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LORETO KIRRIBILLI REDEVELOPMENT

SSD Masterplan Acoustic Assessment

17 August 2017

Artazan Property Group

TJ415-01F04 Acoustic Masterplan Assessment (r5)

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1 Introduction

Renzo Tonin & Associates was engaged to prepare an acoustic assessment to support the State Significant Development (SSD) for the proposed Masterplan redevelopment of Loreto Kirribilli (Loreto), located at 85 Carabella St, Kirribilli.

This report addresses operational noise from the SSD Masterplan. The report has been prepared in accordance with the acoustic requirements of Secretary's Environmental Assessment Requirements (SEARs), North Sydney Council and NSW Environmental Protection Authority (EPA).

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Project description

2.1 Site location

Loreto Kirribilli is located at 85 Carabella St, Kirribilli. The site currently contains two road frontages, with Elamang Avenue to the north and Carabella Street to the south. Multi-storey residential apartments are located along the western site boundary and free standing residential dwelling are located along the eastern site boundary. Both multi-storey residential apartments and free standing dwelling are located across Elamang Avenue and Carabella Street.

Figure 1 presents an aerial photograph of the subject site and surrounding area.

2.2 Hours of operation

The hours of operation for the standard operations of the Masterplan are 8:30am to 3:30pm Monday to Friday. The Auditorium and music rehearsal rooms within the new Music & Performing Arts building may at times operate outside of these hours during the evening and up until midnight.

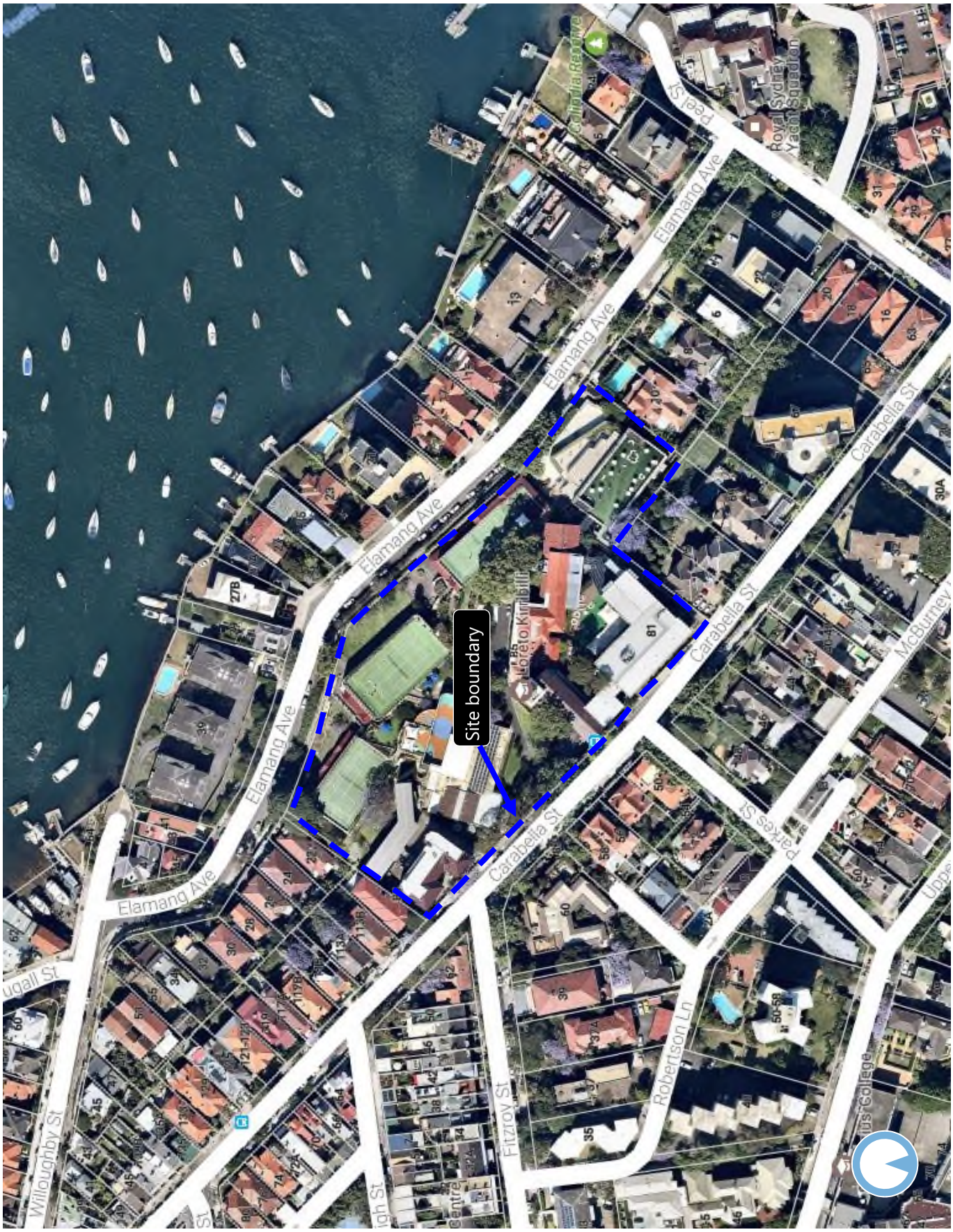


Figure 1: Subject site and surrounding area (Source – Nearmap_Jan_2017)

2.3 Development proposal

The preliminary draft of the site masterplan was issued in May 2016. The major areas of works along with the existing school layout is shown in Figure 2. The works can generally be summarised as follows;

- Western Precinct
  - Demolition of B-Block
  - Construction of Learning Hub & Gymnasium Extension
- Northern Precinct
  - Construction of Vertical Connector
- Eastern Precinct –
  - Demolition of Music & Performing Arts & Mary Ward
  - Construction of New Junior School and 2 storey carpark
- Southern Precinct –
  - Construction of Vertical Connector between Chapel and J-Block
  - Demolition of Junior School
  - Construction of Music & Performing Arts (inc. 500 seat auditorium).

Figure 2: Precinct Plan - Source Loreto Kirribilli Masterplan

The acoustic assessment has been prepared on the basis on the following documentation:

Table 1: Reference documentation

Discipline	Ref no.	Rev	Title	Date
Architectural - Francis-Jones Morehen Thorp	-	-	160502 Loreto Kirribilli Masterplan (89 page document)	May 2016
	MP-1000	01	Cover Sheet	-
	MP-1001	01	Location Plan - Existing	7/07/2017
	MP-1002	01	Site Plan - Existing	7/07/2017
	MP-1003	01	Site Analysis	7/07/2017
	MP-1004	01	Site Plan - Precincts	7/07/2017
	MP-1101	01	Site Plan - Proposed Envelopes First Phase	7/07/2017
	MP-1102	01	Site Plan - Proposed Envelopes Mid Phase	7/07/2017
	MP-1103	01	Site Plan - Proposed Envelopes Final Phase	7/07/2017
	MP-1104	01	Western Precinct Development Site	7/07/2017
	MP-1105	01	Western Precinct Envelope	7/07/2017
	MP-1106	01	Northern Precinct Development Site	7/07/2017
	MP-1107	01	Northern Precinct Envelope	7/07/2017
	MP-1108	01	Eastern Precinct Development Site	7/07/2017
	MP-1109	01	Eastern Precinct Envelope	7/07/2017
	MP-1110	01	Southern Precinct Development Site 1	7/07/2017
	MP-1111	01	Southern Precinct Envelope 1	7/07/2017
	MP-1112	01	Southern Precinct Envelope 2	7/07/2017
	MP-2001	01	Masterplan Proposed Plan - LG4 LG3	7/07/2017
	MP-2002	01	Masterplan Proposed Plan - LG2 LG1	7/07/2017
	MP-2003	01	Masterplan Proposed Plan - G L1	7/07/2017
	MP-2004	01	Masterplan Proposed Plan - L2 L3	7/07/2017
	MP-2005	01	Masterplan Proposed Plan - L4 L5	7/07/2017
	MP-3001	01	Elamang Ave - Elevation	7/07/2017
	MP-3002	01	Carabella St - Elevation	7/07/2017
	MP-4001	01	Eastern & Southern Precinct	7/07/2017
	MP-4002	01	Northern & Southern Precinct	7/07/2017
	MP-4003	01	Western Precinct	7/07/2017
Traffic - McLaren Traffic Engineering	16575.01DA	A	Traffic and Parking Impact Assessment of Loreto School at 85 Carabella Street, Kirribilli	13 March 2017

2.4 Acoustic aspects, methodology

In order to assess the potential noise impact from the development proposal, the following methodology was adopted:

- Identify nearest sensitive receiver locations to the subject site.

- Determine existing background noise levels at the receiver locations.
- Use ambient noise and background levels to establish noise goals in accordance with the acoustic requirements of SEARs, North Sydney Council and NSW EPA.
- Using predictive noise modelling to determine the extent of noise impact from the proposal on the nearest sensitive receivers. Including, noise generated by all external and internal student areas, loading docks, noise generated from onsite car parks and vehicle movements, as well as noise generated from potential increased traffic on the surrounding road network.
- Identify where noise emission from the proposal may exceed the noise goals, and
- Where noise emission from the proposal may exceed the noise goals, provide recommendations to reduce noise impacts from the site.

3 Noise criteria and SEARs

The following sections presents criteria applicable to noise generated by the school students within classrooms and external areas, on-site vehicle movements, loading dock, carparks, music noise (Music and Performing Arts building), mechanical equipment, as well as noise generated from potential increased traffic on the surrounding road network.

3.1 SEARs

The Department of Planning and Environment have prepared Secretary's Environmental Assessment Requirements (SEARs) for the project.

For the Concept Proposal, the SEARs state:

- ***Noise and Vibration***

Identify and provide a quantitative assessment of the main noise and vibration generating sources during operation. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.

- *Relevant Policies and Guidelines:*
- *NSW Industrial Noise Policy (EPA)*

In addition:

> *The EPA has identified the following site specific concerns base on the information (including the draft SEARs) supplied to it by Department of Planning and Environment in its letter dated 29 August 2016:*
>
> *(f) operational noise and vibration impacts on noise sensitive receivers (especially surrounding residences) arising from operational activities such as public address/school bell systems, community use of school facilities, waste collection services and mechanical services (especially air conditioning plant).*

3.2 Industrial Noise Policy (INP)

In accordance with the SEARs conditions, noise emission from school students within classrooms and external areas, on-site vehicle movements, loading dock, carparks, music noise (Music and Performing Arts building) and mechanical equipment are assessed in accordance with the NSW Industrial Noise Policy (INP). The assessment procedure of the NSW INP has two components, being:

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

3.2.1 Intrusive noise criteria

The intrusiveness criteria is applicable to residential premises only. According to the INP, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous

(energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor) does not exceed the background noise level measured in the absence of the source by more than 5dB(A).

The intrusiveness criterion is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5dB

3.2.2 Amenity noise criteria

The INP amenity criteria are designed to maintain noise level amenity for particular land uses, including residential and other land uses. The INP recommends base acceptable noise levels for various receivers, including residential, commercial, industrial receivers and other sensitive receivers in Table 2.1 of the INP. Noise from new sources need to be designed such that the cumulative effect does not produce levels that would significantly exceed the criterion.

Table 2: INP Amenity Criteria - Recommended L_{Aeq} noise levels from industrial noise sources [NSW INP Table 2.1]

Type of receiver	Indicative Noise Amenity Area	Time of day	Recommended $L_{Aeq(Period)}$ noise level	
			Acceptable	Recommended maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45

Note:

Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am

On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

3.2.3 Draft Industrial Noise Policy (DINP)

Whilst still in draft form EPA's Draft Industrial Noise Policy (DINP) September 2015 has been referred to for guidance. In particular, '*Fact Sheet C: Adjustments for annoying noise characteristics*' has been referred to when assessing music noise.

3.3 Sleep disturbance

Noise emanating from project has been assessed for its potential to disturb sleep. The NSW EPA has made the following policy statement with respect to sleep disturbance:

> *Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*

Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, the EPA recognised that the current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:

- *how often high noise events will occur*
- *time of day (normally between 10pm and 7am)*
- *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*

The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max).

Source: http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm Downloaded: 04.12.2014

In summary, the sleep disturbance criteria of $L_{A1(1min)} \leq L_{A90(15min)} + 15dB(A)$ is to be used for initial assessment. The L_{Amax} may be used as an alternative to the $L_{A1(1min)}$. It is noted that the background $L_{A90(15minute)}$ noise level used for establishing the sleep disturbance criteria includes all background noise including noise from the project.

Where the background noise level is very low, this may result in a limit which is unnecessarily strict. Therefore, where the screening limit $L_{A90(15min)} + 15$ is less than 55 dB(A) outside, a value of 55 dB(A) would be appropriate to ensure the internal noise level does not exceed 45 dB(A), on the assumption that there is a 10 dB(A) outside-to-inside noise loss through an open window (see NSW Industrial Noise Policy, p17). Where windows are likely to remain closed on the basis of adequate ventilation that meets the Building Code of Australia's ventilation requirements, then outside noise levels can be greater than 65 dB(A), on the assumption that there is a min. 20 dB(A) outside-to-inside noise loss through a closed window.

3.4 NSW Road Noise Policy (RNP)

Noise impact from the potential increase in traffic on the surrounding road network is assessed against the NSW Road Noise Policy (RNP, Department of Environment, Climate Change and Water NSW, 2011).

The RNP sets out criteria to be applied to particular types of road and land uses. These noise criteria are to be applied when assessing noise impact and determining mitigation measures for developments that are potentially affected by road traffic noise, with the aim of preserving the amenity appropriate to the land use.

With regard to the surrounding road network, Carabella Street and Elamang Avenue are classified as local roads. The criteria for residential receivers are presented in the Table 3 below. These criteria are for noise levels assessed in front of a building facade.

Table 3: Road traffic noise assessment criteria for residential land uses

Road category	Type of project/land use	Assessment Criteria, dB(A)	
		Day 7:00am-10:00pm	Night 10:00pm-7:00am
Local Roads	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)

Note: Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for residences near busy roads (see RNP Appendix C10).

Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of a project by applying the relative increase criteria.

In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

4 Assessment locations and existing noise environment

4.1 Assessment locations

The residential areas surrounding the project have been divided into Noise Catchment Areas (NCAs) which are outlined in Table 4 and Figure 3. Depending the project noise source, the nearest noise sensitive receiver locations within these catchments has been identified for assessment.

Table 4: Assessment locations

ID	Receiver Type	Address/location	Approx. Distance to Project
NCA_1	Residential Noise Catchment	Multi-storey residential dwellings located along the Western site boundary.	Adjacent
NCA_2	Residential Noise Catchment	Multi-storey and free standing residential dwellings located directly opposite Elamang Ave.	20m
NCA_3	Residential Noise Catchment	Free standing residential dwellings located along the Eastern site boundary and multi-storey dwellings located further to the east.	Adjacent
NCA_4	Residential Noise Catchment	Multi-storey and free standing residential dwellings located directly opposite Carabella St.	15m

4.2 Existing noise environment

Criteria for the assessment of operational noise are usually derived from the existing noise environment of an area, excluding noise from the subject development.

Appendix B of the NSW EPA *Industrial Noise Policy* (INP) outlines two methods for determining the background noise level of an area, being 'B1 – Long-term background noise method' and 'B2 – Short-term background noise method'. This assessment has used long-term noise monitoring.

As the noise environment of an area almost always varies over time, background and ambient noise levels need to be determined for the operational times of the proposed development. For example, in a suburban or urban area the noise environment is typically at its minimum at 3am in the morning and at its maximum during the morning and afternoon traffic peak hours. The INP outlines the following standard time periods over which the background and ambient noise levels are to be determined:

Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays

Evening: 18:00-22:00 Monday to Sunday & Public Holidays

Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

The INP also outlines methods for assessing 'shoulder periods' being shorter periods on either side of a standard period, where the standard period noise levels are not representative. For example a 'shoulder

period' may be warranted for 22:00-00:00 where the night time period background noise level is not representative.

4.2.1 Noise measurement locations

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. Section 3.1.2 of the INP specifies that often several locations will be affected by noise from the development. In these cases, locations that can be considered representative of the various affected areas should be monitored.

An alternative, representative location should be established in the case of access restrictions or a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site. The long-term measurement location is outlined in Table 5 and shown in Figure 3. The noise monitoring locations undertaken were taken in close proximity and at a similar RL to the nearest sensitive receivers and are considered representative.

Table 5: Noise monitoring locations

ID/Location	Description
Long-term noise monitoring	
L1 - Loreto Kirribilli Western boundary	The monitor was located at the façade, near the western edge of the top floor northern facing balcony of the Marian Centre. The noise monitoring location is considered representative of NCA_1.
L2 - Loreto Kirribilli Eastern boundary	The monitor was located in the free-field, on the second-tier triangular shaped terrace of the Music and Performing Arts building. The noise monitoring location is considered representative of NCA_2 and NCA_3.
L3 - Loreto Kirribilli Southern boundary	The monitor was located at the free-field, 15 metres north-east of the Carabella Road main entry. The noise monitoring location is considered representative of NCA_4.

Figure 3: Site, receiver and noise monitoring locations (Source – Nearmap_Jan_2017)

4.3 Long-term noise measurement results

Long-term noise monitoring at locations L1, L2 and L3 was carried out from Monday, 23 January 2017 to Saturday, 11 February 2017. School returned to typical operation on Wednesday, 1 February 2017. The monitoring was conducted so that comparison could be made between a non-operational school and an operational school. The long-term noise monitoring methodology is detailed in Appendix B, and noise level-vs-time graphs of the data are included in Appendix C.

Table 6 presents the overall single Rating Background Levels (RBL) and representative ambient L_{eq} noise levels for each assessment period, determined in accordance with the INP.

Table 6: Long-term noise monitoring results, dB(A)

Monitoring Period	School Operation	L_{A90} Rating Background Level (RBL)				L_{Aeq} Ambient noise levels			
		Day	Evening	10pm-Midnight	Night	Day	Evening	10pm-Midnight	Night
L1 - Loreto Kirribilli Western boundary									
Weekdays	School Holidays	47	48	44	41	51	51	45	45
	School Operational	47	45	42	40	54	49	45	43
Week (7 days)	School Holidays	47	48	44	41	51	51	45	45
	School Operational	46	46	42	41	54	49	45	44
L2 - Loreto Kirribilli Eastern boundary									
Weekdays	School Holidays	43	45	39	35	53	52	46	45
	School Operational	45	42	39	35	54	51	46	45
Week (7 days)	School Holidays	43	45	39	35	53	52	46	45
	School Operational	44	43	39	36	53	51	46	45
L3 - Loreto Kirribilli Southern boundary									
Weekdays	School Holidays	44	47	43	41	56	58	49	48
	School Operational	45	43	42	40	56	53	48	49
Week (7 days)	School Holidays	44	49	43	41	55	58	49	48
	School Operational	45	44	42	40	55	53	48	49

Notes: Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays

Evening: 18:00-22:00 Monday to Sunday & Public Holidays

Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

The shoulder period has been established for 22:00-24:00. The shoulder period rating background level has been calculated from the measurement data.

As required by the INP, the external ambient noise levels presented are free-field noise levels. [ie. no façade reflection]

The data above shows that there is little difference in background noise levels between an operational and non-operational school and little difference between a weekday (5 days) and whole week (7 days) data set. For a conservative assessment, the lowest background noise level for each period has been adopted for the noise goal. With regard to the shoulder period, noise levels from monitoring location L2 have been adopted for all locations, as L1 and L3 was affected from existing mechanical plant during the night-time.

4.4 Project noise goals

The project noise goals have been established from the criteria presented in Section 3 and the background noise measurements presented in Table 6 above.

4.4.1 NSW EPA's INP noise goals

The INP noise goals presented in Table 7 are established for the assessment of school students, music noise, mechanical equipment, loading docks and carparks.

Table 7: NSW EPA Industrial noise criteria, dB

Location	Intrusiveness criteria $L_{Aeq,15min}$			Amenity criteria $L_{Aeq,period}$		
	Day	Evening	10pm-Midnight	Day	Evening	10pm-Midnight
NCA_1	51	50	44	55	45	40
NCA_2 & NCA_3	48	47	44	55	45	40
NCA_4	49	48	44	55	45	40

Notes: All residential locations have been categorised as 'Suburban'.

The shoulder period has been established for 22:00-24:00. The shoulder period rating background level has been calculated from the measurement data.

4.4.2 NSW EPA sleep disturbance noise goals

The sleep disturbance noise goals are presented in Table 8.

Table 8: NSW EPA Sleep disturbance criteria, dB

Location	Sleep disturbance criteria, 10:00pm - Midnight, $L_{A1,1minute}$ or L_{Amax}
	$L_{A90(15min)}$ + 15
NCA_1	59
NCA_2 & NCA_3	59
NCA_4	59

5 Operational noise assessment

5.1 Noise sources,

The primary operational noise sources associated with the development are considered to be:

- Classrooms and students (see Section 5.2.1)
    - Breakout noise from internal classrooms/studios/gymnasium;
    - External outdoor learning areas/balconies;
    - External multi-purpose/tennis court sports activities;
    - External recess/lunchtime eating areas/courtyards;
- Vehicular movement on site (see Section 5.2.2);
- Loading dock activities (see Section 5.2.3);
- Carpark (see Section 5.2.4);
- Music and Performing Arts building (see Section 5.2.5);
- Mechanical plant and equipment (see Section 5.2.6);

This section of the report addresses noise emission associated with these sources at the nearest noise-sensitive receivers. Where necessary, noise mitigation and/or management measures will be identified

5.2 Noise predictions

5.2.1 Classrooms and students

Classroom and areas of student occupation for the Masterplan have been summarised in Table 9. Also, provided in the maximum number of students for each particular area and if the building will operate with windows closed or open. Also provided is a breakdown of where students are typically located during lunch breaks. This information along with the Architectural package has been utilised to undertake the classroom and student noise predictions.

Table 9: Classrooms and areas of student occupation

Existing Building	Proposed Building	Levels/Classrooms	Number of Students	Ventilation	Building Operates with Windows Open/Closed[1]
Western Precinct					
Marian Centre	Marian Centre	LG - Photography	30 for all studios/classrooms	Natural	Potentially Open
		GRD - Visual Arts			
		LV1 - English			
		LV2 - English			
		LV3 - Apartment	-	-	-
B-Block	Learning Hub Five Storey building Roof Terrace	LG1 - PDHPE Studios/Outdoor Learning	Typically, 24 students max.30 for all studios/classrooms 30 for LG1 Outdoor Learning 10 for all other Outdoor Learning 30 for Roof Terrace	Mixed Mode	Mixed Mode
		LG2 - Void			
		LG3 - Food Technology/Outdoor Learning			
		LG4 - Metalwork/Jewellery/Woodwork/Outdoor Learning			
		GRD - Robotics/Presentation/Outdoor Learning			
		LV1 - Design Art/Textiles/Outdoor Learning			
		Roof - Outdoor Terrace/Mech Plant			
Gymnasium	Gymnasium Extension	LG1 - GYM	150	Air Conditioning	Closed
		LG2 - PDHPE Staff/GYM Void	-		
Multi-Purpose Court	Multi-Purpose Court	LG3 - Multi-Purpose Court	30	-	-
Junior School Play Terrace	Extended Junior School Play Terrace	GRD - Terrace	80	-	-
Northern Precinct					
Centenary Hall	Centenary Hall	LV1 - Centenary Hall	1200 (includes 1100 students and staff/visitors)	Air Conditioning	Closed
		LV2 - Mezzanine			
Multi-Purpose Court	Multi-Purpose Court	Roof - Multi-Purpose Court	30	-	-
Science Building	Science Building	LV1 - Science Rooms	30 for all studios/classrooms	Air Conditioning	Closed
		LV2 - Science Rooms			
Multi-Purpose Court(s)	Multi-Purpose Court(s)	Roof - Multi-Purpose Court(s)/Lunch Break Space	30	-	-
Eastern Precinct					
Music & Performing Arts Mary Ward	New Junior School 4 Storey building 2 storey carpark	B1 - Carpark	-	Mechanically Ventilated	-
		B2 - Carpark	-	Mechanically Ventilated	-
		GRD - Junior School	30 for all studios/classrooms	Air Conditioning	Closed

Existing Building	Proposed Building	Levels/Classrooms	Number of Students	Ventilation	Building Operates with Windows Open/Closed[1]
		LV1- Junior School			
		LV2-Junior School			
		ROOF- Outdoor Learning			
Southern Precinct					
Elamang Administration	Elamang Administration	GRD -Staff	-	Air Conditioning	Closed
		LV1 -Staff	-		
J-Block	J-Block	GRD - Courtyard & Canteen, Toilets	30 for all studios/classrooms	Air Conditioning	Closed
		LV1- General Teaching			
		LV2- General Teaching			
		LV3- Library			
Chapel	Chapel	GRD -General Teaching	30 for all studios/classrooms	Air Conditioning	Closed
		LV1- Chapel	150		
Junior School	Music & Performing Arts Including 500 Seat Auditorium 5 Storey building	GRD	30 for all studios/classrooms 500 for Auditorium	Air Conditioning	Closed
		LV1			
		LV2			
		LV3			
		LV4			
During Lunch Break					
Gym - Multi-Purpose Court	Gym - Multi-Purpose Court	Multi-Purpose Court	50	-	-
Junior School Play Terrace	Extended Junior School Play Terrace	Terrace	80	-	-
Centenary Hall - Multi-Purpose Court	Centenary Hall - Multi-Purpose Court	Multi-Purpose Court	50	-	-
Science building - Multi-Purpose Court	Science building - Multi-Purpose Court	Multi-Purpose Court	50	-	-
Science building - Roof Top	Science building - Roof Top	Roof top	50	-	-
J-Block Courtyard	J-Block Courtyard	Court Yard	400	-	-
Junior School - Roof Top	Music & Performing Arts Roof Top	Roof top	100	-	-
Remainder of students within Library/other classrooms or scattered throughout school in small groups			320 (based on 1100 students)	-	-

Existing Building	Proposed Building	Levels/Classrooms	Number of Students	Ventilation	Building Operates with Windows Open/Closed[1]

Notes 1. All windows assumed to be 6mm laminated glass except for the following:

- Metalwork Workshop/Woodwork Workshop/Music Practice Studios - double glazing 10.38mm laminated with 100mm air gap.
- Operable glazed partitions separating 'Studios and Outdoor Learning areas' and 'Studios and Circulation/Collaboration areas' – Single glazing 12.5mm laminated
- Connector stairs – 16mm glazing

With the exception of the Metalwork Workshop and Woodwork Workshop within the Learning Hub, noise emanating from classrooms and areas will primarily be due to student voices. Note the Auditorium and Music classrooms within the new Music and Performing Arts building is assessed in Section 5.2.5. The noise levels used for this assessment are shown in Table 10. Conservatively, the assessment is based on a worst-case scenario, which assumes all classrooms/learning spaces, multi-purpose courts and gymnasium and are fully occupied and the Centenary Hall has live music playing inside.

Table 10: Sound power level used for classrooms and students

Noise Source	L_{Aeq} [dB(A) re: 1pW]
Classrooms/studios and outdoor learning - A normal (female)[1,2]	60
Multi-Purpose Court - Tennis/netball game	88
Gymnasium - Basketball game	93
Centenary Hall – Live Music and Patrons	102[2]
Metalwork and Woodwork Workshop	107

Notes: 1. For classrooms/studios and outdoor learning, assessment is based on 50% of people talking at one time. Source reference – Handbook of Acoustical Measurements and Noise Control, Third Edition, Cyril M. Harris.

2. With reference to the EPA DING a maximum adjustment of 7 dB was added for Tonal noise (5dB) and Low Frequency noise (2 dB – just daytime operation)

The nearest most potentially affected residential receiver during standard class times and during the lunch break is respectively located to the west of the site, within NCA_1 and to the north of the site, within NCA_2. The assessment at the identified locations is presented in Table 11 below. Noise compliance is achieved at all residential receivers for the period of use.

Table 11: Classroom and Student assessment

Assessment Location	Predicted Noise Level $L_{Aeq,15min}$			Project Specific Noise Goal $L_{Aeq,15min}$		
	Day	Evening	Night	Day[1]	Evening[2]	Night[1]
During standard class times						
NCA_1 - 22 Elamang Avenue, Kirribilli	48	-	-	51	45	40
During lunch break						
NCA_2 - 21 Elamang Avenue, Kirribilli	42	-	-	48	45	40

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.
1 INP Intrusive Criteria
2 INP Amenity Criteria

5.2.2 On-site vehicular movements

On-site vehicular movements for Loreto are limited. The site's existing carpark entrance/exit along Elamang Ave will be maintained and used for access for the existing underground carpark located below the Music & Performing Arts building/Science Building. The only other on-site vehicle movements will be for the loading dock activity operations, which is assessed in Section 5.2.3, and the carpark operations which is assessed in Section 5.2.4.

Noise predictions have been undertaken for the Elamang Ave entrances/exit based upon the carpark capacity of 80 spaces. The peak hour movements have conservatively been predicted to be 80 vehicles two-way. On this basis it was considered reasonable to average the peak hour movements for the 15-minute noise assessment period, resulting in an average 20 vehicles in and out.

To assess on site vehicle movement noise, the L_{Aeq} noise level was determined for the relevant time period based on the number of vehicle activities expected to occur during that period at the nearest affected residential premises. Noise level measurements from our database and library files were used for the purpose of this assessment.

The nearest most potentially affected residential receiver has been established as located to the north of the site, within NCA_2. The assessment at the identified location is presented in Table 12 below. Noise compliance is achieved at all residential receivers for all periods.

Table 12: On-site vehicular noise assessment, 13 Elamang Ave, Kirribilli

Assessment Location	Predicted Noise Level $L_{Aeq,15min}$			Project Specific Noise Goal $L_{Aeq,15min}$		
	Day	Evening	Night	Day[1]	Evening[2]	Night[1]
NCA_2 - 13 Elamang Ave	31	31	31	48	45	40

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.
1 INP Intrusive Criteria
2 INP Amenity Criteria

5.2.3 Loading dock activity

The loading dock will be situated towards the middle of the site, near the eastern façade of the proposed Learning Hub. Access to the loading dock is via a driveway located adjacent to the eastern façade of the Marian Centre, which connects to Carabella Street. Truck movements associated with the loading dock will be limited to 7:00am to 6:00pm Monday to Saturday and 08:00am to 6:00pm Sundays & Public Holidays. The loading dock will be approximately 35 metres from the developments southern boundary.

The following noise levels from Renzo Tonin & Associate's database have been used for the assessment and are shown in Table 13.

Table 13: Loading dock activity – Sound power levels

Activity	Sound Power Level, dB(A) re: 1pW
	$L_{Aeq\ 15\ minute}$
Loading and Unloading	85
Small Truck Moving (10km/h) – LW / m	61

The most exposed residential receptor has been established as located to the south of the site, within NCA_4. The assessment at the identified location is presented in Table 14, below. Noise compliance is achieved at all residential receivers for the period of use.

Table 14: Loading dock assessment, NCA_4 - 60 Carabella St, Kirribilli

Assessment Location	Predicted Noise Level $L_{Aeq,15min}$			Project Specific Noise Goal $L_{Aeq,15min}$		
	Day	Evening	Night	Day[1]	Evening[2]	Night[1]
NCA_4 -60 Carabella St, Kirribilli	41	-	-	49	45	40

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.
1 INP Intrusive Criteria
2 INP Amenity Criteria

5.2.4 Car park

The existing underground carpark located below the Music & Performing Arts building/Science building has a capacity of 80 spaces. This carpark is not proposed to change as part of the Masterplan Future DA. The carpark is enclosed except for openings along Elamang Avenue. Calculations been undertaken to assess the breakout noise from these openings at the nearest sensitive receivers.

The noise sources generated by carparks include, vehicle doors closing, vehicle engines starting, vehicles accelerating and vehicles moving. Noise level measurements from our database and library files were used for the purpose of this assessment.

For this assessment, the entire carpark (80 spaces) has been estimated to be filled or emptied within any hour, during the day, evening and night. Carpark usage during the evening and night is only anticipated to be used for Auditorium events.

The nearest most potentially affected residential receiver has been established as located to the north of the site, within NCA_2. The assessment at the identified location is presented in Table 15 below. Noise compliance is achieved at all residential receivers for all time periods.

Table 15: Car park noise Assessment, NCA_2 - 15 Elamang Ave, Kirribilli

Assessment Location	Predicted Noise Level $L_{Aeq,15min}$			Project Specific Noise Goal $L_{Aeq,15min}$		
	Day	Evening	Night	Day[1]	Evening[2]	Night[1]
NCA_2 - 15 Elamang Ave	35	35	35	48	45	40

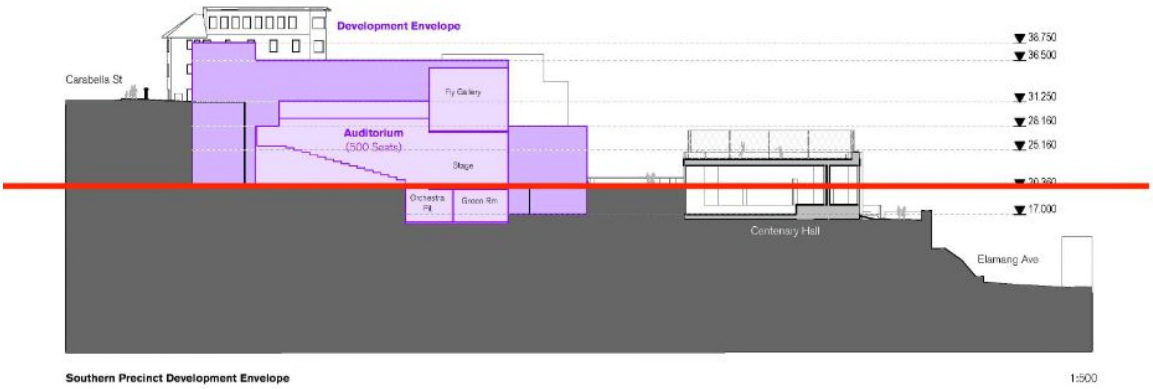
Assessment Location	Predicted Noise Level $L_{Aeq,15min}$			Project Specific Noise Goal $L_{Aeq,15min}$		
	Day	Evening	Night	Day[1]	Evening[2]	Night[1]

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.
1 INP Intrusive Criteria
2 INP Amenity Criteria

5.2.5 Music and Performing Arts building

Below is a section drawing taken from the masterplan architectural masterplan documents.

Figure 4: Southern precinct – Performing Arts Level C



The nearest residential receivers to the Performing Arts Building are located to the south along Carabella Street, which is to the left of the building in Figure 4. Based on this concept drawing, there will be will be internal spaces located to the south and above the auditorium which will provide acoustic shielding to the nearest residences. Furthermore to maximum acoustic shielding, it is recommended that the proposed music rehearsal rooms be located below street level, to the south of the auditorium.

A detailed review of the building envelope will be carried out during the design development process, inclusive of walls and roof constructions to ensure compliance with the noise goals is achieved.

5.2.6 Mechanical plant

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. This is common for a development of this size, as detailed design of the mechanical services system would not typically be undertaken until after approval. In most cases, detailed assessment of operational noise emission from mechanical services equipment would form a conditional requirement of the development, to be satisfied prior to the issue of the construction certificate.

While the intent of this report is to identify potential impacts at sensitive receivers surrounding the site, it is noted that the acoustic objectives of the *NSW Department of Education - Acoustic Performance Guidelines* and *AS:2107: Recommended Design Sound Levels and RT for Building Interiors* may also be desired to be met at classrooms and areas within the development. If this is the case, the classrooms and areas within the development may also be the determining locations for the acoustic design as they could be situated in closer proximity to the mechanical plant equipment than the surrounding receiver locations.

Notwithstanding the above, the following review of proposed development has been carried out and noise management measures are provided for mechanical plant servicing the proposed development.

The proposed development is to include the following primary mechanical plant and equipment:

- Air-conditioning;
- Kitchen and toilet exhausts;
- Woodwork, metalwork, food technology room(s) exhausts;
- Laundry exhaust and supply systems;
- Garbage and bin store exhaust systems;
- Refrigeration equipment; and
- Carpark exhaust and supply fans.

Recommendations

For the Learning Hub (western precinct) the majority of plant and equipment is to be located within a plant room on the western side of the roof. The plant room will be enclosed, with provision for silencers for the condenser units and acoustic louvres for fresh air intake, therefore reducing noise emission from the site to surrounding areas. For other plant rooms a partial or complete roof can be adopted and acoustic louvres and silencers can be incorporated to allow adequate heat dissipation and air flow for equipment. Where possible, the outlet of the equipment should point east, towards the centre of the site, to maximise acoustic directivity and limit noise emission to surrounding residences along the western boundary.

For the remaining stages of development, mechanical equipment should be located towards the centre of the site away from the surrounding residential receivers. Further recommendations are provided in Section 5.3.

5.2.7 Sleep Disturbance

Sleep disturbance would most potentially be caused by a single event of a vehicle door closing, engine starting or a visitor shouting while in the carpark area, where there is a limited degree of acoustic shielding (compared with internal activities) and due to the relatively high L_1 noise levels that can be

generated. The following noise levels from Renzo Tonin & Associate's database have been used for the assessment and are shown in Table 16.

Table 16: Sleep disturbance - Sound power levels

Activity	Sound power level, dB(A) re: 1pW
	$L_{1\ (1\text{-minute})}$
Vehicle door closing	100
Vehicle engine starting	100
Male shouting*	96

Note: * Source reference - Handbook of Acoustical Measurements and Noise Control, Third Edition, Cyril M. Harris

The most exposed residential receptor has been established as located to the north of the site, within NCA_2. The assessment at the identified location is presented in Table 17.

Without any restriction or acoustic shielding, the predicted noise level at the identified receiver location from a single event of vehicle door closing is 57 dB(A). Noise compliance is achieved at all residential receivers. Furthermore, the use of the auditorium at night-time is expected to be infrequent.

Table 17: Sleep disturbance noise assessment, NCA_2 - 15 Elamang Ave, Kirribilli

Assessment Location	Predicted Noise Level	Sleep disturbance criteria, 10:00pm - Midnight, $L_{A1,1minute}$ or L_{Amax}
	$L_{1\ (1\text{-minute})}$ dB(A)	$L_{A90(15min)}$ + 15
NCA_2 - 15 Elamang Ave	57	59

Notes: Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

5.2.8 Cumulative noise impact

Based on the predicted noise level for the relevant on-site activities, as well as the relevant times periods for each activity, a cumulative noise impact assessment has been carried out and is summarised for the two most sensitive receivers in Table 18.

The cumulative noise predictions to the nearest residential receptors show that noise compliance is achieved at all residential receivers for all periods. For a comprehensive set of predictions for all surrounding receivers refer to Appendix D.

Table 18: Cumulative predicted noise levels $L_{Aeq,15min}$

	Activity	NCA_1 22 Elamang Ave			NCA_2 21 Elamang Ave		
		Day	Evening	Night	Day	Evening	Night
Predicted Noise Levels	Classrooms/students - Standard	48	-	-	45	-	-
	Classrooms/students - Lunchbreak	39	-	-	42	-	-
	Onsite Vehicle Movements	<20	<20	<20	29	29	29
	Loading Dock Activities	<20	<20	<20	<20	<20	<20
	Car Park	<20	<20	<20	29	29	29

	Activity	NCA_1 22 Elamang Ave			NCA_2 21 Elamang Ave		
		Day	Evening	Night	Day	Evening	Night
	Total - Standard	**48**	**<20**	**<20**	**45**	**32**	**32**
	Total - Lunchbreak	**39**	**<20**	**<20**	**42**	**32**	**32**
	Criteria	*51*[1]	*45*[2]	*40*[1]	*48*[1]	*45*[2]	*40*[1]

Notes: Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.
^ Allowable noise contribution.
1 INP Intrusive Criteria
2 INP Amenity Criteria

5.3 Recommendations

5.3.1 Acoustic performance of building envelope

- A detailed review of the building envelope should be carried out during the design development process, inclusive of walls and roof constructions.
- This assessment has assumed the glazing performances outlined in Table 9. Higher acoustic performance can be readily achieved and may be required, in particular for the Auditorium and Music rooms.
- Incorporation of acoustically absorptive finishes both within internal areas and outdoor areas is recommended to assist in controlling noise emission from the development.
- Floor to ceiling partitions along the western side of the Learning Hub balconies (only the balconies located west of the stairs) is recommended to provide shielding to 111 Carabella St.
- Operation of outdoor learning terraces/spaces will need to be managed so that raised voices are kept to a minimum. Group conversations will be encouraged to be undertaken indoors.

5.3.2 Music noise control

Where an in-house sound system is installed for the Auditorium, it is recommended that the noise level is controlled by an RMS compressor/limiter. A multi-band compression is recommended for greater control over frequency content.

Where different noise limits are to apply at different operating times, the device should include or support multiple time-based settings. The noise limits and setting of the device should be made during acoustic compliance testing by an appropriately qualified acoustic consultant in conjunction with the system engineer/technician.

If entertainment is to require use of non-in-house sound systems, instrument amplification or acoustic instruments, the above mentioned sound system limiter will not effectively control internal noise levels. A permanent sound 'monitor' device is therefore recommended to be installed.

Sound monitors continuously measure sound levels using a microphone and typically display coloured light or alternative indicators to notify operators and musicians if music levels are approaching or exceed the noise limits. Sound monitors can also include a cut-off mechanism, so that if music is continued to be played in excess of the noise limit music stops momentarily either through the removal of the source of power or the disconnection of the audio feed. Where different noise limits are to apply at different operating times, the device should include or support multiple time-based settings.

5.3.3 Mechanical Plant

- Acoustic assessment of mechanical services equipment should be undertaken during the detail design phase of the development to ensure that the cumulative noise of all equipment does not exceed the applicable noise criteria. Development Consent Conditions typically require detailed assessment of mechanical plant and equipment prior to issue of the Construction Certificate.
- Noise control treatment can affect the operation of the mechanical services system. An acoustic engineer should be consulted during the initial design phase of mechanical services system to reduce potential redesign of the mechanical system.
- Mechanical plant noise emission can be controlled by appropriate mechanical system design and implementation of common engineering methods, which may include:
  - Procurement of 'quiet' plant.
  - Air-conditioners and condensers should include day/night modes to further reduce noise emission.
  - Strategic positioning of plant away from sensitive neighbouring premises to maximise intervening acoustic shielding between the plant and sensitive neighbouring premises.
  - Commercially available acoustic attenuators for air discharge and air intakes of plant.
  - Acoustically lined and lagged ductwork.
  - Acoustic barriers between plant and sensitive neighbouring premises.
  - Partial or complete acoustic enclosures over plant.
  - Acoustic louvres.
- The specification and location of mechanical plant should be confirmed prior to installation on site, and
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 '*Rotating and Reciprocating Machinery – Mechanical Vibration*'.

6 Road traffic generated by development

6.1 Road traffic generated by development

Additional noise from traffic generated by a development on the local road network is assessed against the EPA Road Noise Policy. The assessment involves consideration of the existing traffic noise levels and the potential change in noise as a result of the development.

Based on the data presented in Table 13 of the McLaren Traffic Engineering report 'Traffic and Parking Impact Assessment of Loreto School at 85 Carabella Street, Kirribilli', dated 13 March 2017, the below table presents the existing and future peak two-way volumes.

Table 19: Existing and future peak two-way traffic volumes

Street	Peak	Existing Two-way Peak (vehicles)	Additional Traffic (vehicles)	Future Two-way Peak (vehicles)
Carabella Street	AM	122	38	160
	PM	150	21	171
Elamang Avenue	AM	82	18	100
	PM	89	12	101

Based on data within Table 19, the peak hour traffic generation, that is attributed to the Masterplan Future DA, corresponds to a potential noise increase of 1.2 dB(A) along Carabella Street and 0.9 dB(A) along Elamang Avenue. On this basis, the additional traffic noise generated by the development is less than 2dB(A) and is therefore acceptable .

In addition, the existing waste management procedures of the site will not be altered by the proposed development.

7 Noise impact upon development

The development is not located in close proximity to railway lines, arterial roads and flight paths. Based on the monitoring data in Section 4.3 and the existing/future peak two-way traffic volumes within Table 19, the surrounding local road traffic noise is considered insignificant.

A detailed review of the building envelope will be carried out during the design development process, inclusive of walls and roof constructions to ensure that noise generating activities from the development itself do not have any impacts.

8 Conclusion

Renzo Tonin & Associates has carried out an acoustic assessment to support the State Significant Development (SSD) for the proposed Masterplan redevelopment of Loreto Kirribilli (Loreto), located at 85 Carabella St, Kirribilli.

The report has quantified operational noise emission from the proposed development and has assessed noise at the nearest sensitive receivers. The report has been prepared in accordance with the acoustic requirements of Secretary's Environmental Assessment Requirements (SEARs), North Sydney Council and NSW Environmental Protection Authority (EPA).

On the basis of the assessment, recommendations have been made in regard to noise mitigation measures to be incorporated into the design and operation of the development. In addition, further detailed acoustic assessment and design review will be required during the design development. This further detailed assessment may also be required to address specific conditions stipulated by the consent authority.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Long-term noise monitoring methodology

B.1 Noise monitoring equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave band data	Logger location
RTA06 (NTi XL2)	Type 1	1/1	L1
RTA06 (NTi XL2)	Type 1	1/1	L2
RTA06 (NTi XL2)	Type 1	1/1	L3

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 calibrator. No significant drift in calibration was observed.

B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW INP. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

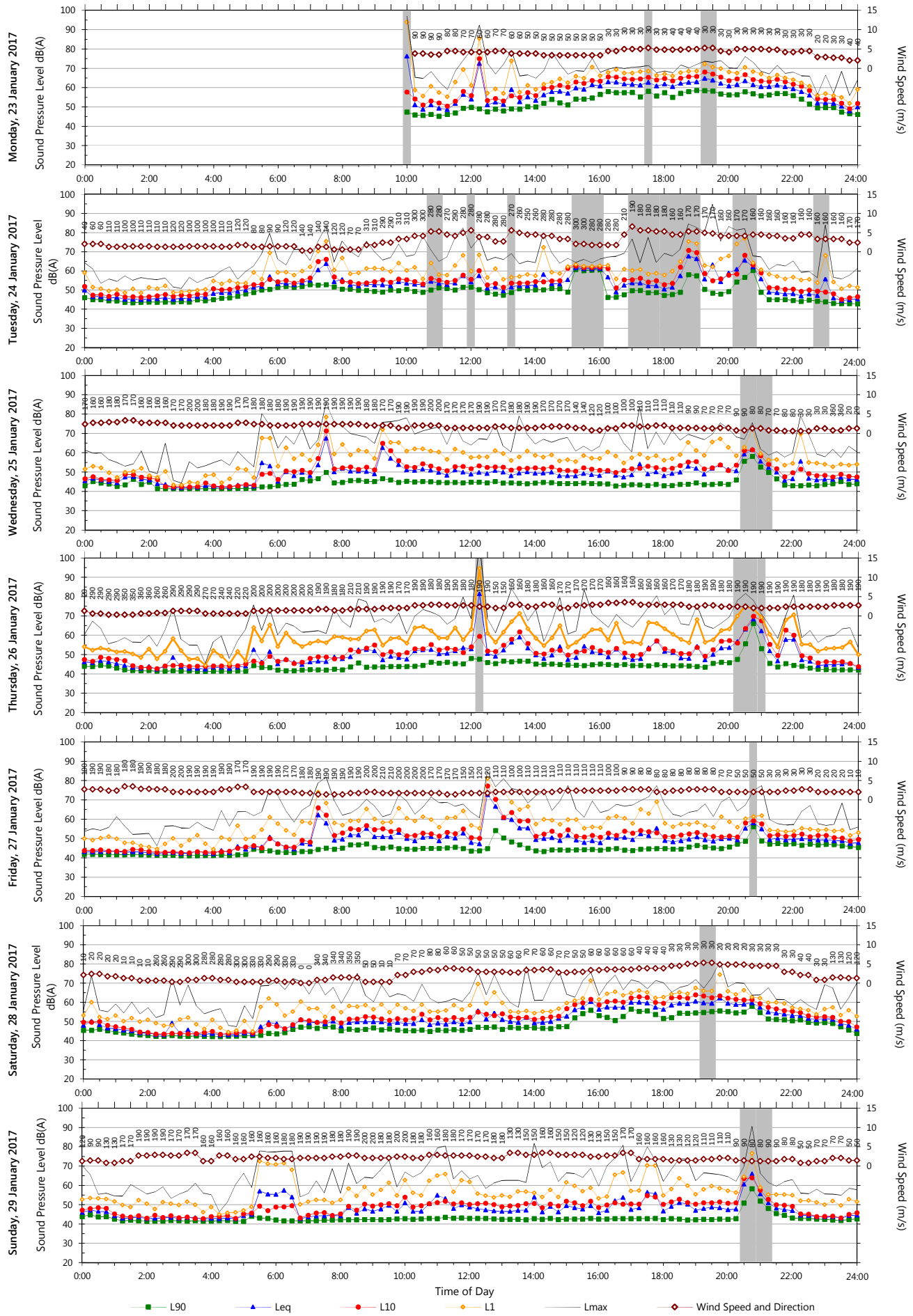
B.3 Noise vs time graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Long-term noise monitoring results

Unattended Monitoring Results

Location: Loreto Kirribilli - Southern side of site

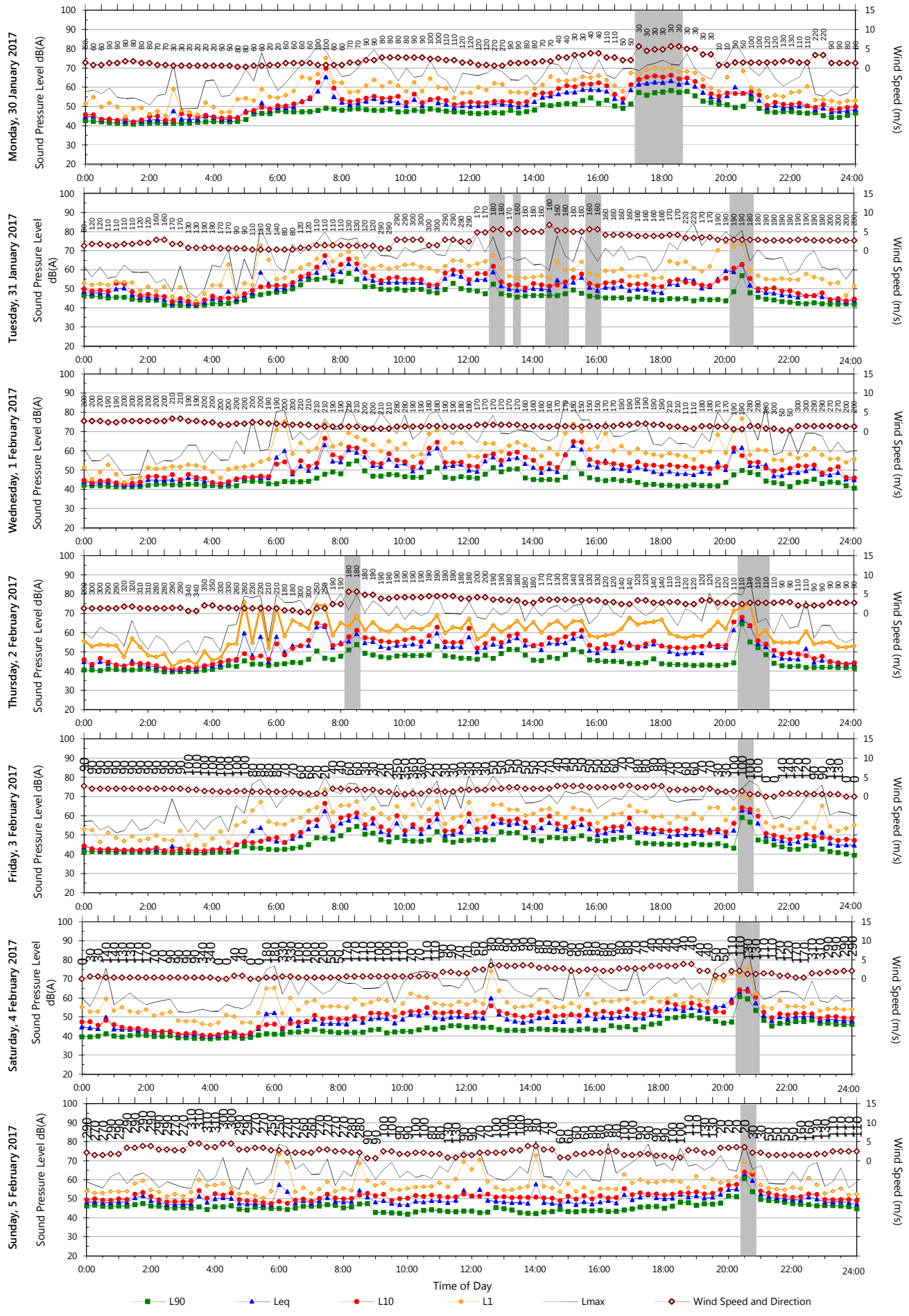


Data File: _123_Rpt_Report.txt

Template: QTE-26 (rev 14) Logger Graphs Program

Unattended Monitoring Results

Location: Loreto Kirribilli - Southern side of site

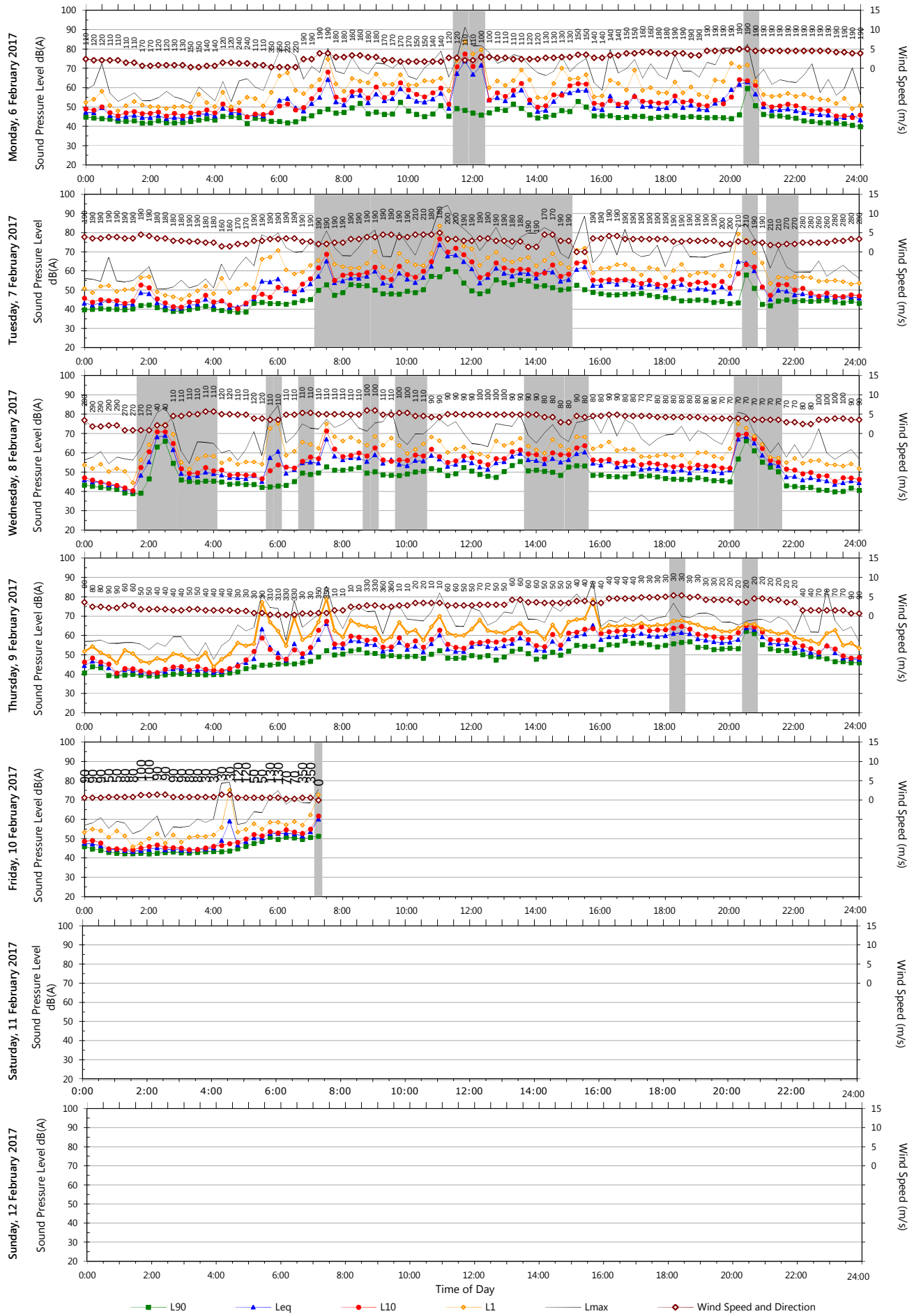


Data File: _123_Rpt_Report.txt

Template: QTE-26 (rev 14) Logger Graphs Program

Unattended Monitoring Results

Location: Loreto Kirribilli - Southern side of site

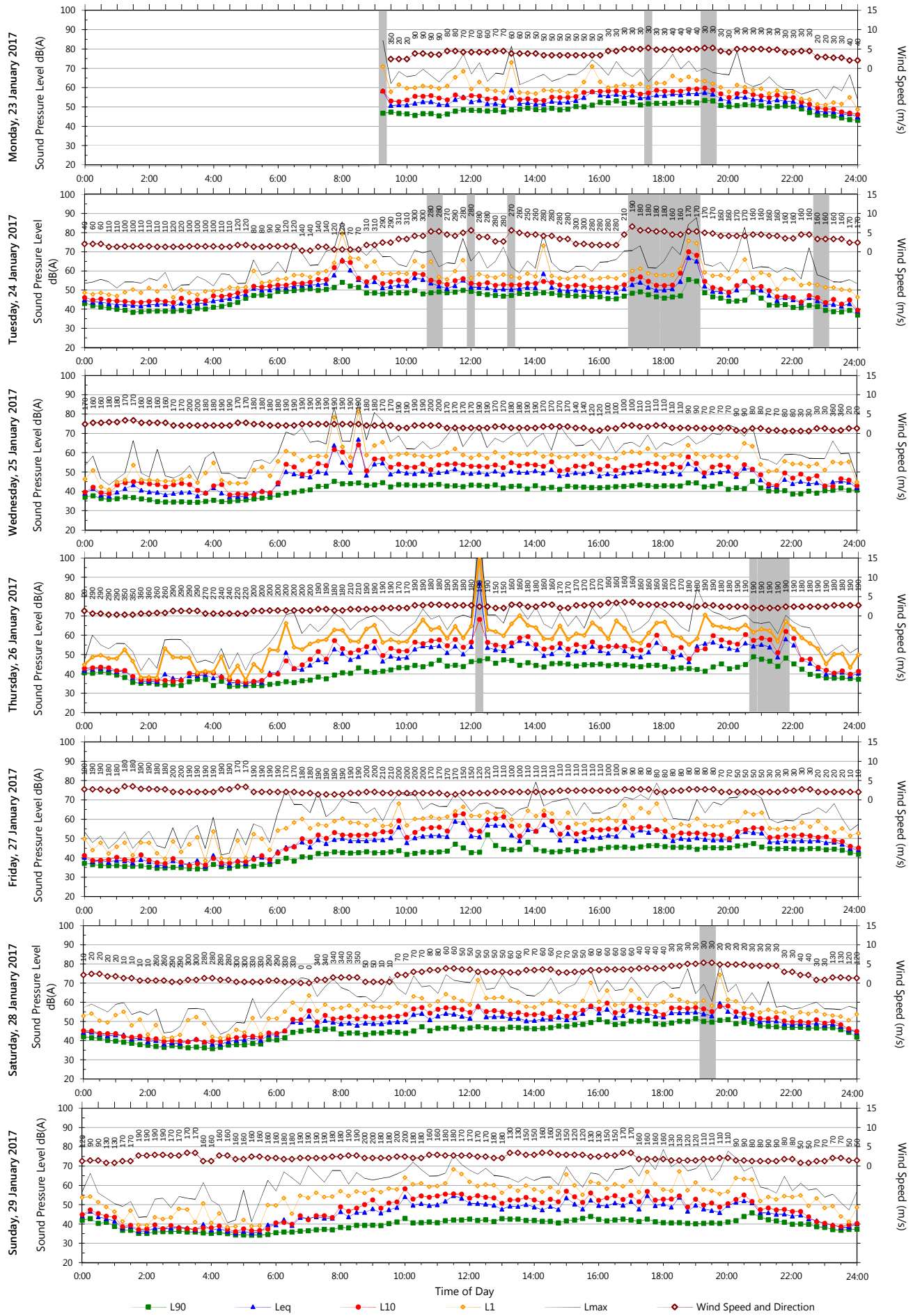


Data File: _123_Rpt_Report.txt

Template: QTE-26 (rev 14) Logger Graphs Program

Unattended Monitoring Results

Location: Loreto Kirribilli - NE corner of site



Data File: _123_Rpt_Report.txt

Template: QTE-26 (rev 14) Logger Graphs Program