ACOUSTICS AND AIR

SCECGS REDLANDS, CREMORNE, CONCEPT PROPOSAL AND STAGE 1 DEVELOPMENT APPLICATION

CONSTRUCTION & OPERATIONAL NOISE REPORT

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PREPARED FOR

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C/ SANDRICK PROJECT DIRECTIONS
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DOCUMENT CONTROL

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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.

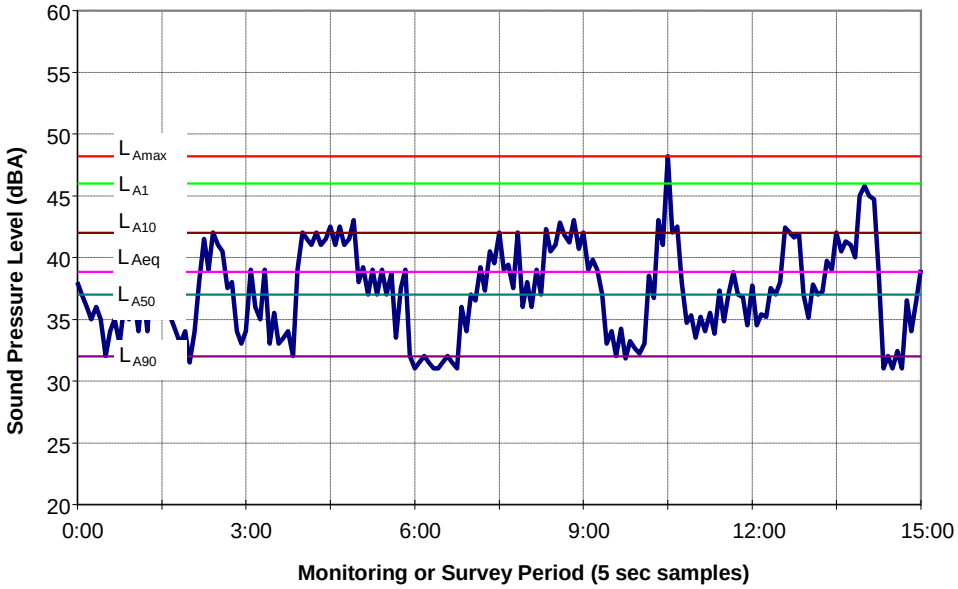
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

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 on behalf of SCECGS Redlands Ltd ("the Proponent"). It accompanies an environmental impact statement (EIS) prepared in support of State Significant Development Application SSD14_6454 for the staged development of the SCECGS Redlands Senior Campus ("Redlands").

This application seeks a staged development approval comprising a concept proposal for the school over five stages and consent for a detailed proposal for the first stage development referred to as "Stage 1". Details of the project are described below:

(1) Concept Proposal: A Concept Proposal has been prepared for the site to guide its future redevelopment and is intended to provide a statutory framework for the long term planning of the site.

The Concept Proposal will be delivered in five stages and will generally involve the following buildings and works:

Stage 1 – New Learning Hub:

- Demolition of existing buildings and structures
- Construction of a new multi-purpose education building with basement car park and associated vehicular entry off Gerard St
- Temporary fitout of a portion of the basement carpark shell for music and general education uses
- Construction of landscaped podium over new basement carpark and music facilities
- Creation of a new internal vehicular link between Waters Rd and Military Rd

Stage 2 - Sports and Performing Arts Centre:

- Demolition of existing buildings and structures
- Construction of a new sports and performing arts centre

Stage 3 - Redlands Hall, Roseby Building and Liggins Building Refurbishment:

- Internal alterations and additions of existing buildings

Stage 4 - Humphery Learning Hub and Resource Centre:

- Construction of a new multi-purpose education building with swimming pool and associated facilities at roof top level
- Decanting of temporary music facilities upon completion of the new Humphery Learning Hub providing additional carparking

Stage 5 - Adams Centre Extension:

- Alterations and additions to the Adams Centre at 219 Military Road

(2) Detailed Proposal for "Stage 1" development – New Learning Hub:

- Demolition of existing buildings and structures (Mowll Building, 1, 3, 7, 9 and 11 Gerard Street, 7 and 8 Monford Place, staff offices, multi-purpose building and Design and Technology buildings on the western boundary).
- Fit-out of 7 and 8 Monford Pl for temporary use as an educational facility
- Construction of a new purpose built education building generally comprising a four storey building with basement car park and outdoor learning area at roof level.
- Temporary fitout of a portion of the basement carpark shell for music and general education uses
- Construction of landscaped podium over new basement carpark and music facilities
- Creation of new vehicular access road off Gerard Street for the new basement car park.
- Creation of new internal vehicular access link facilitating ingress from Waters Rd and egress onto Military Rd
- Associated landscaping improvements.
- New services infrastructure.
- New servicing area including loading dock and waste enclosure
- Erection of temporary demountable classrooms.

The purpose of this NIA is to provide an acoustic assessment of the proposal as described above and detailed within the EIS. A plan for the site is presented in Figure 1-1.

Figure 1-1 Site Plan

Figure 1-2 shows a plan identifying all the buildings on site. The site is surrounded by single storey houses and multi-level residences.

Figure 1-2 Building Identification Plan

Table 1-1 Site Buildings

Ref	Building Details	Ref	Building Details
1	Adams Centre	12	Design and technology
2	Staff offices	13	Canteen & assembly hall
3	Main reception and administration (2 Monford Place)	14	Mowll Building
4	Hattersley Sports Courts	15	Design and technology (21 Waters Road)
5	Multi-purpose building accommodating medical room, meeting rooms, staff rooms and classroom	16	Humphery Building (Humanities / library)(23 Waters Road)
6	Liggins Building	17	Lang Gymnasium (25-27 Waters Road)
7	Roseby Building (drama studio and science)	18	Facilities / ICT (1 Gerard Street)
8	Residential flat building (8 Monford Place)	19	Music tuition (3 Gerard Street)
9	Residential flat building (7 Monford Place)	20	Performing arts (7 Gerard Street)
10	Residential flat building (5 Monford Place)	21	Music (9 Gerard Street)
11	Dwelling house (6 Winnie Street)	22	Visual arts (11 Gerard Street)

Wilkinson Murray Pty Limited has reviewed and assessed the drawings and relevant documentation prepared in respect of this State Significant Development (SSD 14_6454) submission.

The NIA details established site specific noise and vibration criteria to be applied to the entire Concept proposal. In addition, an assessment of the Stage 1 proposal has been conducted. The NIA was conducted general in accordance with the following policies:

- *NSW Road Noise Policy (EPA);*
- *NSW Industrial Noise Policy (EPA);*
- *Assessing Vibration: A technical guideline (EPA); and*
- *Interim Construction Noise Guideline (DECC).*

2 AMBIENT NOISE MONITORING

2.1 Ambient Noise Levels at 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 are shown in Figure 2-1.

Figure 2-1 Aerial showing Noise Monitoring Locations

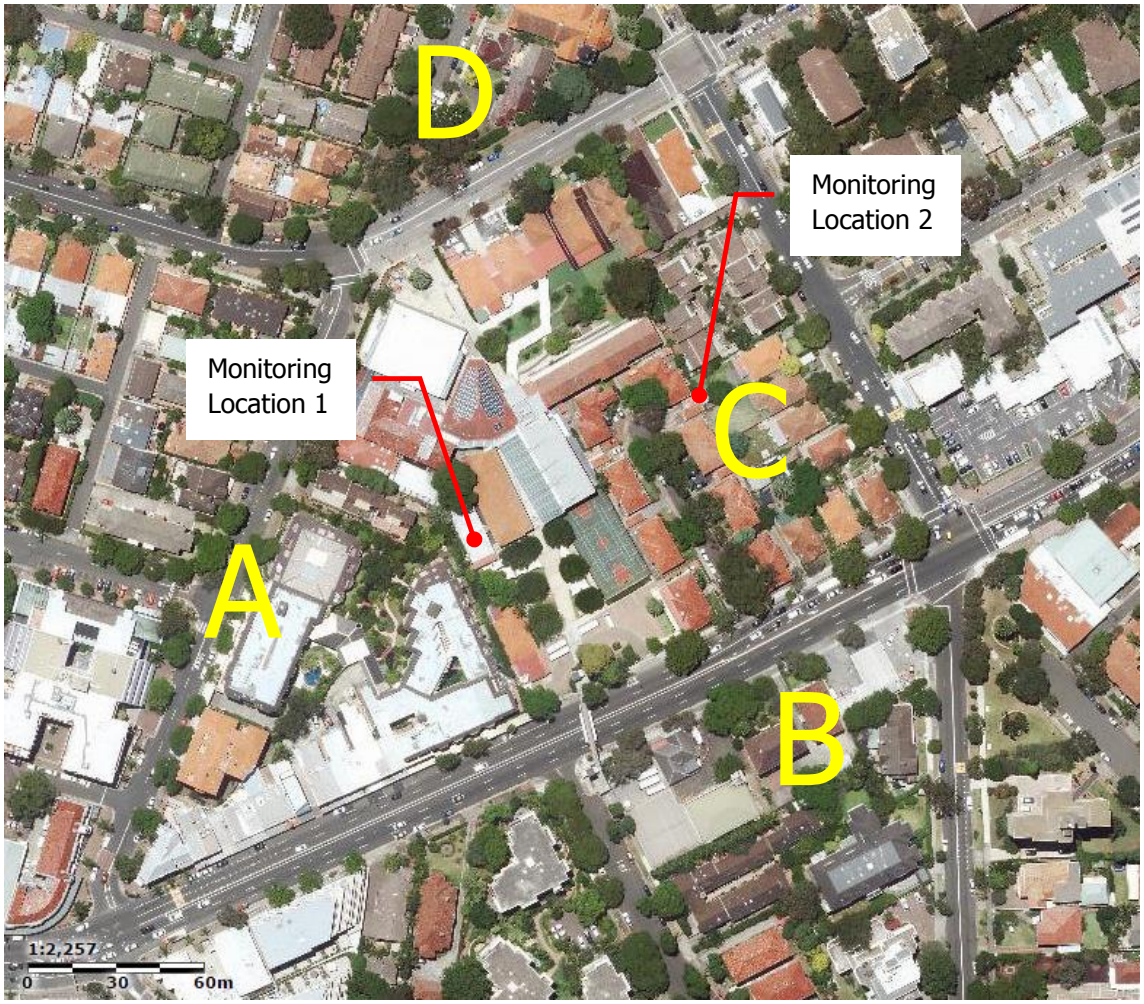


Table 2-1 Surrounding Receivers

Receivers	Comments
A – Waters Rd	Multi storey residential building.
B – Military Rd	Multi-storey residential buildings on the opposite side of Military Rd.
C – Winnie St	Mix of single and multi-storey residential buildings.
D – Gerard St	Church on the opposite of Gerard 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	SCEGGS Redlands Western Boundary	20 – 27 November 2014
2	6 Winnie St, Cremorne	20 – 27 November 2014

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 *Industrial Noise Policy (INP)*. Additionally, noise monitoring results for Saturday (7.00am-5.00pm) have been included as construction is proposed outside standard hours.

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	44	36	44	58	53	50	52
2	44	42	32	43	51	51	46	54

Since it is proposed that some activities at the school associated with future stages would commence at 6.00am, it is also necessary to know the RBL during the 6.00am and 7.00am shoulder period. This information is shown in Table 2-4.

Table 2-4 RBL during Morning Shoulder Period (6 am – 7am)

Noise Logging Site	RBL (dBA) 6.00am – 7.00am
1	48
2	43

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.

3 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

This section of the assessment relates to Stage 1 works as construction 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 Master plan.

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*" *(CNG)* 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 + 5 dB	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 $L_{Aeq\ ,15\ min}$ 65dBA
- Industrial premises: external $L_{Aeq\ ,15\ min}$ 75dBA
- Offices, retail outlets: external $L_{Aeq,15\ min}$ 70dBA
- Classrooms at schools and other educational institutions: internal $L_{Aeq\ ,15\ min}$ 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 – Waters Rd	57	49	41	54	75
B – Military Rd	57	49	41	54	75
C – Winnie St	54	47	37	53	75
D – Gerard Street	57	49	41	54	75

* Standard Saturday Construction Hours

3.2 Hours of Operation and Programme

The proposed working hours for this project are as follows:

- Monday to Friday- 7:00am to 7:00pm
- Saturdays- 8:00am to 1:00pm
- Sundays 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

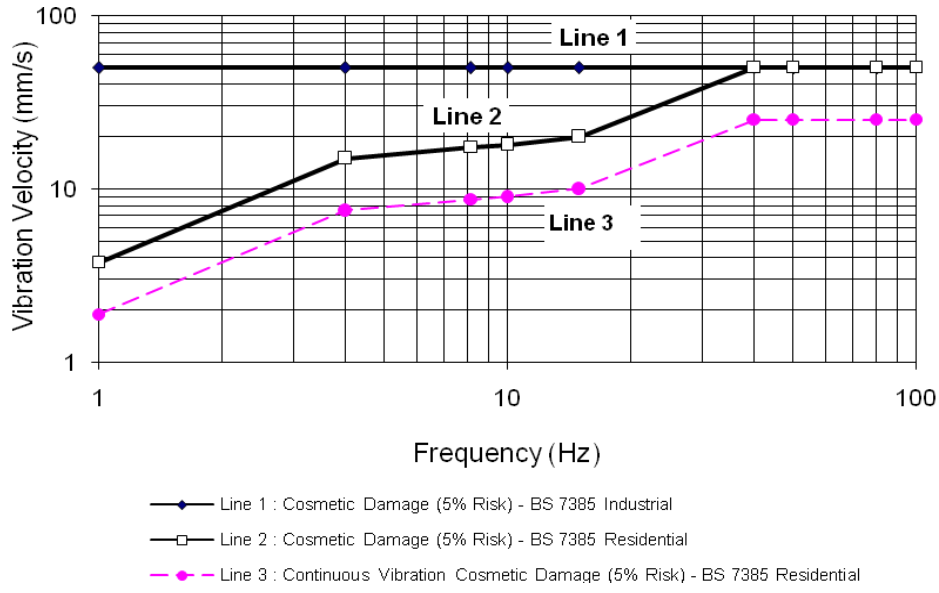
Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Un-reinforced or light framed structures Residential or light commercial type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

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



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"*. The following Table 3-6 details these recommendations for

heritage buildings.

Table 3-6 DIN 4150 recommend 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
Bulldozer	114	89
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.

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. Further details of construction methodology are contained in the

Table 3-8 Construction Scenarios for Construction Works

Scenario	Description	Works
A	Bulk Excavation	Bulk Excavation in rock - excavation using rocksaw, ripping using excavator mounted claws or bulldozers Bulk Excavation other than rock(OTR) - mainly using excavators with dozers used to breakdown large rock elements Truck Movements - loaded into trucks sent offsite
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 15minutes. Also concrete trucks and normal delivery trucks assumed to be 2 movements in 15minutes.
C	Façade / Fitout	In the event that the construction of the facade occurs in isolation. Forklift, truck, tower crane and power tools assumed. 2 truck movements in 15minutes assumed.

Noise modelling has been conducted for each of the above scenarios, with plant located across the 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	Weekday NML*	Exceedance	Sat NML	Exceedance
Scenario A – Bulk Excavation (with Rock)					
A – Waters Rd	43	57	0	54	0
B – Military Rd	49	57	0	54	0
C – Winnie St	73	54	19	53	20
D – Gerard Street	62	57	5	54	8
Scenario B – Building Construction					
A – Waters Rd	45	57	0	54	0
B – Military Rd	47	57	0	54	0
C – Winnie St	70	54	16	53	17
D – Gerard Street	61	57	4	54	7
Scenario C – Façade / Fitout					
A – Waters Rd	31	57	0	54	0
B – Military Rd	31	57	0	54	0
C – Winnie St	63	54	9	53	10
D – Gerard Street	52	57	0	54	0

A review of results of construction noise indicates that these may be well above construction noise management levels at nearby residences particularly in area C (which are the residences immediately adjacent to the construction site), during excavation and construction stages. On Saturdays, the exceedance is likely to be slightly greater.

3.6 Discussion of Results

Exceedances of noise management levels of up to 20 dBA at residences to the east of the site may be expected during excavation 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.

Greater exceedances are predicted on Saturdays due to more stringent noise management levels that are triggered by the proposed extended hours of operation on this day.

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	(300 kg – 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (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 3-4 metres. Therefore the use of medium to large rock-breakers 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 Macpherson 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 rock-saws and ripping in preference to rock-breakers;
- Localised treatment such as barriers, shrouds and the like around fixed plant such as pumps, generators and concrete pumps;
- Provision of respite periods, particularly on Saturdays; and
- Trial testing of vibration levels is conducted where equipment is identified as having the potential to exceed the human comfort criteria.

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 adoptions of the above measures are 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.

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 the western end of level 6 of the Stage 1 learning hub.

It is noted that the building will operate outside normal school hours and as such proposed activities have been reviewed with respect to potential noise impact on residences.

4.1 Operational Noise Criteria

Noise impact from the general operation of the proposed facilities is to be assessed with respect to the site specific noise criteria based on site monitoring and the NSW *Industrial Noise Policy (INP).* The assessment procedure in terms of the *INP* has two components:

- Controlling intrusive noise impacts in the short-term for residences
- Maintaining noise level amenity for particular land uses for residences and other land uses.

The *NSW Industrial Noise Policy (INP)* recommends two criteria, "Intrusiveness" and "Amenity", both of which are relevant for the assessment of noise. In most situations, one of these is more stringent than the other and dominates the noise assessment. The criteria are based on the L_{Aeq} descriptor, which is explained in the glossary.

4.1.1 Intrusiveness Noise Criterion

The intrusiveness criterion requires that the L_{Aeq} noise level from the source being assessed, when measured over 15 minutes, should not exceed the Rating Background Noise Level (RBL) by more than 5dBA. The RBL (as presented in Table 3.3 for each long term monitoring site) represents the 'background' noise in the area, and is determined from measurement of L_{A90} noise levels, in the absence of noise from the source. The definition of L_{A90} and the procedure for calculating the RBL is presented in the glossary.

An intrusiveness criterion applies for residential receivers only.

4.1.2 Amenity Noise Criterion

The amenity noise criterion sets a limit on the total noise level from *all industrial noise sources* affecting a receiver. Different criteria apply for different types of receiver (e.g. residence, school classroom); different areas (e.g. rural, suburban); and different time periods, namely daytime (7.00am-6.00pm), evening (6.00pm-10.00pm) and night time (10.00pm-7.00am).

The noise level to be compared with this criterion is the L_{Aeq} noise level, measured over the time period in question, due to all industrial noise sources, but excluding non-industrial sources such as transportation.

Where a new noise source is proposed in an area with negligible existing industrial noise, the amenity criterion for that source may be taken as being equal to the overall amenity criterion. However, if there is significant existing industrial noise, the criterion for any new source must be set at a lower value. If existing industrial noise already exceeds the relevant amenity criterion, noise from any new source must be set well below the overall criterion to ensure that any increase in noise levels is negligible. Methods for determining a source-specific amenity criterion where there is existing industrial noise are set out in the *INP.*

4.1.3 Determination of Project Specific Noise Criteria

Table 4-1 presents the intrusiveness criteria for each surrounding residential receiver area. This was calculated by adding 5dB to the RBL of the nearest long term monitoring location, as discussed in Section 4.1.1 above.

Table 4-1 Intrusive Noise Criteria

Site	Intrusiveness Criterion $L_{Aeq,15min}$ (dBA)			
	Daytime 7am-6pm	**Evening 6pm-10pm**	**Night Time 10pm-7am**	**Morning Shoulder 6am-7am**
A – Waters Rd	52	49	41	52
B – Military Rd	52	49	41	52
C – Winnie St	49	47	37	48
D – Gerard Street	52	49	41	52

For this assessment, all residential receivers were considered as 'Suburban' in line with the *INP*. Given our observations on and around site, noise at all locations is dominated by general traffic or urban hum, and other sources that are not classified as industrial. As such, it has been assumed that the $L_{Aeq,period}$ from industrial noise is more than 10dB below the designated amenity criterion during any time period. Therefore, no correction to the amenity criteria is warranted. Table 4-2 presents the amenity criteria for each receiver.

Table 4-2 Amenity Criteria

Site	Type of Receiver	Amenity Criterion $L_{Aeq,period}$ (dBA)		
		Daytime 7am-6pm	**Evening 6pm-10pm**	**Night Time 10pm-7am**
A – Waters Rd	Residential	55	45	40
B – Military Rd	Residential	55	45	40
C – Winnie St	Residential	55	45	40
D – Gerard Street	Residential	55	45	40
Commercial Receivers	Commercial	65	65	65

Intrusiveness noise criteria are expressed in terms of $L_{Aeq,15min}$, whereas amenity criteria are in terms of $L_{Aeq,Period}$. The $L_{Aeq,Period}$ levels are typically lower than $L_{Aeq,15min}$ levels, however for noise from continuously-operating mechanical plant this difference is small, as such the $L_{Aeq,15min}$ will be used as the noise descriptor for project.

The lowest of the intrusive and the amenity criteria are then used as project specific noise criteria for the site and are presented in Table 4-3.

Table 4-3 Project Specific Noise Criteria - $L_{Aeq,15min}$ (dBA)

Site	Site Specific Noise Criteria			
	Daytime 7am-6pm	Evening 6pm-10pm	Night Time 10pm-7am	Morning Shoulder 6am-7am
A – Waters Rd	52	45	40	52
B – Military Rd	52	45	40	52
C – Winnie St	49	45	37	48
D – Gerard Street	52	45	40	52
Commercial Receivers	65	65	65	65

It is noted that the above criteria is applicable to all stages of the development as well as Stage 1 works.

4.2 Operational Mechanical Noise Assessment

The Stage 1 construction of the learning hub consists of a new multi-purpose education building with basement car park (See Figure 4-1).

For the detailed design there are two options being considered, namely:

Option 1

- Car park exhaust and supply fans serving the basement carpark. The location of the carpark exhaust fans are to be confirmed during detail design.
- Natural ventilation of the building for the majority of the year – openable perimeter windows and an air transfer detail to the central space. When the temperatures begin to rise, a fan will pull air through the classrooms, to the central space and up to the roof via a large shaft. At night the fans would reverse at a lower speed to force the air in the opposite direction and purge the space.
- Number of small local exhausts to serve the DT/kiln/photography room etc.
- Heating via small boiler mounted on the roof of the main building.

Option 2

- Car park exhaust and supply fans serving the basement carpark. The location of the carpark exhaust fans is to be confirmed during detail design.
- Natural ventilation of the building for the majority of the year – openable perimeter

windows and an air transfer detail to the central space. When the temperatures begin to rise the windows will close and small fan coil units mounted in a bulkhead in the classrooms will temper the space.

- Number of small local exhausts to serve the DT/kiln/photography room etc.
- Heating and a limited cooling via a VRF (refrigerant system) mounted on the roof of the main building.

Figure 4-1 Stage 1 –Plan.

The major noise source associated with the stage 1 development will be carpark exhaust fans which are likely to be located on the western or northern side of the building footprint. Based on preliminary selection of exhaust fan (Sound power level of 101dBA), levels at the rear of residences on Gerard Street will be in the order of 49dBA. Therefore, noise mitigation in the order of 12dBA will be required to meet night time project specific night time noise level of 37dBA. This can be readily achieved by standard noise control measures such as acoustic silencers on the out let fan.

Detailed specifications of mechanical services equipment that would otherwise allow an acoustic assessment of noise emission 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

development detailed assessment of operational noise emission should form a conditional requirement of the development, to be satisfied prior to the issue of the construction certificate.

To mitigate noise from mechanical plant, silencers could be incorporated in the out lets of the exhaust fans and roof top plant would be housed in a louvred acoustic barriers if required. The mechanical plant noise emission would be designed to meet the criteria present in Table 4-3 at the closest receivers.

4.3 Music Area and Classrooms

Music areas and classrooms are to be located below the northern landscape area between Gerard Street and the carpark. Noise from these activities will be contained by the concrete and landscaped roof along with a masonry façade on Gerard Street.

The control of noise ingress to these areas is an important consideration which will be addressed at detailed design stage. The constructions required to stop street noise entering the music areas will also contain noise generated by the operations of this area.

5 ROAD TRAFFIC NOISE ASSESSMENT

The proposed development will result in additional traffic on the local road network.

5.1 Traffic Noise Criteria

Noise Criteria for assessment of road traffic noise are set out in the NSW Government's *NSW Road Noise Policy (RNP)*. Table 6-1 sets out the assessment criteria for residences to be applied to particular types of project, road category and land use.

Table 6-1 Traffic Noise Criteria extracted from the NSW *RNP*

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	$L_{Aeq,\ (15\ hour)}$ 55 (external)	$L_{Aeq,\ (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from **new** local road corridors 5. Existing residences affected by noise from **redevelopment** of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq,\ (1\ hour)}$ 55 (external)	$L_{Aeq,\ (1\ hour)}$ 50 (external)

In summary, the noise level goals at the residential receivers on all the surrounding roads which are classified as sub-arterial roads, based on the *RNP* are:

- $L_{Aeq,15hr}$ day 60dBA; and
- $L_{Aeq,9hr}$ night 55dBA

In addition, where the above criteria are already exceeded as a result of existing traffic the policy notes:

> *For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.*

5.2 Traffic Noise Assessment

Traffix, the traffic consultants, in their report Traffic Impact Assessment SCECGS Redlands School at 272 Military Road, Cremorne Concept Plan has provided traffic flows for the future Masterplan operational scenario as detailed in Table 6-1.

Table 6-2 School Existing and Projected Daily Traffic Generation (vehicles)

Period	Existing Trips		Future Trips		Increase in dB
	Student	Staff	Student	Staff	
AM Arrivals	185	87	202	93	0.4
PM Departures	107	87	123	93	0.3

It is noted that the relative increase of noise associated traffic generation on weekdays is less than 0.5 dBA and therefore insignificant. Given the existing environs and traffic such a change would be indistinguishable.

It is noted that with the operation of the new Sports Hall increased traffic generation is expect to occur on surrounding Streets, notably Gerard Street. It is predicted that up to 139 vehicle movements per hour will occur on weekend with the operation of this facility. This compares to a typical weekend peak hour (12 to 1 pm) traffic flow on Gerard Street of 2024 vehicles an hour.

The noise contribution of these movements along surrounding streets has been assessed with respect to the total $L_{Aeq,1hr}$ day traffic noise level at surrounding residences, using the *Calculation of Road Traffic Noise (CORTN)* traffic noise prediction technique.

The predicted hourly noise contribution of this traffic at residences on Gerard Street form traffic associated with the sports hall is 58.6 dBA. This compares with existing traffic noise levels of 70.2 dBA resulting in an overall noise levels of 70.5 dBA at these residences.

Therefore the resultant potential increase in traffic on weekend is predicted to also be indistinguishable from existing traffic noise Belgrave Street.

6 SUMMARY OF RECOMMENDATIONS

Based on our investigations of the project, the following findings have been determined.

6.1 Construction Noise Management Levels

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 6-1 presents applicable noise management levels at residential receivers in the vicinity of the site.

Table 6-1 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 – Waters Rd	57	49	41	54	75
B – Military Rd	57	49	41	54	75
C – Winnie St	54	47	37	53	75
D – Gerard Street	57	49	41	54	75

6.2 Construction Noise

It has been determined that noise from construction activities during the day period will potentially exceed established construction noise management levels. Therefore, the planning and management of construction activities must take into account 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 and Vibration Management for Stage 1.

The following project specific mitigation measures are recommended;

- Selection of quietest feasible construction equipment.
- A 2.4 m plywood hoarding around the construction site.
- Use of rocksaws and ripping in preference to rockbreakers
- Localised treatment such as barriers, shrouds and the like around fixed plant such as pumps, generators and concrete pumps
- Provision of respite periods, particularly on Saturdays
- Trial testing of vibration levels is conducted where equipment identified as having the potential to exceed the human comfort criteria
- In the case of potential vibration the following measures are recommended:

- Use rock saws in lieu of rockbreaker or alternatively use smaller rockbreakers in the eastern side of the site.
- Conduct trail vibration testing prior to use of rockbreakers when near the eastern site boundary.

6.3 Operational Noise

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

Table 6-2 presents applicable operational noise levels at residential and commercial receivers in the vicinity of the site.

Table 6-2 Project Specific Noise Criteria

Site	Noise Criteria $L_{Aeq,15min}$ (dBA)			
	Daytime 7am-6pm	Evening 6pm-10pm	Night Time 10pm-7am	Morning Shoulder 6am-7am
A – Waters Rd	52	45	40	52
B – Military Rd	52	45	40	52
C – Winnie St	49	45	37	48
D – Gerard Street	52	45	40	52
Commercial Receivers	65	65	65	65

Mechanical plant such as carpark exhaust fans, rooftop exhausts, and VRFs 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 out lets of the exhaust fans and roof top plant would be housed in a louvred acoustic barriers if required. The mechanical plant noise emission would be designed to meet the criteria present in Table 4-3 at the closest receivers.

6.4 Traffic Noise

Noise levels associated with weekday and weekend traffic have been predicted. Based on these predictions and the road classification the operation of the facility will not result in unacceptable traffic noise impacts at surrounding residences.

7 CONCLUSION

A construction and operational noise and vibration assessment of the SCECGS Redlands Masterplan and Stage 1 development at Cremorne has been conducted. Site-specific noise criteria that are applicable to this entire project have been presented. These have been determined for surrounding receivers to be applied on all future State Significant Development applications. A noise assessment has been conducted for the proposed construction activities associated with Stage 1 to determine the potential for noise and vibration impact at surrounding receivers. Exceedances of noise management levels are expected at many surrounding receivers.

Vibration associated with on-site construction activities has the potential to impact on residences to the east of the site should large equipment, such as rock breakers be used. Trial monitoring and selection of less vibration intensive equipment is recommended.

Accordingly, management of noise from construction activities will be required to be included in the Site Construction Environmental Management Plan.

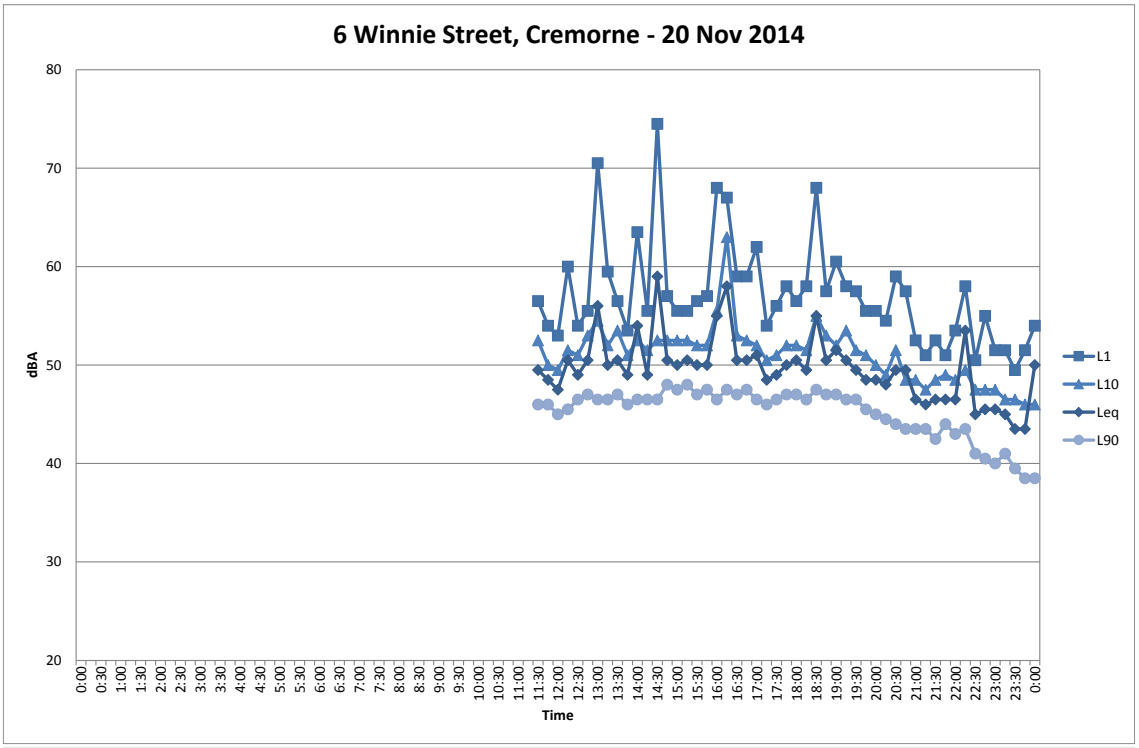
Site specific operational noise criteria for mechanical services have been determined for the project based on ambient noise monitoring. A preliminary review of major plant indicate that noise levels will comply with established noise criteria during proposed operation with acoustic treatment. A review of all plant with respect to site specific noise criteria is required at detailed design stage. At this stage any necessary noise mitigation should be determined and included in the detailed design of mechanical design.

Traffic noise contributions from school day operations have been determined to be insignificant. In addition weekend operations will not increase traffic noise levels at residences on Gerard Street beyond acceptable levels.

Therefore, based on the above predictions and the road classification the operation of the facility will not result in unacceptable traffic noise impacts at surrounding residences.

APPENDIX A

NOISE MEASUREMENT RESULTS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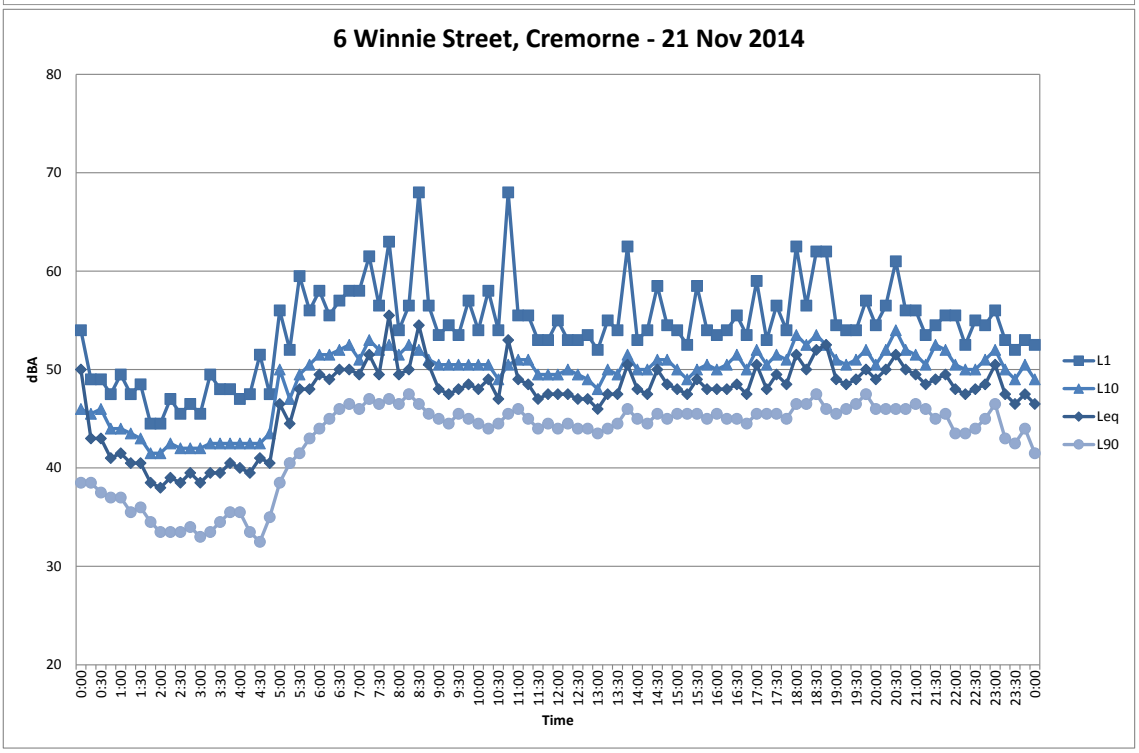
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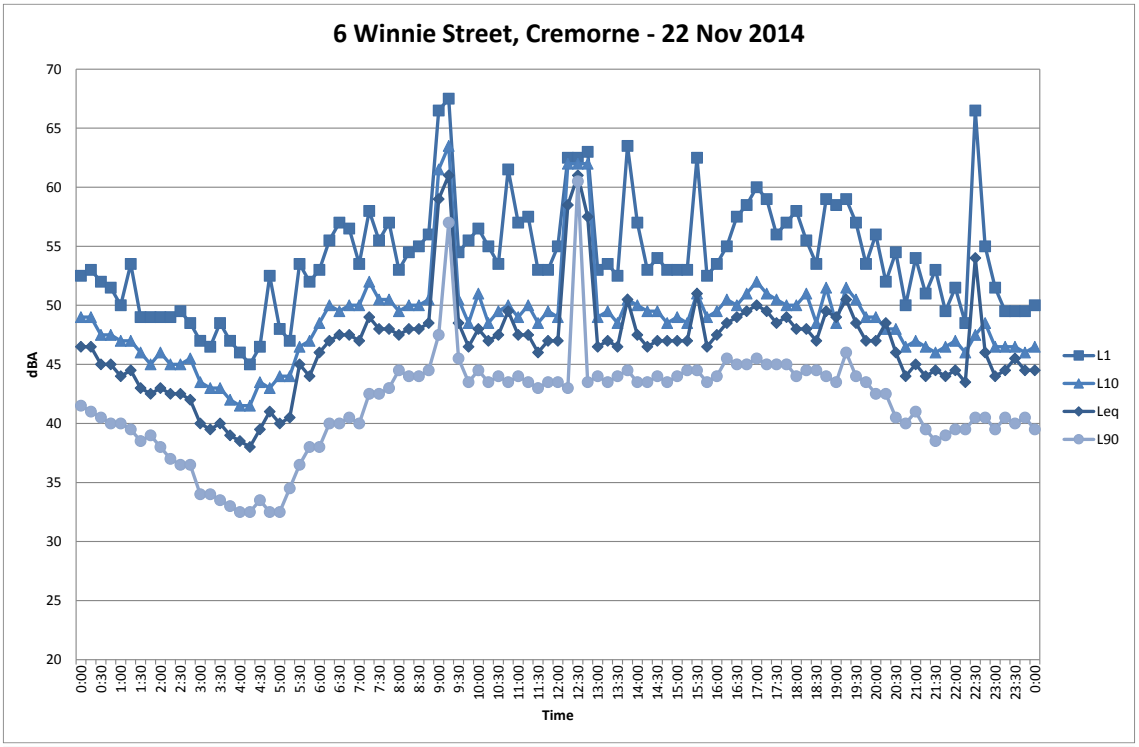
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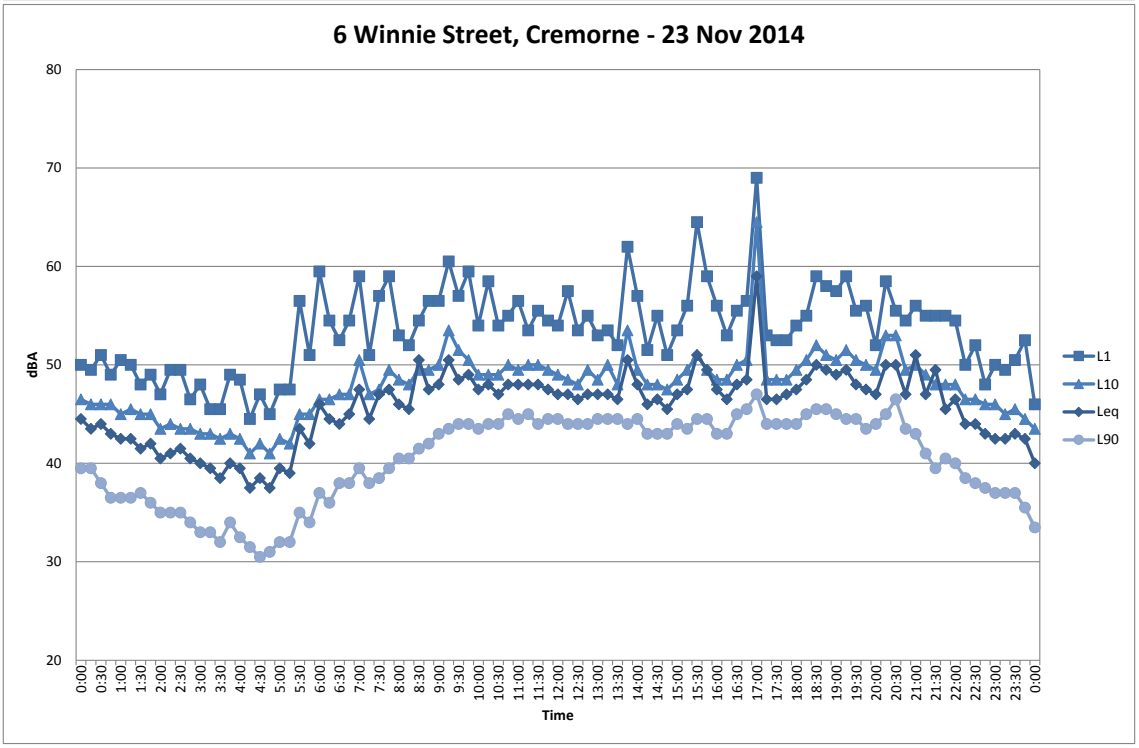
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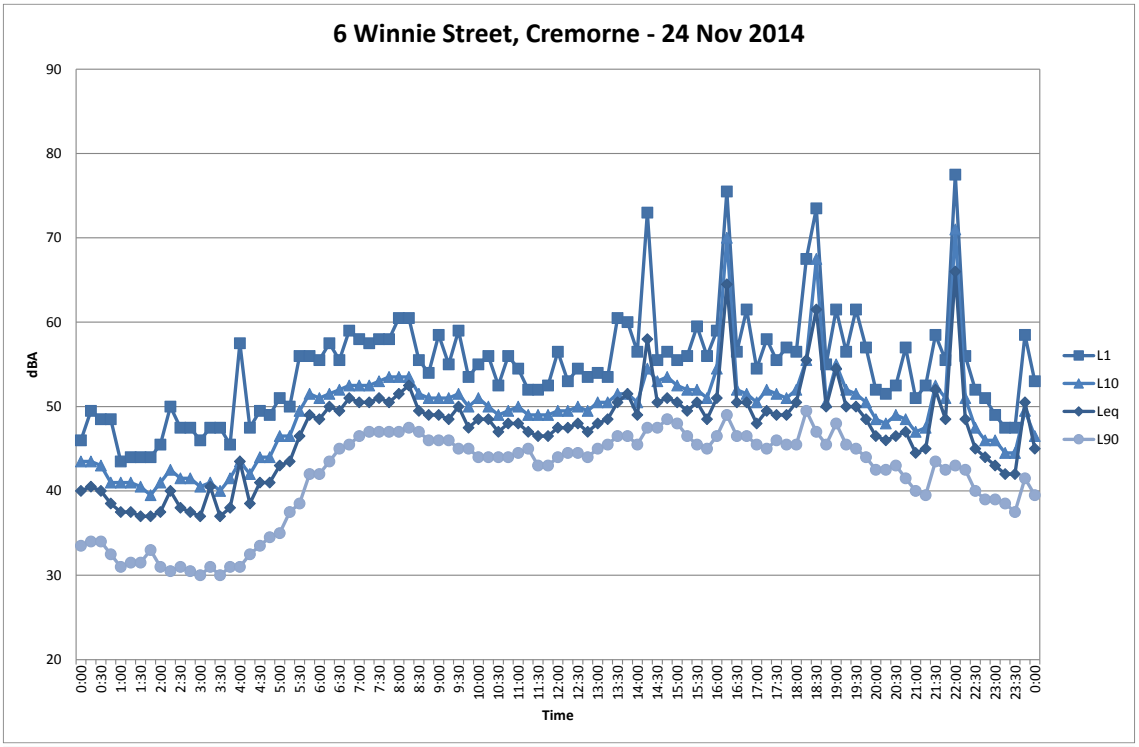
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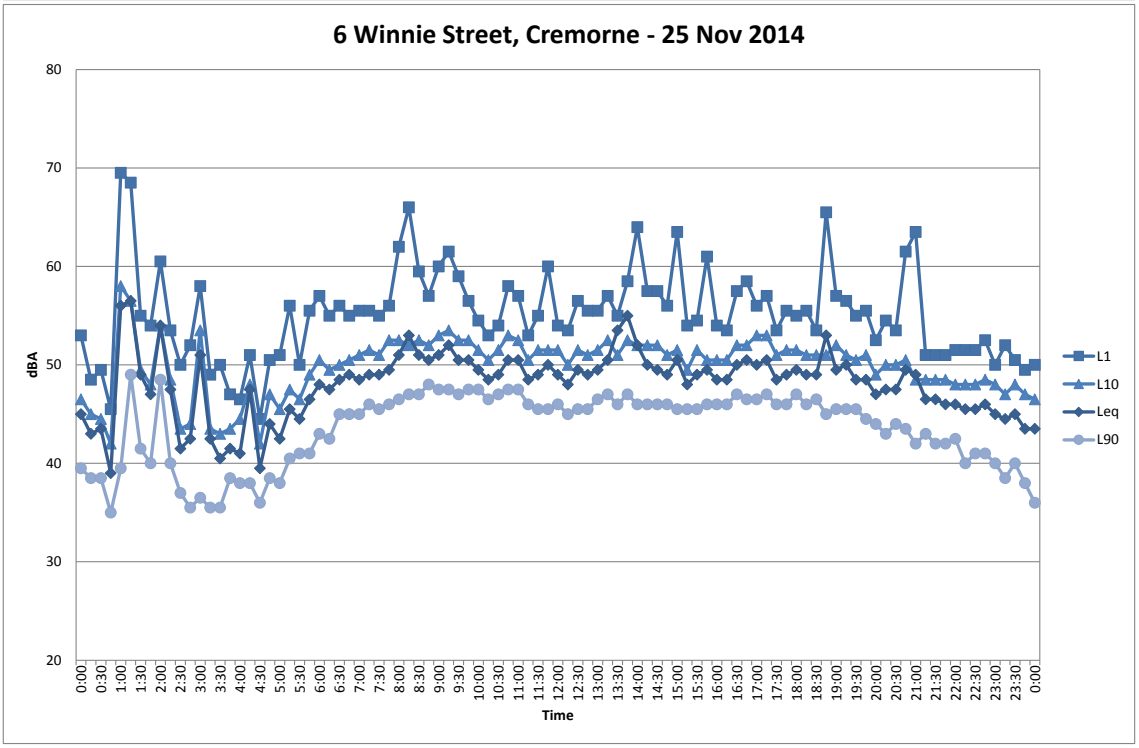
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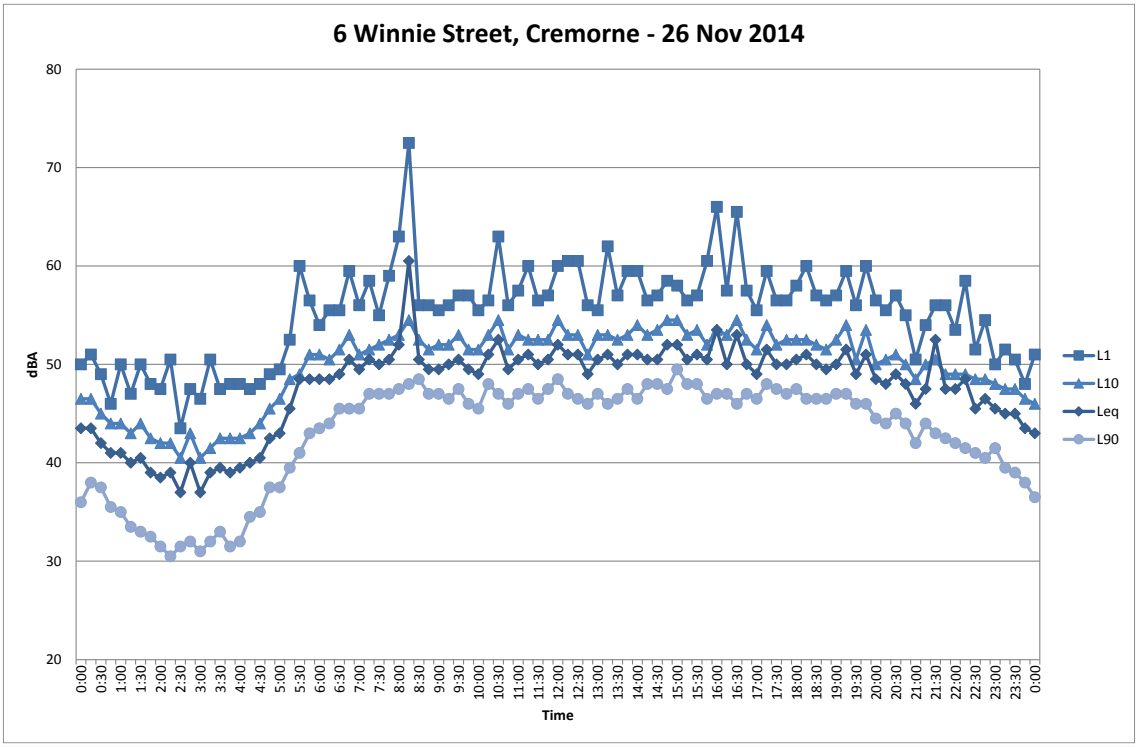
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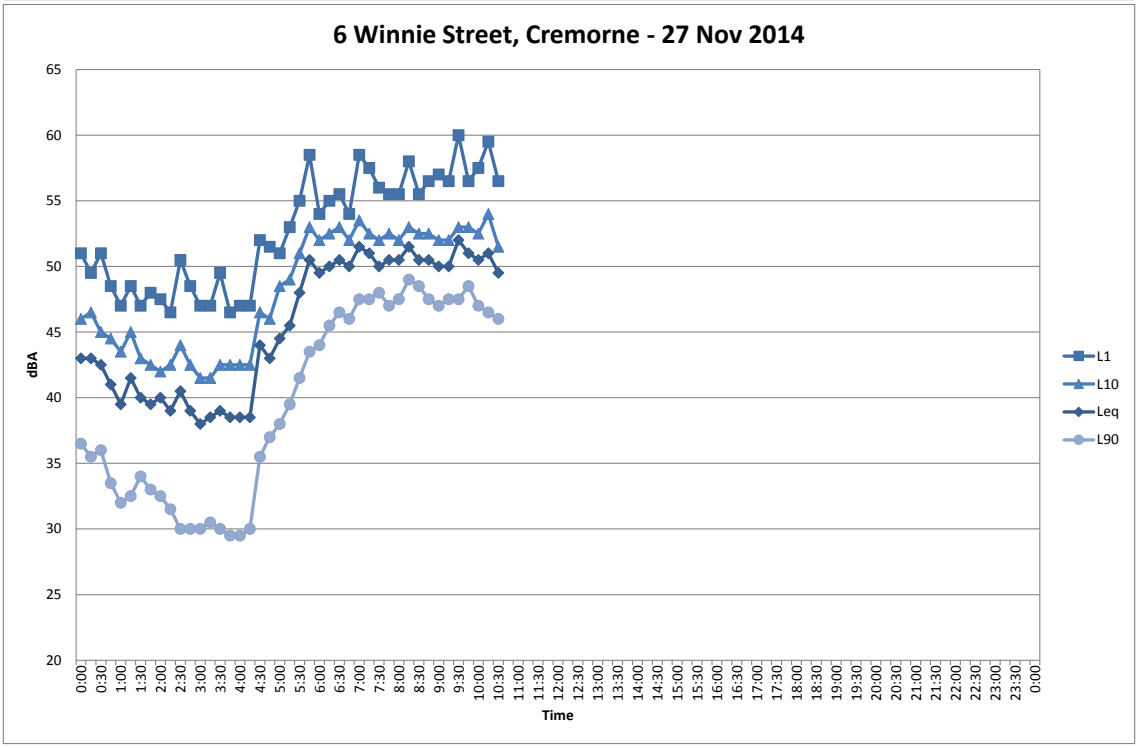
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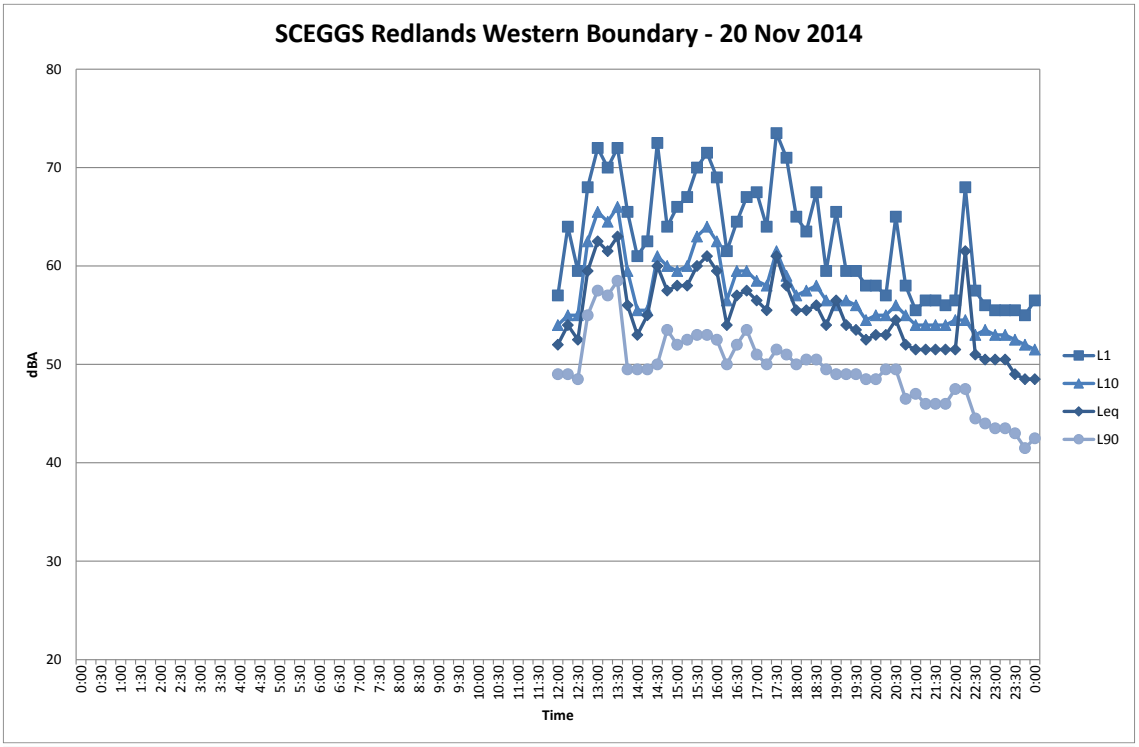
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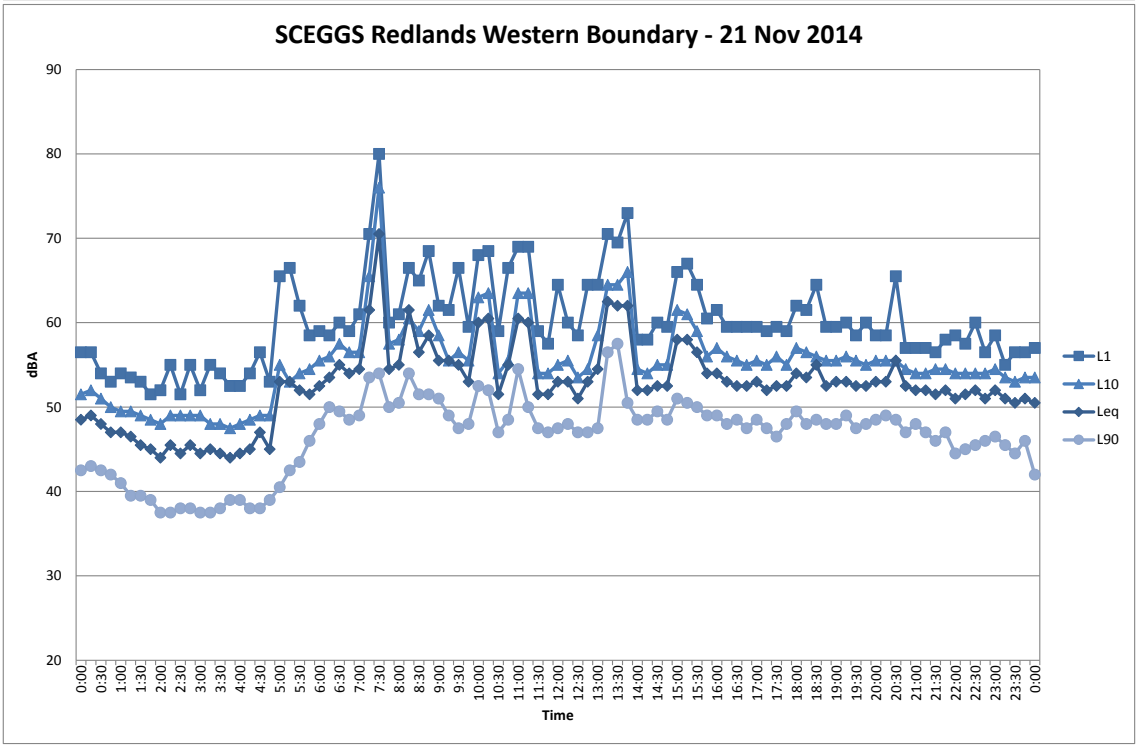
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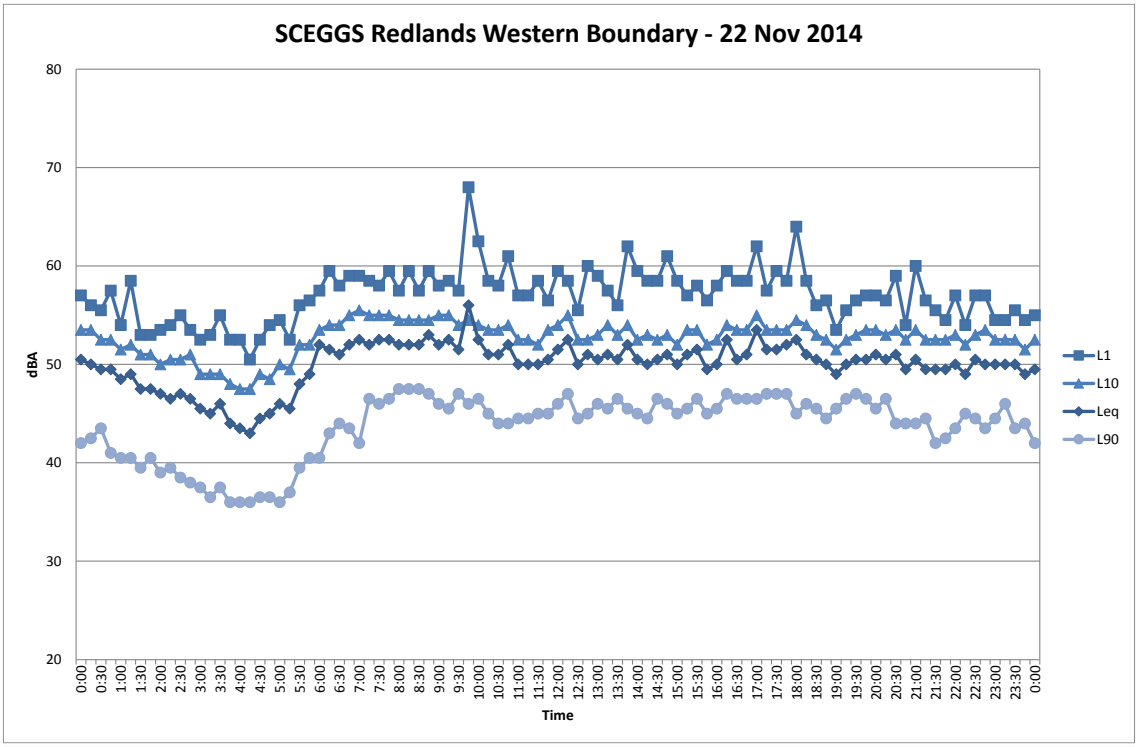
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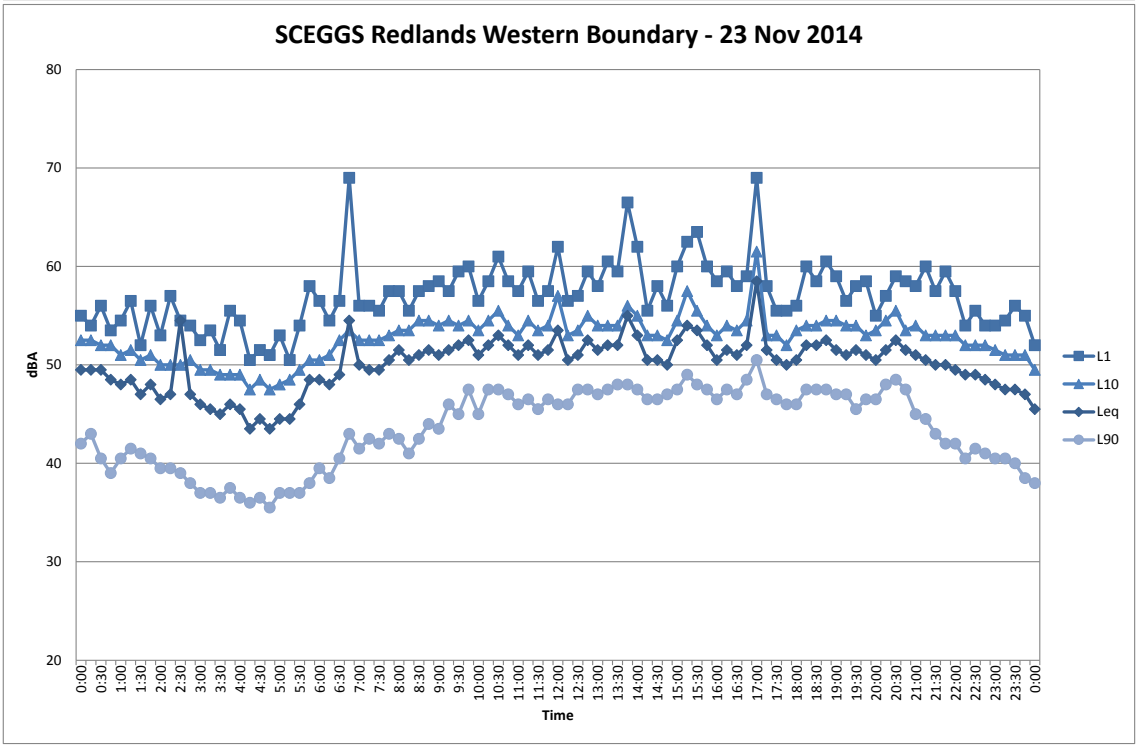
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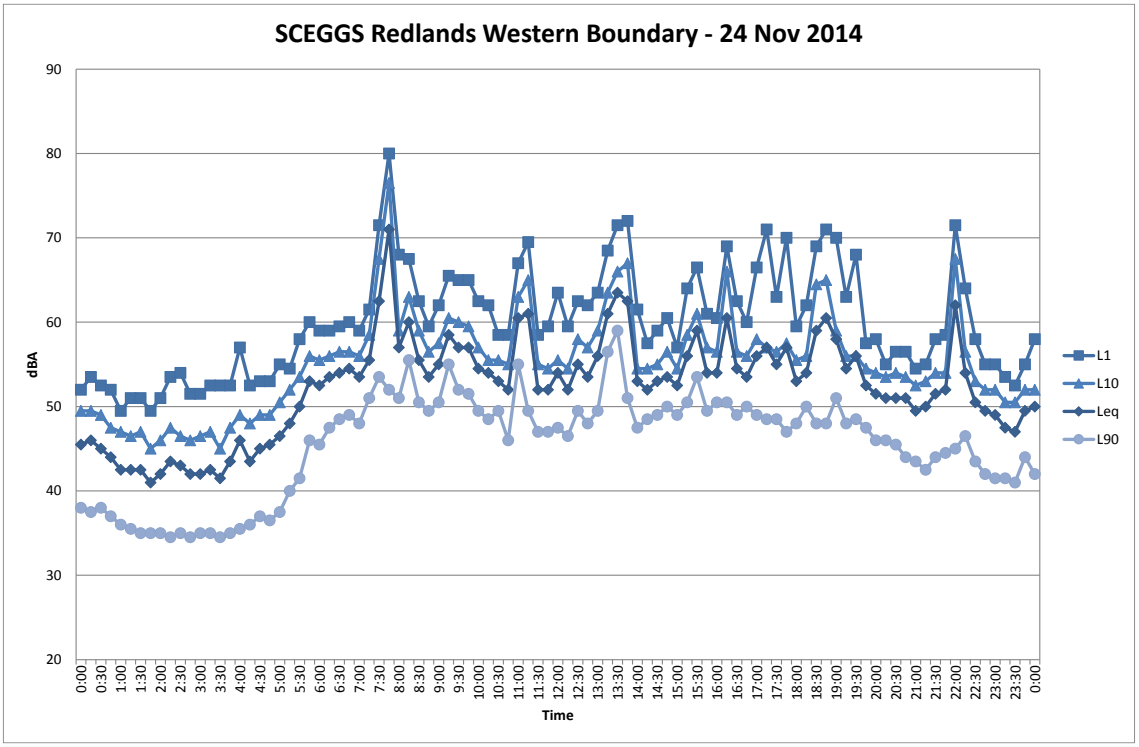
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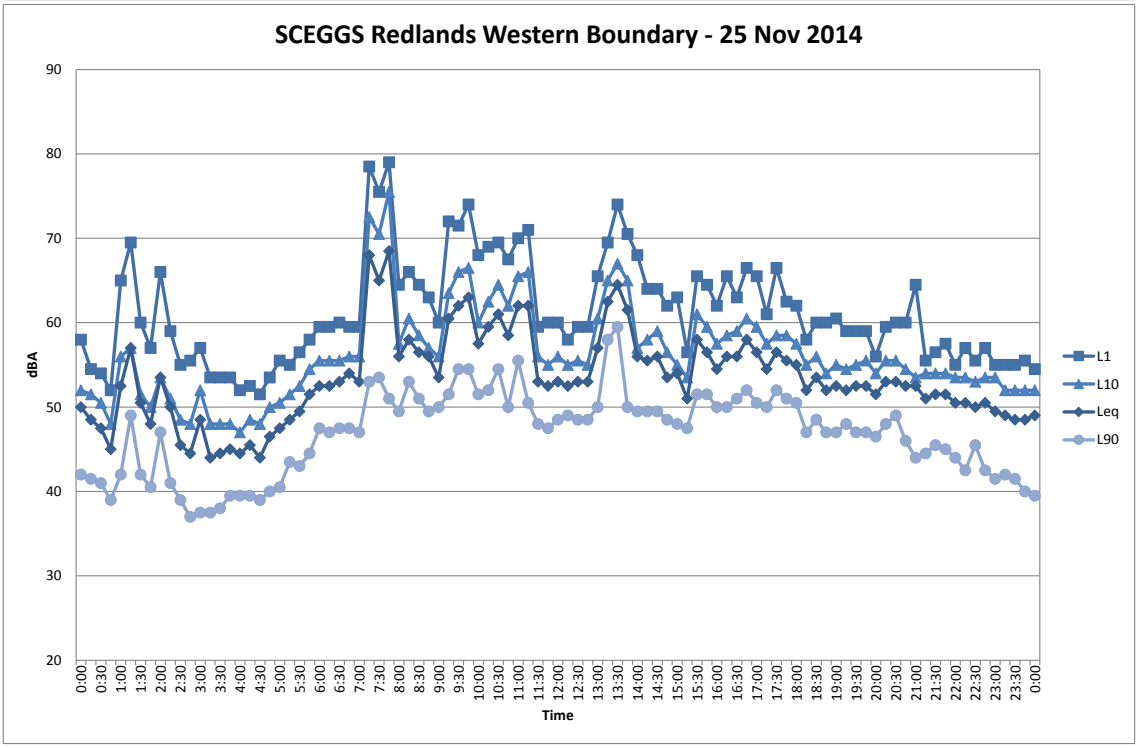
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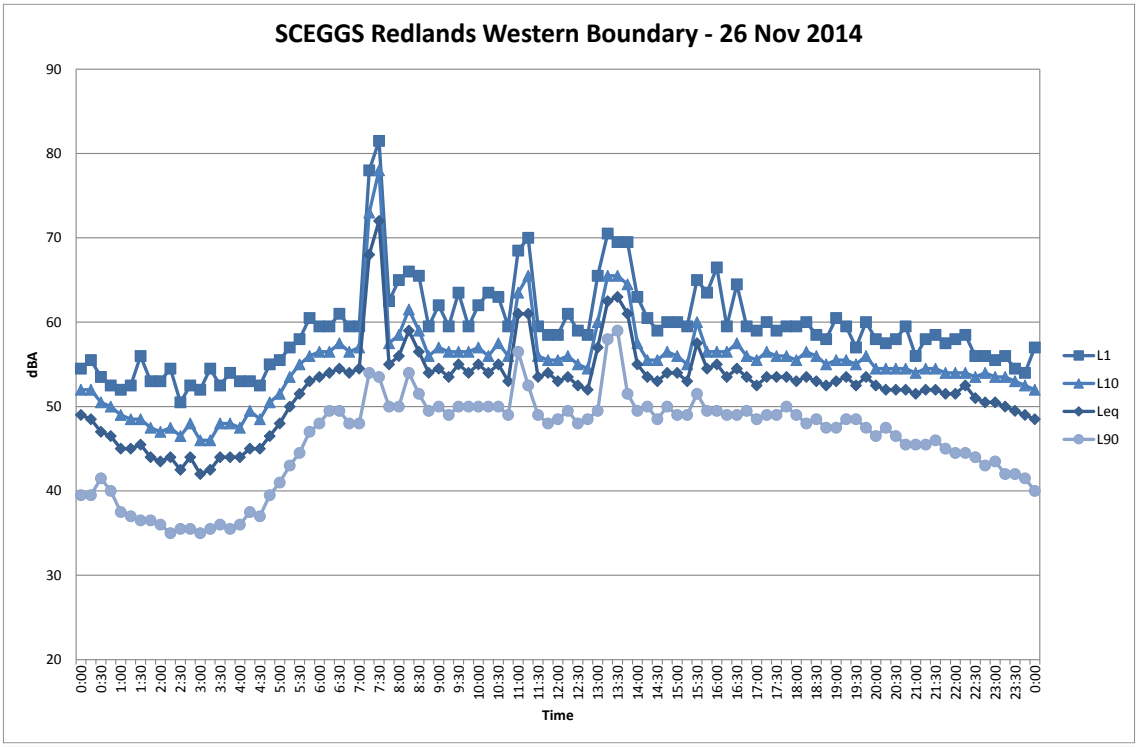
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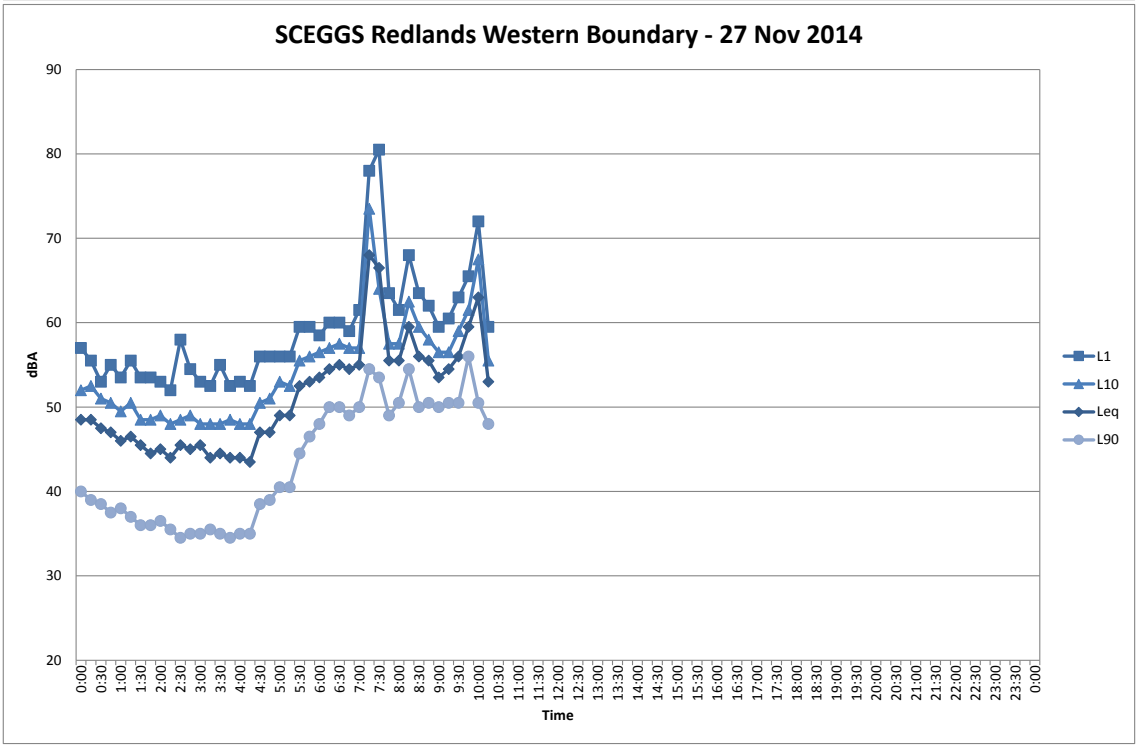
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