No work

This compares with council's recommended hours of 7.30am and 5.30pm Monday to Friday and 7.30am to 3.30pm on Saturday.

Item 2 – Noise from Students

One respondent raised the issue of noise from Students during sport and lunchtime. This indicates that student noise from outside areas is an issue to at least one respondent.

Response:

There is no proposed increase in the Student population, apart from the potential Childcare Area which is discussed in further sections. As such, no increase in noise associated with students can be expected.

Item 3 – Mechanical Services Noise Emissions

Rooftop air-conditioning and other services should be silenced.

Response:

Site-specific noise criteria for emissions from the site have been established based on site noise logging. All new mechanical plant will be silenced where necessary to meet the established noise criteria. Measures such as silencers, lined duct and barriers will be determined when the detailed design and selection of plant is know, as is standard practice.

Item 4- Multi-Purpose Building

No indication of the future use of the multi-purpose building so impacts of future noise have not been assessed or considered.

Response

The future use of the multi-purpose building will be confirmed as part of a subsequent detailed DA for it's construction, operation, and fit out of the building. However, it could accommodate an information and research centre (contemporary library), early learning centre (maximum 45 children), classrooms and general learning areas / meeting rooms.

It is noted that the above activities are not what can be classified as "acoustically significant" activities that could not be contained within the fabric of a future building. This fact and the fact that a separate DA will be submitted when detailed uses are known will ensure that noise emissions from the facility will not adversely impact on surrounding residences.

The only noise source associated with the building will be mechanical plant that would be subject to the same conditions as mentioned earlier and would be controlled using standard engineering

noise control.

It is noted that an early learning centre with up to 45 children is one of the likely uses. Whilst details of the exact configuration of this area has yet to be defined it is likely that any outdoor play area noise to be located on the northern side of the new building will be contained by surrounding school buildings.

Should an outdoor play area be located on the southern side of the new multi-purpose building resultant noise levels of 50dBA can be expected at Terraces on Thomson Street. This assumes 30 children aged between 3 and 6 playing in an eastern area at any one time (Sound Power Level of 90dBA), distance attenuation and shielding by a boundary fence. This compares to a daytime noise criterion of 52 dBA at these residences.

Therefore, it can be concluded that the operation of the multi-purpose building is unlikely to adversely impact on surrounding residents noting that a project specific assessment of operation will be submitted when the Development Application for this stage is submitted.

Item 5 – Rooftop After Hours Activities on Rooftop Level

Rooftop level on the proposed multi-purpose building could be utilised for after school hour activities which may have noise impacts to the surrounding properties.

Response:

A review of the EIS indicates that there is no proposal for the use of the rooftop level of the multi-purpose building for after hour functions. None the less, we have conducted a preliminary assessment of noise emissions based on a scenario that up to 100 persons are located on the roof up to 10.00pm.

Based on a sound power of 90 persons speaking on the roof terrace (Sound Power Level of 96dBA) and distance of 15 metres to Thomson Street residences a resultant noise level of 53dBA is predicted. This compares to an established evening criterion of 48dBA.

Therefore, if the roof terrace were to be used for after-hours functions, additional measures such as a southern acoustic screen would be required to protect the amenity of nearby residences. Such a measure could be included in any future development application should the roof terrace use be proposed.

It is noted the above calculation has been provided to demonstrate acoustic feasibility should the roof terrace, in future, be proposed for after school functions. Such as use is not proposed in the current application.

Item 6 – Number of Students

Acoustic Impact Report does not make any reference to the number of students.

Response:

A review of the EIS indicates that "The proposed Concept and Detailed DA does not include an increase in the population of staff or students". As there is no change in students, there will be no acoustic change in student noise levels.

Item 7 Dirt and noise for an extended period of time will impact work, home, quality of life and health

Response:

Noise from construction sites across the city do have some impact on surrounding receivers. As such a quantitative preliminary assessment of construction noise has been conducted in accordance with the EPA's Interim Construction Noise Guideline.

The assessment has identified exceedances of Noise Management Objectives which is consistent with most construction site in the Sydney City Area. The potential noise producing activities have been reviewed and measures to minimise the impact at surrounding residences have been identified. These consist of physical (barriers) and procedural (Community Consultation and Standard Hours of Operation) measures that have been included in the assessment.

In addition a draft Noise and Vibration Management Plan has been included in this response to be used by the successful contractor to identify risks, determine mitigation and monitor noise and vibration so that impacts are minimised at surrounding receivers.

It is important to note that the exact methods of construction are not known until a successful contractor has been engaged following tender of the project. At that time the details of noise and vibration management can be clearly defined and managed. This is consistent will all large construction projects.

APPENDIX C

DRAFT CONSTRUCTION NOISE & VIBRATION MANAGEMENT PLAN

The following draft construction noise and vibration management plan has been prepared to be included in Tender documenation to ensure that noise and vibration from construction activities in Stage 1 of the project are appropriatly managed. This plan should be finalised by the sucessful contractor taking into account, conditions of consent, the recommended noise mitigation measures, noise management levels and vibration objectives contained in the Plan.

In addition the plan should be prepared to compliment and be consistent with the SCEGGS Preliminary Construction Management Plan dated 26 November 2018 prepared by Tracey Brunstrom & Hammond.

1 INTRODUCTION

The Contractor xxx Pty Ltd proposes the replacement of Wilkinson House with a new building. The development was approved State Significant Development Application SSD 8993. The Approval Conditions require preparation of a Construction Noise and Vibration Management Plan (CNVMP).

This document is the draft CNVMP and addresses all conditions relating to construction noise and vibration. The contents of this plan are to be reviewed by the successful contractor and incorporated where appropriate into site management procedures.

The site location is shown in Figure 1-1. The proposal includes: (To be modified as required by the contractor).

- Demolition of Wilkinson House;
- Building Construction; and
- Facade Installation.

2 SENSITIVE NOISE RECEIVERS

The locations of noise sensitive receivers are listed in Table 1-1 and shown in Figure 1-1.

Table 1-1 Noise Sensitive Receivers

Receivers	Comments
A – Thomson Street & Lane Residences	Terrace residences
B – Bourke Street	Terrace residences and Commercial receivers
C – Forbes Street	Mix of single and multi-storey residential buildings
D – St Peters Street	Church on the opposite of St Peters Street

Figure 1-1 Noise Sensitive Receivers

3 NOISE MANAGEMENT LEVELS

Construction Noise Management Levels, based on ambient noise logging, are detailed in the following table.

Table 3-1 Site-Specific Construction Noise Management Levels

Area	Construction Noise Management Level, L_{Aeq} – dBA				Highly noise affected Noise Level, L_{Aeq} dBA
	Day	Evening	Night	Saturday*	
A – Thomson Street & Lane Residences	57	50	49	57	75
B – Bourke Street	57	50	49	57	75
C – Forbes Street	60	54	52	60	75
D – St Peters Street	60	54	52	60	75

* Standard Saturday construction hours.

In addition, the following construction noise management levels $L_{Aeq,15\ min}$ are recommended for other receivers and areas:

- Active recreation areas (such as parks): external $L_{Aeq,15min}$ 65dBA
- Industrial premises: external $L_{Aeq,15min}$ 75dBA
- Offices, retail outlets: external $L_{Aeq,15min}$ 70dBA
- Classrooms at schools and other educational institutions: internal $L_{Aeq,15min}$ 45dBA

3.1 Hours of Operation

The proposed working hours for this project are as follows:

- Monday to Friday 7.00am to 6.00pm
- Saturday 8.00am to 1.00pm
- Sunday and Public Holidays No work

If required, after hours permits will be sought from the relevant authorities.

3.2 Vibration Criteria

Criteria for assessment of the effects of vibration on human comfort are set out in British Standard 6472-1992. Methods and criteria in that Standard are used to set "preferred" and "maximum" vibration levels in the document *Assessing Vibration: A Technical Guideline* (2006) produced by the NSW DECCW.

Acceptable values of human exposure to continuous vibration, such as that associated with drilling, are dependent on the time of day and the activity taking place in the occupied space (e.g. workshop, office, residence, or a vibration-critical area). Guidance on preferred values for continuous vibration is set out in Table 3-3.

Table 3-2 Criteria for Exposure to Continuous Vibration

Place	Time	Peak Particle Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (e.g. hospital operating theatres precision laboratories)	Day or Night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices	Day or Night time	0.56	1.1
Workshops	Day or Night time	1.1	2.2

In the case of intermittent vibration, which is caused by plant such as rock breakers, the criteria are expressed as a Vibration Dose Value (VDV) and are presented in Table 3-4.

Table 3-3 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime		Night Time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Calculation of VDV requires knowledge of the number of events, and their duration in the relevant time period.

3.2.1 Building Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 *"Explosives – Storage and Use – Part 2: Use of Explosives"* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"*, as they "are applicable to Australian conditions".

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 3-5.

Table 3-4 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Un-reinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

The Standard states that the guide values in Table 3-5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Note that rock breaking / hammering, and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.

The British Standard goes on to state that "*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity*". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

In addition to the British Standard, for the case of nearby heritage buildings, guidance for structural damage is derived from the German Standard DIN 4150 -3 *Structural Vibration Part 3 – Effects of Vibration on Structures*. Table 3-5 details these recommendations for heritage buildings.

Figure 3-2 Graph of Transient Vibration Guide Values for Cosmetic Damage

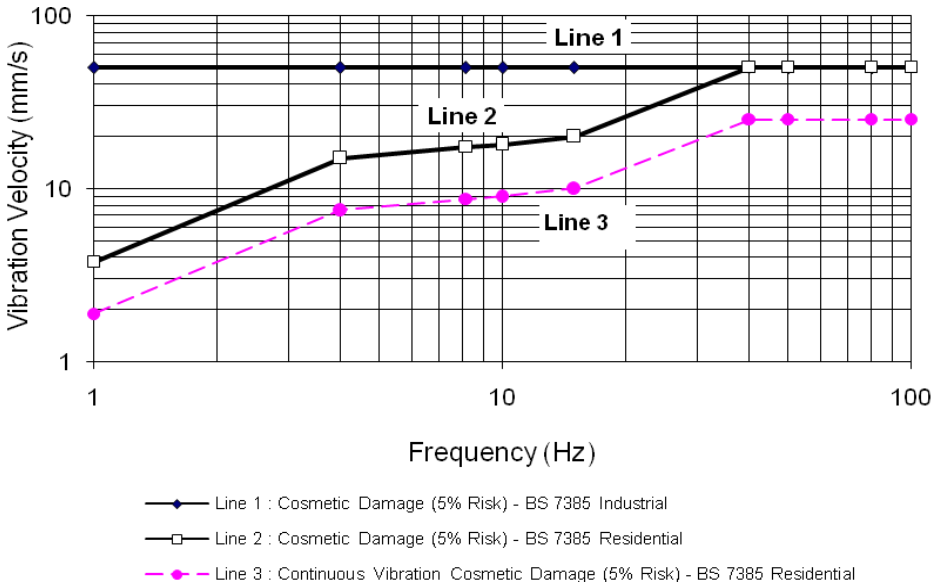

Table 3-5 DIN 4150 recommended PPV Vibration Level for Heritage Buildings

Guideline Values for Velocity – mm/s		
1-10 Hz	10 to 15 Hz	40 to 50 Hz
3	3 to 8	8-10

4 CONSTRUCTION ACTIVITIES & SCHEDULE

The following works and indicative equipment are proposed:

- **Demolition** – Include description.
- **Construction** – Include description.
- **Façade** – Include description.

Table 4-1 lists typical source sound power level of equipment.

Table 4-1 Sound Power Levels for Construction Equipment

Plant	Sound Power Level	Sound Pressure Level at 7m
Concrete Truck	109	84
Angle Grinder	109	84
Concrete Pump – 120 mm diameter / 50 bar	112	87
Concrete Saw	116	91
Mobile Crane	98	73
Dump Truck	108	83
Compressor	100	75
Bobcat	103	78
Hand Tools	90	65
Excavator	108	83
Crawler Cranes	98	73
Tower Crane	104	79
Front End Loader	112	87
Excavator	107	82
Hammer Hydraulic	122	97
Bored Pile Rig	112	87

4.2 Predicted Noise Levels

Noise levels at receiver locations will vary considerable depending on the location and nature of work being undertaken.

Table 4-2 shows predicted noise levels from each stage of construction.

Due to the proximity of the nearest receivers, significant exceedances of the NML will be expected during demolition and excavation activities near the boundaries of the site. During the longest phase, the construction phase, noise will generally comply once the building envelope is commenced.

Table 4-2 Predicted Construction Noise Levels at Residence – $L_{Aeq(15\ min)}$ – dBA

Residential Receiver	Predicted Noise Level	NML	Exceedance
Scenario A – Demolition			
A – Thomson Street & Lane Residences	42	57	0
B – Bourke Street	51	57	0
C – Forbes Street	72	60	12
D – St Peters Street	71	60	11
Scenario B – Building Construction			
A – Thomson Street & Lane Residences	33	57	0
B – Bourke Street	51	57	0
C – Forbes Street	65	60	5
D – St Peters Street	68	60	8
Scenario C – Façade / Fitout			
A – Thomson Street & Lane Residences	27	57	0
B – Bourke Street	34	57	0
C – Forbes Street	60	60	0
D – St Peters Street	60	60	0

4.3 Construction Vibration Assessment

Sources of minor vibration would be expected during demolition phases. In the demolition / excavation phase a 15-20t rockbreaker with a 500 kg head will result in vibration levels typically of around 1mm/s at a distance of 10 metres from a receiver. Vibration levels of this magnitude would be clearly perceptible at adjacent residences.

At a distance of 5m vibration levels would approach 4 – 5mm/s which would most likely cause significant complaint by residences. Therefore, the following mitigation should be considered:

- Use of alternative methods, such as rock saws and / or rock crushers,
- Use smaller hydraulic hammers after saw cuts have been made.
- Use of smaller hydraulic hammers for finishing works.

Mitigation of vibration impacts is discussed in Section 5.

Should part of the Heritage Facade be retained compliance with criteria detailed in Table 3-6 is to be achieved. Low vibration methods should be adopted within 5 metres of Heritage facades such as auger piling, rock saws and smaller rockbreakers. Should large rockbreakers be proposed in this zone trial hammering with rockbreakers is recommended.

5 NOISE & VIBRATION MANAGEMENT PROCEDURES

The following project specific mitigation measures are to be adopted;

- Installation a 2.4 metre plywood hoarding around the construction site;
- Selection of quietest feasible construction equipment;
- Use of jaw crushers in preference to rock-breakers where feasible;
- Localised treatment such as barriers, shrouds, and the like around fixed plant such as pumps, generators, and concrete pumps; and
- Provision of respite periods.

In addition, the following measures should be included in a Noise and Vibration Management Plan.

- *Plant Noise Audit* – Noise emission levels of all critical items of mobile plant and equipment should be checked for compliance with noise limits appropriate to those items prior to the equipment going into regular service. To this end, testing should be established with the contractor.
- *Operator Instruction* – Operators should be trained in order to raise their awareness of potential noise problems and to increase their use of techniques to minimise noise emission.
- *Equipment Selection* – All fixed plant at the work sites should be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures, and other noise attenuation measures in order to ensure that the total noise emission from each work site complies with EPA guidelines.
- *Site Noise Planning* – Where practical, the layout and positioning of noise-producing plant and activities on each work site should be optimised to minimise noise emission levels.

The adoption of the above measures is aimed at working towards achieving the noise management levels established at surrounding receivers.

The following is a summary of the recommended procedure to manage noise and vibration.

The single most critical aspect it to ensure complete engagement with the nearby receivers so that sufficient notifications are provided, complaints/enquires are handled quickly and that ALL site personnel are briefed on the importance of undertaking what is reasonable and feasible in reducing noise and vibration impacts.

Table 5-1 Noise and Vibration Management Procedures

Issue	Area of Concern	Manage Measures	Responsibility
Noise	Site Induction	All personnel, contractors and sub-contractors to work on site will be given an environmental induction prior to the commencement of work. This induction will include the following: • Advice of any operational restrictions and environmental noise management levels; • Explanation of the nearby noise and vibration sensitive receivers and the level of sensitivity expected; • The approved hours of operation; • Site-specific noise and vibration mitigation measures; and • Complaints procedures; • All site employees, contractors and sub-contractors will be made aware of the importance of following the procedures in this CNVMP.	Site Manager
Noise	Neighbour Friendly Behaviour	Some basic rules are required at the site to ensure that unnecessary noise is not created in a way that may affect nearby residential receivers: • No swearing on site; • No unnecessary shouting or loud radios; • No dropping of materials during work or unloading, such as formwork; • No unnecessary use of equipment on site which should be turned off or left on low idle when not used.	All
Noise	Site Monitoring	Monitoring maybe undertaken on the basis of noise complaints. Monitoring should be carried out by qualified personnel. L_{Aeq} and L_{Amax} noise levels at or near the residential boundary are to be measured.	Site Manager
Noise	Equipment Monitoring	Equipment may require noise testing if, for example: • It is new to the site; • Is the subject of repeated noise complaints. Monitoring should be carried out by qualified personnel. L_{Aeq} should be determined at 7m from the equipment and should be compared to the levels in Table 4-1.	Site Manager

Issue	Area of Concern	Manage Measures	Responsibility
All	Complaints Handling	All complaints or enquiries will be kept in a register, including the following details: • Date and time of complaint or enquiry; • Means by which the complaint or enquiry was made; • Details of the complainant; • The nature of the complaint or enquiry; and • Any action taken to investigate the complaint or enquiry and the date of follow up with the complainant. All complaints of noise and vibration shall be investigated and action to be taken to remove the cause of the complaint (where feasible and possible) shall be determined and registered. In all cases, a response shall be provided to the complainant after investigation. Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night time only if requested by the complainant to avoid further disturbance.	Site Manager
Vibration	Monitoring	Vibration monitoring is to be conducted at the two residential properties immediately adjacent to the site. This is to be supplemented by trial testing at the beginning of excavation works. Where predicted vibration levels potentially exceed the criteria for cosmetic damage to buildings, vibration monitoring will be done. Monitoring to be done by suitably qualified personnel. Measure ppv vibration levels on the building foundations or at an equivalent location. Where levels exceed the 10mm/s damage alert level, the offending operation must cease, and alternate construction methods devised. It is likely that human comfort limits will be exceeded in the first instance and need to be managed.	Site Manager
Vibration	Equipment	Use of rocksaws during excavation, thereby minimising rockbreakers.	
All	Communication with Community	A noise and vibration complaint protocol shall be developed for the site to apply during the construction period. The contact details (phone number, email address and postal address) shall be widely distributed to the surrounding residential area. The communication should include details of construction timing.	Site Manager
All	Site Notice	A site notice shall be erected on the site prior to any work commencing and shall be displayed throughout the works period. The site notice must: • be prominently displayed at the boundaries of the site for the purposes of informing the public that unauthorised entry to the site is not permitted; • display project details including, but not limited to the details of the builder, Principal Certifying Authority and structural engineer;	Site Manager

Issue	Area of Concern	Manage Measures	Responsibility
		• be durable and weatherproof and display the approved hours of work, the name of the site/project manager, the responsible managing company (if any), its address and 24 hour contact phone number for any inquiries, including construction/noise complaint are to be displayed on the site notice be mounted at eye level on the perimeter hoardings/fencing and is to state that unauthorised entry to the site is not permitted.	
All	Working Hours	Working hours must be within the hours stipulated in the CoA: • 7.00am to 5.30pm Monday to Friday and 7.00am to 1pm Saturday. Work is not to be carried out on Sundays and public holidays.	Site Manager
All	Work outside Normal Hours	Where it is necessary for works to occur outside of these hours (ie) placement of concrete for large floor areas on large residential/commercial developments or where building processes require the use of oversized trucks and/or cranes that are restricted by the RTA from travelling during daylight hours to deliver, erect or remove machinery, tower cranes, pre-cast panels, beams, tanks or service equipment to or from the site, approval for such activities will be subject to the issue of an "outside of hours works permit" from Council as well as notification of the surrounding properties likely to be affected by the proposed works.	Site Manager
All	Tenders & Contracts	Include in tenders, employment contracts, subcontractor agreements and work method statements clauses that require minimisation of noise and vibration and require compliance with directions from management to minimise noise.	Site Manager
All	Worker Concerns	Workers may at times need to discuss or negotiate practices with their managers if they are concerned about noise and vibration.	Site Manager
All	Maintain equipment	• Regularly inspect and maintain equipment to ensure it is in good working order; • Also check the condition of mufflers; • Equipment must not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified; • For machines with enclosures, check that doors and door seals are in good working order and that the doors close properly against the seals; • Return any hired equipment that is causing noise that is not typical for the equipment – the increased noise may indicate the need for repair; • Ensure air lines on pneumatic equipment do not leak.	Site Manager

Issue	Area of Concern	Manage Measures	Responsibility
Noise	Operate equipment in a quiet and efficient manner	Reduce throttle setting and turn off equipment when not being used.	Site Manager
Noise	Location of Plant	Place as much distance as possible between the plant or equipment and residences and other sensitive land uses.	Site Manager
Noise	Hoarding	Hoarding to the side boundaries to be 2.4mm solid plywood to act as a noise barrier to adjacent residences	Site Manager
Noise	Scheduling	Nominate an off-site truck parking area, away from residences, for trucks arriving prior to gates opening.	Site Manager
Noise	Scheduling	Schedule deliveries to nominated hours only.	Site Manager
Noise	Reversing Alarms	Where possible minimise the use of reversing on-site OR ensure that non-tonal reversing alarms are fitted to all vehicles.	Site Manager