ACOUSTICS AND AIR

KINCOPPAL ROSE BAY SCHOOL
PROJECT APPLICATION

CONSTRUCTION & OPERATIONAL NOISE REPORT

REPORT NO. 20187
VERSION A

JUNE 2020

PREPARED FOR

KINCOPPAL – ROSE BAY SCHOOL OF THE SACRED HEART
C/- MAHADAY MANAGEMENT

WILKINSON MURRAY

DOCUMENT CONTROL

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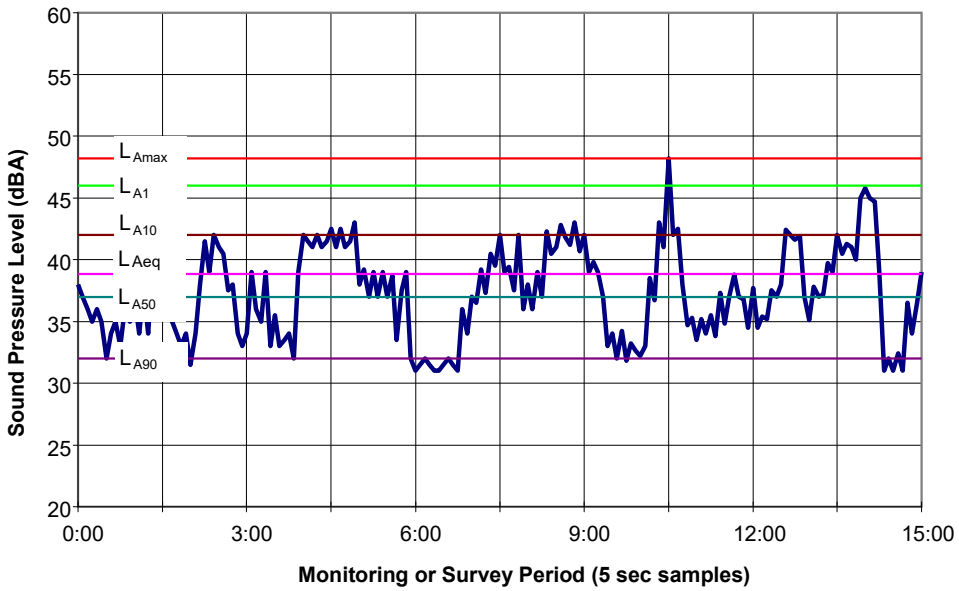
GLOSSARY OF ACOUSTIC TERMS

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



GLOSSARY OF REPORT TERMS

Term	**Definition**
The Site	2 Vaucluse Road: Lot 104 in DP 1092747
The Project	Whole Campus Masterplan and Stage 1 works.

ABBREVIATIONS

Abbreviation	**Meaning**
AS	Australian Standard
BCA	Building Code of Australia
CMP	Construction Management Plan
Council	Woollahra Council
CPTMP	Construction Parking and Traffic Management Plan
DOPIE/Department	NSW Department of Planning, Industry and Environment
DP	Deposited Plan
DSI	Detailed Site Investigation
EIS	Environmental Impact Statement
EPA	*NSW Environment Protection Authority*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESD	Ecologically Sustainable Development
Education SEPP	*State Environmental Planning Policy (Educational Establishments and Child Care Facilities) 2017*
GANSW	NSW Government Architect's Office
HIS	Heritage Impact Statement
HMS	Hazardous Materials Survey
IMP	Infrastructure Management Plan
Infrastructure Strategy	*State Infrastructure Strategy 2018-2038*

Abbreviation	Meaning
LGA	Local Government Area
m	metre
NIA	Noise Impact Assessment
OEH	Office of Environment and Heritage
OWMP	Operational Waste Management Plan
PSI	Preliminary Site Investigation
RAP	Remediation Action Plan
RAPs	Registered Aboriginal Parties
RMS	Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SEPP 55	*State Environmental Planning Policy No.55 – Remediation of Land*
sqm	Square Metres
SSD	State Significant Development
SEPP SRD	*State Environmental Planning Policy (State and Regional Development) 2011*
SSDA	State Significant Development Application
TfNSW	Transport for New South Wales
The Minister	The Minister for Planning, Industry and Environment
The Regulation	*Environmental Planning and Assessment Regulation 2000*
Urbis	Urbis Pty Ltd

1 INTRODUCTION

Wilkinson Murray Pty Limited has been commissioned by Kincoppal Rose Bay School (the **Applicant**) to prepare this noise impact assessment in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (**SEARs**), and in support of the SSD-10325 for Kincoppal Rose Bay School (Concept and Stage 1)

This assessment responds to the issues raised in item 12 (Concept) and Item 6 (Stage 1) of the SEARs and the following table details the areas in this Assessment that address the items identified.

<table>
<tr><th>SEARs</th><th colspan="2">Report Reference</th></tr>
<tr><td><u>Concept Proposal</u></td><td colspan="2"></td></tr>
<tr><td rowspan="5">12. Noise and Vibration

Identify and assess operational noise at a concept level, including consideration of any use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.

Relevant Policies and Guidelines:
• NSW Noise Policy for Industry 2017 (EPA)
• Interim Construction Noise Guideline (DECC)
• Assessing Vibration: A Technical Guideline 2006
• Development Near Rail Corridors and Busy Roads – Interim Guideline
• (Department of Planning, 2008)</td><td>Item</td><td>Section</td></tr>
<tr><td>Operational Noise</td><td>Section 6.1</td></tr>
<tr><td>Mechanical Services</td><td>Section 6.3</td></tr>
<tr><td>Public Address System and School Bell</td><td>Section 6.6</td></tr>
<tr><td><u>Stage 1 works</u></td><td colspan="2"></td></tr>
<tr><td rowspan="7">6. Noise and Vibration

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

Identify and assess operational noise including consideration of any public address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.

Relevant Policies and Guidelines:
• Interim Construction Noise Guideline (DECC)
• Assessing Vibration: A Technical Guideline 2006</td><td>Item</td><td>Section</td></tr>
<tr><td>Construction Noise</td><td>Section 5.5</td></tr>
<tr><td>Construction Vibration</td><td>Section 5.7</td></tr>
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<tr><td>Roof Terrace</td><td>Section 6.4</td></tr>
<tr><td>Public Address System and School Bell</td><td>Section 6.6</td></tr>
</table>

2 DESCRIPTION OF SITE

The school is sited on the western side of New South Head Road at 2 Vaucluse Road within the established residential neighbourhood of Vaucluse in Sydney's eastern suburbs and is located within the Woollahra Council Local Government Area (LGA).

The site is irregular in shape and is located approximately 10 kilometres east of Sydney CBD and caters for boys (ELC-6) within the Junior School and girls (ELC-12) within both the Junior School and Senior School.

The legal description of the site is Lot 104 in DP 1092747 and the site's address is commonly identified as either 2 Vaucluse Road, Vaucluse or New South Head Road, Rose Bay.

The school site spans both the eastern and western sides of Vaucluse Road. The outdoor play areas, sports facilities and landscaped spaces are predominantly located on the eastern side of Vaucluse Road, including the Maureen Tudhope Centre (MTC), while the main school campus on the western side of Vaucluse Road comprises extensive grounds and includes a mix of building typologies ranging in age, architectural style and heritage significance.

As part of the main school campus on the western side of Vaucluse Road, the Junior School is situated within the northern portion and the Senior School within the southern portion of the site.

The location of the site and its relationship with surrounding development is illustrated in Figure 2-1.

Figure 2-1 Aerial photograph of the site

Source: Urbis

The site is currently surrounded by multiple low-density residential dwellings. Specifically, the site is surrounded by the following:

- North — Low-density residential dwellings and the St Michael's Anglican Church.
- South — Directly adjacent to the south is Forsyth Park and several low-density residential dwellings. Further south beyond Bayview Hill Road is Kambala School.
- East — To the east the pattern of low density residential continues.
- West — To the west is the Heritage Foreshore Walk that is adjacent to Sydney Harbour.

3 PROJECT DESCRIPTION

KRB extends across both sides of Vaucluse Road, however the proposed works is limited to the land on the western side of the road. The proposal reinforces KRB's commitment to providing modern facilities required for a contemporary teaching and learning environment. The proposed works seek to upgrade and adaptively reuse the existing facilities and provide new facilities to address immediate operational needs and to enable the long-term growth of the school for the future generation.

Through this proposal, KRB is seeking to cater for the increased demand of high-quality teaching and learning spaces. The proposed development will adaptively reuse existing buildings to provide new classrooms, collaborative learning spaces, amenities, staff areas and improve access and circulation into and throughout the campus.

3.1 Concept & Detailed Development

3.1.1 Concept Development

The proponent requests that part of the proposed State Significant Development (SSD) application be treated as concept development application (DA) made pursuant to clause 4.22(1) of the EP& A Act.

The proposal seeks concept approval for the following works as shown on the Architectural concept plans prepared by BVN, noting that these works would be the subject of further detailed applications at a later stage:

- Refurbishment of internal spaces within the Senior School to create an integrated circulation hub providing a greater level of access, circulation and permeability through the School (Precinct B).
- Internal alterations to the Hughes Centre (Precinct B).
- Provision of on on-site bus parking bay and associated parking area adjacent to the main entrance (Precinct B).
- The extension and expansion of the existing boarding house (Precinct C).

3.1.2 Detailed Development

The application also seeks consent for detailed components for the first stage of development which involves the detailed design, construction, fit out and operation of the following components:

Junior School (Precinct A)

The proposed works associated with the Junior School is intended to comprise of the following:

- Expansion of the Early Learning Centre (ELC) to accommodate the pre-school (Joigny Centre).
- Alterations and additions to the Junior School to include new general learning spaces, outdoor play areas, amenities, storage and wet areas for K-4 students, a new K-6 assembly hall and a new vertical circulation hub.

- Refurbishment of Levels 1 to 3 of the East Wing, including an extension of the roof to the building line and enclosure of the top floor to create additional teaching and learning spaces.
- A new roof terrace on top of the east wing.

Senior School (Precinct B)

The proposed works associated with the Senior School is intended to comprise of the following:

- Expansion and refurbishment of Level 3 of the North Wing to provide additional learning and staff areas for Year 8.
- Refurbishment of the Senior School Reception and upgrade of the Main Entrance, including replacement of vehicular access with pedestrian friendly access and associated landscaping.
- Reconfiguration of the main forecourt to provide a dedicated bus parking area for set down/pickup, separate carpark area and separate pedestrian pathway.
- Construction of a new driveway crossing and internal road from Vaucluse Road.

The proposed development will be staged, as the School will continue to operate during the various project works.

It is noted that no community uses or additional out of hours activities or operations are proposed.

Figure 3-1 Proposed development

Source: BVN Architects

4 AMBIENT NOISE MONITORING

4.1 Ambient Noise Levels at the Site

Residential receivers surrounding the site that may be affected by construction and operational noise have been identified. Other nearby land holdings are occupied for commercial use. These are detailed in Table 4-1 and shown in Figure 4-1

Figure 4-1 Aerial showing noise monitoring locations

Table 4-1 Surrounding receivers

Receivers	Address
A – Southern Residences	Bayview Hill Drive Vaucluse
B – Northern Residences	Vaucluse Road Vaucluse

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.

Long-term noise monitoring locations are presented in Table 4-2 and shown in Figure 4-1.

Table 4-2 Long-term noise monitoring locations

Logger	Location	Monitoring Period
1	Boundary with 5A Bayview Hill Road	1st -11th May 2020
2	Boundary with 2A Vaucluse Road	12th – 19th May 2020

The noise monitoring equipment used for the 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 4-3 summarises the noise results, for daytime, evening and night time periods as defined in the EPA's *Interim Construction Noise Guidelines (ICNG)* and the NSW *Noise Policy for Industry (NPfI)*.

Table 4-3 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	43	39	36	43	52	46	44	50
2	43	40	38	42	57	46	47	48

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

Results of noise monitoring are presented in Appendix A.

5 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

5.1 Construction Noise Criteria

The following sections detail the applicable site-specific noise and vibration criteria for Stage 1 works based on the EPA *Interim Construction Noise Guideline*.

5.1.1 Construction Noise Management Levels

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

For residences, the 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 defined by the EPA as 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 5-1 details the *ICNG* noise management levels (NMLs).

Table 5-1 Construction noise management levels at residences using quantitative assessment

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

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

In addition, the following NMLs ($L_{Aeq,15min}$) are recommended for other receivers and areas:

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

Based on the above, Table 5-2 presents the applicable NMLs for construction activities at surrounding receivers that have been adopted for all applications.

Table 5-2 Site-specific construction noise management levels

Area	NML (L_{Aeq} – dBA)				Highly noise affected noise level, L_{Aeq} dBA
	Day	Evening	Night	Saturday*	
A – Southern Residences	53	44	41	53	75
B – Northern Residences	53	45	43	52	75

* Saturday construction hours 8am to 1pm.

5.2 Hours of Operation & Programme

The proposed working hours for this project, are as follows:

- Monday to Friday 7.00am to 5.00pm
- Saturday 8.00am to 1.00pm
- Sunday and Public Holidays No work

This approach is consistent with the EPA as these times are within the period defined as "standard hours". If required, after hours permits will be sought from the relevant authorities.

5.3 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 5-3.

Table 5-3 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 5-4.

Table 5-4 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.

5.3.1 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 5-5.

Table 5-5 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 5-5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

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

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

In addition to the British Standard, for the case of nearby heritage buildings, guidance for structural damage is derived from the German Standard DIN 4150 -3 *Structural Vibration Part 3 – Effects of Vibration on Structures*. Table 5-6 details these recommendations for heritage buildings.

Figure 5-1 Graph of transient vibration guide values for cosmetic damage

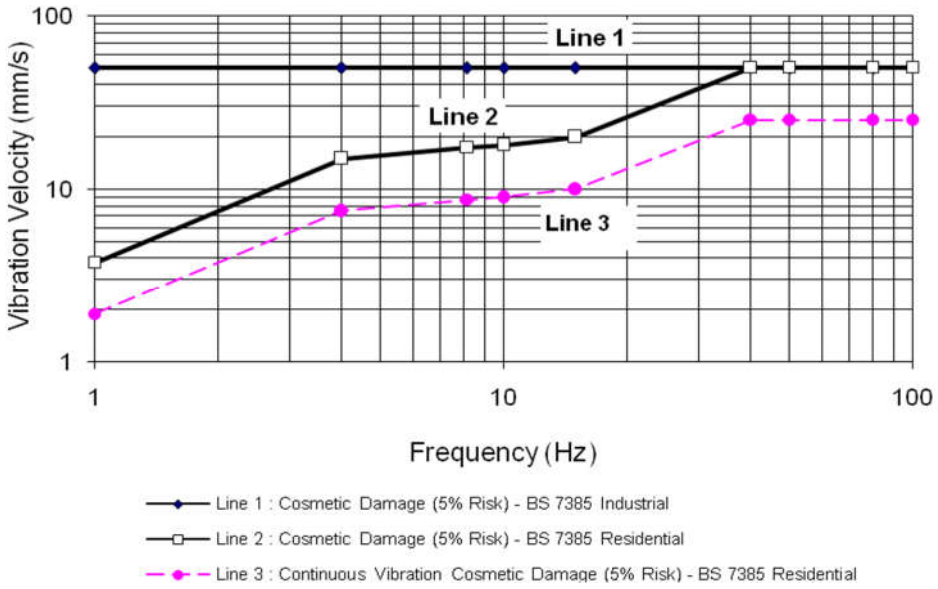


Table 5-6 DIN 4150 recommended Peak Particle Velocity (PPV) vibration levels for heritage buildings

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

5.4 Construction Equipment & Noise Source Levels

Sound Power Levels (SWLs) for typical construction plant are identified in Table 5-7. 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 5-7 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 – 120mm 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
Mid sized Excavator / (with hammer)	108/117	83/92

Plant	Sound Power Level	Sound Pressure Level at 7m
Crawler Cranes	98	73
Tower Crane	104	79
Front End Loader	112	87

5.5 Construction Noise Predictions

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

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

- Equipment sound level emissions and location
- Screening effects from buildings
- Receiver locations
- Ground topography
- Noise attenuation due to geometric spreading
- Ground absorption
- Atmospheric absorption.

Modelling has been conducted for a number of construction scenarios. The four works scenarios considered are summarised in Table 5-8.

Table 5-8 Construction scenarios for North End – Area A

Scenario	Description	Works
A	Demolition / Strip out	Removal of existing structure infills, e.g. brickwork, using jack hammers. Truck movements – loaded into trucks sent off site.
B	Building Construction Vertical Riser – Lift Area	1 concrete pump, 2 forklifts, 1 compressor, 1 crane, a boom truck and tower crane are assumed to operate in 15 minutes. Also, concrete trucks and normal delivery trucks assumed to be one movement in 15 minutes.
C	Facade / Fitout	Forklift, truck, tower crane and power tools assumed. Two truck movements in 15 minutes assumed.
D	Building Construction New ELC Building	1 concrete pump, 2 forklifts, 1 compressor, 1 crane, a boom truck are assumed to operate in 15 minutes. Also, concrete trucks and normal delivery trucks assumed to be one movement in 15 minutes.

Table 5-9 Construction scenarios for Carpark & Landscaping – Area B

Scenario	Description	Works
A	Excavation	Excavation of site using excavators and rock saws. Truck movements – loaded into trucks sent off site.
B	Piling	This scenario includes concreting and lifting. Auger Piling of Carpark foundation.
C	Construction	1 concrete pump, 2 forklifts, 1 compressor, 1 crane, a boom truck and tower crane are assumed to operate in 15 minutes. Also, concrete trucks and normal delivery trucks assumed to be two movements in 15 minutes.
D	Landscaping	1 backhoe / bobcat and power tools are assumed to operate in 15 minutes. Also, trucks and normal small trucks assumed to be one movement in 15 minutes.

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 5-10 details results of construction noise modelling for each scenario.

Table 5-10 Predicted construction noise levels North End Area A – $L_{Aeq(15\ min)}$ – dBA

Residential Receiver	Predicted Noise Level (dBA)	NML (Weekday/ Saturday)	Exceedance (Weekday/ Saturday)
Scenario A – Demolition / Strip out			
2A Vaucluse	52	53 /52	0/ 0
13 Queens Avenue	42	53 / 52	0/ 0
Scenario B – Building Construction Vertical Riser – Lift Area			
2A Vaucluse	67	53 /52	14 / 15
13 Queens Avenue	57	53 / 52	4 /5
Scenario C – Facade / Fitout			
2A Vaucluse	62	53 /52	9 / 10
13 Queens Avenue	54	53 / 52	1/ 2
Scenario D – Building Construction New ELC Building			
2A Vaucluse	64	53 /52	11 / 12
13 Queens Avenue	64	53 / 52	11 / 12

A review of results of construction noise predictions indicates that these may be, at times, well above construction noise management levels at nearby residences particularly during the demolition stage; however, no predictions exceed the highly noise affected management level of 75dBA.

Table 5-11 Predicted construction noise levels South End – Area B – $L_{Aeq(15\ min)}$ – dBA

Residential Receiver	Predicted Noise Level (dBA)	NML (Weekday/ Saturday)	Exceedance (Weekday/ Saturday)
Scenario A – Excavation			
2A Vaucluse	60	53 /53	7 / 7
13 Queens Avenue	47	53 /53	0 / 0
Scenario B – Piling			
2A Vaucluse	53	53 /53	0 / 0
13 Queens Avenue	44	53 /53	0 / 0
Scenario C – Construction			
2A Vaucluse	61	53 /53	8 / 8
13 Queens Avenue	51	53 /53	0 / 0
Scenario D – Landscaping			
2A Vaucluse	47	53 /53	0 / 0
13 Queens Avenue	44	53 /53	0 / 0

5.6 Discussion of Results

Exceedances of noise management levels of up to 14 dBA (Weekdays) and 15 dBA (Saturdays) at residences to the north of the site may be expected during lift shaft construction when major equipment is located on site. This magnitude of exceedance is consistent with similar sites where residences overlook development sites.

During the demolition and fit out stages, the magnitude of exceedance will reduce due to the nature of construction activities.

At the Southern End of the site exceedances of up to 8 dBA can be expected for excavation and construction works. During the piling and landscaping stages, no exceedance is predicted.

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.

5.7 Construction Vibration Assessment

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

Table 5-12 sets out the typical ground vibration levels at various distances for safe working distances.

Table 5-12 Recommended safe working distances for vibration intensive plant

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

- Construction Noise & Vibration Strategy (V4.1), 2019, TfNSW.

The highest vibration levels will occur when excavation equipment is located in Area B of the site near residences on the southern 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 15 metres. Therefore, the use of medium to large rock breakers in the ground should be avoided on the structural damage to nearby buildings.

It is noted that the use of rock breakers in the excavation of the Area B site carpark should be limited and the use of rock saws, which generate much lower vibration levels, should be adopted.

At the northern end of the suite (Area A) noise vibration intensive activities are associated with these works that will impact adversely on surrounding residences.

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.

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.

5.8 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:

- Selection of quietest feasible construction equipment.
- Use of rock saws in preference to rock breakers where feasible; and
- Localised treatment such as barriers, shrouds, and the like around fixed plant such as pumps, generators, and concrete pumps.

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

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

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

5.9 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.

5.10 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.

5.11 Management of Construction Noise & Vibration to the School

Noise and vibration levels from construction are likely to be similar to the levels predicted for receivers immediately surrounding the site. The Construction Noise Management Plan would adopt procedures to manage construction noise within the school.

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

- Closing of classroom windows and installation of secondary windows were deemed necessary;
- Relocating classes during busy construction periods; and
- Scheduling works during school holidays.

The management of construction noise and vibration between the site and school areas will be managed internally by the school itself.

6 OPERATIONAL NOISE & VIBRATION

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

6.1 Operational Noise Criteria

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

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

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

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

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

Intrusiveness Noise Level

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

Amenity Noise Level

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

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

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

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

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

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

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

An extract from the NSW *NPfI* that relates to the amenity noise levels for surrounding receivers is given in Table 6-1.

Table 6-1 Amenity noise levels

Receiver	Noise Amenity Area	Time of day[1]	Recommended Amenity Noise Level L_{Aeq} (dBA)
Residence	Suburban	Day	55
		Evening	50
		Night	40

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

Maximum Noise Level Events

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

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

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

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

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

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

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

6.2 Project Noise Trigger Levels

The amenity and intrusiveness noise levels and resulting project trigger levels (shown in **bold**) applicable to sources of continuous operational noise associated with the project (i.e. mechanical plant and equipment) are shown in Table 6-2.

Table 6-2 Project noise trigger levels

Receiver	Period	Intrusiveness Noise Level[1] $L_{Aeq,15min}$ (dBA)	Project Amenity noise Level[2] $L_{Aeq,15min}$ (dBA)
A – Northern Residence	Day	48	53
	Evening	44	48
	Night	41	38
B – Southern Residences	Day	48	53
	Evening	45	48
	Night	43	38

Note 1: Intrusiveness noise level is $L_{Aeq,15min} \leq$ RBL +5.
Note 2: Project amenity noise level (ANL) is suburban ANL minus 5dBA plus 3dBA to convert from a period level to a 15-minute level.

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

Table 6-3 Sleep disturbance trigger levels

Receiver	$L_{Aeq,15min}$	L_{AFmax}
A – Northern Residence	46	56
B – Southern Residences	48	58

6.3 Mechanical Services

The major mechanical noise sources associated with works in northern end of the site in Area A. In this are equipment is likely to be air-cooled condenser plant that will be located on the roof of the refurbished building that have yet to be determined.

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

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

Preliminary selection of major plant consists of:

- Rooftop Heat Pumps x 3 with a sound pressure level of 65dBA at 1 metre (each).
- Toilet Exhaust Fans with a sound pressure level of 43dBA at 1 metre.

Based on the above plant, a preliminary calculation at nearby residences indicates the following resultant noise levels as detailed in Table 6-4.

Table 6-4 Preliminary services noise levels at northern residences – dBA

Receiver	Prediected Noise Level	Day / Evening Noise Criteria
2A Vaucluse	35	48 / 44
13 Queens Avenue	30	48 / 44

A review of the results indicates that compliance is likely without the need for any noise mitigation plant. However, a detailed assessment of operational noise emission will be conducted at detailed design stage to confirm these findings.

Should it be determined at detail design stage that some mitigation to noise from mechanical plant is required, the following measures can be adopted where necessary:

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

The mechanical plant will be designed to meet the criteria presented in Table 6-2 at the identified nearby receivers.

It is noted that the only mechanical plant associated with the works in Area B with be a carpark exhaust fans services the new underground carpark. Based on a typical sound level of 65 dBA at 3 resultant noise level of 40 dBA can be expected at the nearest residences on 1 Bayview Hill Road. This indicates compliance with established day/ evening criteria of 48 / 45 dBA.

However, received at detailed design stage will be conducted to confirm this finding.

6.4 KBR Terrace Area

The roof of the KBR Junior School is proposed on the top of the refurbished building. Figure 6-1 illustrates this.

Figure 6-1 New terrace area

Based on the above layout we have predicted noise levels at surrounding residences based on:

- 20 persons peaking in a raised voice (68 dBA at 1 m) in the southern end of the terrace area.
- 5 persons speaking in a normal voice (60 dBA at 1 m) in the northern end of the terrace area garden.

Based on the above "worst case" scenario the following resultant noise levels have been predicted using the CadnaA noise model of the site.

Table 6-5 Preliminary services noise levels at northern residences – dBA

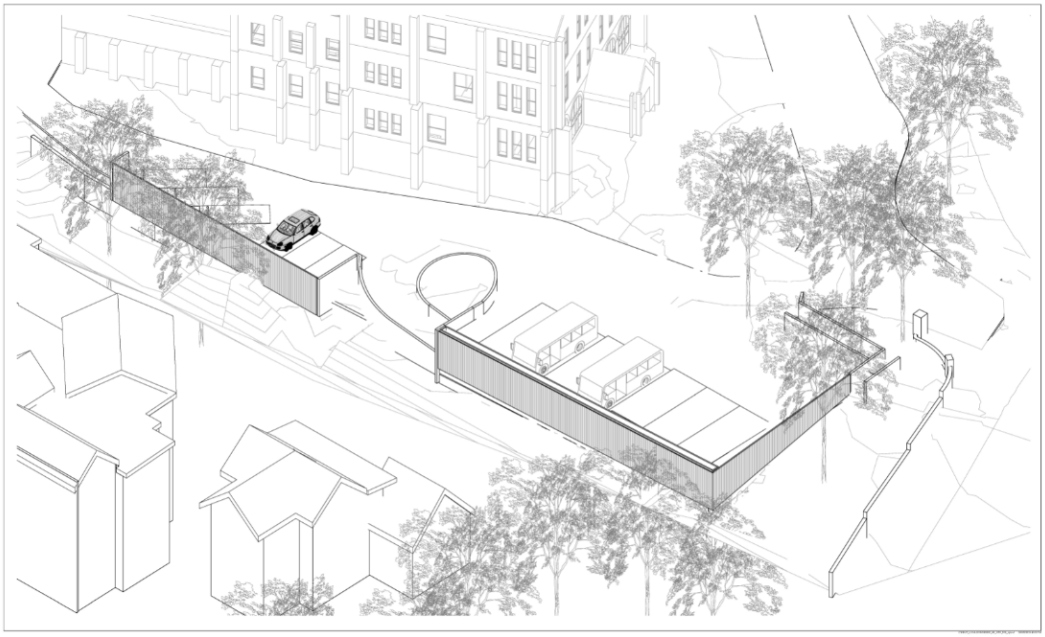
Receiver	Prediected Noise Level	Day Noise Criteria
2A Vaucluse	42	48
13 Queens Avenue	44	48

A review of results indicates that compliance with noise criteria is indicated for daytime operations. As use of this area is not proposed outside normal school hours.

6.5 Carpark & Bus Parking Area

It is proposed to construct the bus parking and below ground carpark as shown in Figure 6-2.

Figure 6-2 New carpark and bus parking area



In operational terms the buses will arrive between 8.00am and 8.30am each morning. They will remain parked until the end of the school day, and then exit the campus between 3.30pm and 4.00pm.

The carpark is for staff parking. The cars will arrive at campus between 7.45am and 8.30am. and depart between 3.30pm and 5.00pm.

Given the limited hours of use, the screening proposed at ground level and the fact that the carpark is to be underground the operation of these areas is not considered acoustically significant.

6.6 School Announcements & Bells

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

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

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

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

7 SUMMARY OF RECOMMENDATIONS

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

7.1 Construction Noise & Vibration

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 7-1 presents applicable noise management levels at residential receivers in the vicinity of the site.

Table 7-1 Site-specific construction noise management levels – dBA

Area	NML (L_{Aeq} – dBA)				Highly Noise Affected Noise Level, L_{Aeq} dBA
	Day	Evening	Night	Saturday*	
A – Southern Residences	53	44	41	53	75
B – Northern Residences	53	45	43	52	75

It has been determined that noise from construction activities during the day period will potentially exceed established construction noise management levels; however, no predictions exceed the highly noise affected management level of 75dBA. Therefore, the planning and management of construction activities must consider the sensitivities of surrounding residents so as to minimise the impact of construction activities at these receivers.

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

The following project-specific mitigation measures are recommended:

- Selection of quietest feasible construction equipment.
- Use of smaller rock breakers where feasible.
- Use of rock saws for excavation.
- Localised treatment, such as barriers, shrouds, and the like around fixed plant such as pumps, generators, and concrete pumps, etc.

7.2 Operational Noise

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

The applicable operational noise levels at residential in the vicinity of the site are presented in Table 7-2.

Table 7-2 Project noise trigger levels – dBA

Receiver	Period	Intrusiveness noise Level[1] $L_{Aeq,15min}$ (dBA)	Project Amenity Noise Level[2] $L_{Aeq,15min}$ (dBA)
A – Northern Residence	Day	48	53
	Evening	44	48
	Night	41	38
B – Southern Residences	Day	48	53
	Evening	45	48
	Night	43	38

Note 1: Intrusiveness noise level is $L_{Aeq,15min} \leq$ RBL +5.
Note 2: Project amenity noise level (ANL) is suburban ANL minus 5dBA plus 3dBA to convert from a period level to a 15-minute level.

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

To mitigate noise from mechanical plant, attenuators could be incorporated in the outlets of the exhaust fans. Attenuators can be installed to the fans if required. The mechanical plant noise emission would be designed to meet the criteria present in Table 7-2 at the closest receivers.

In the case of the proposed terrace area, noise has been assessed and determined to be compliant with criteria in Table 7-2 for daytime operation.

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

No community or additional out of hours uses are proposed with the development.

8 CONCLUSION

A construction and operational noise and vibration assessment of the Project at Kincoppal Rose Bay School development has been conducted. Site-specific noise criteria that are applicable to this project have been presented.

A noise assessment has been conducted for the proposed construction activities associated with the development to determine the potential for noise and vibration impact at surrounding receivers. Exceedances of construction noise management levels are expected at surrounding receivers to the north and South of construction sites.

Vibration associated with on-site construction activities is unlikely to impact on surrounding receivers provided heavy rock breakers are not used in Area B. Accordingly, management of noise from construction activities should be included in the Site Construction Environmental Management Plan.

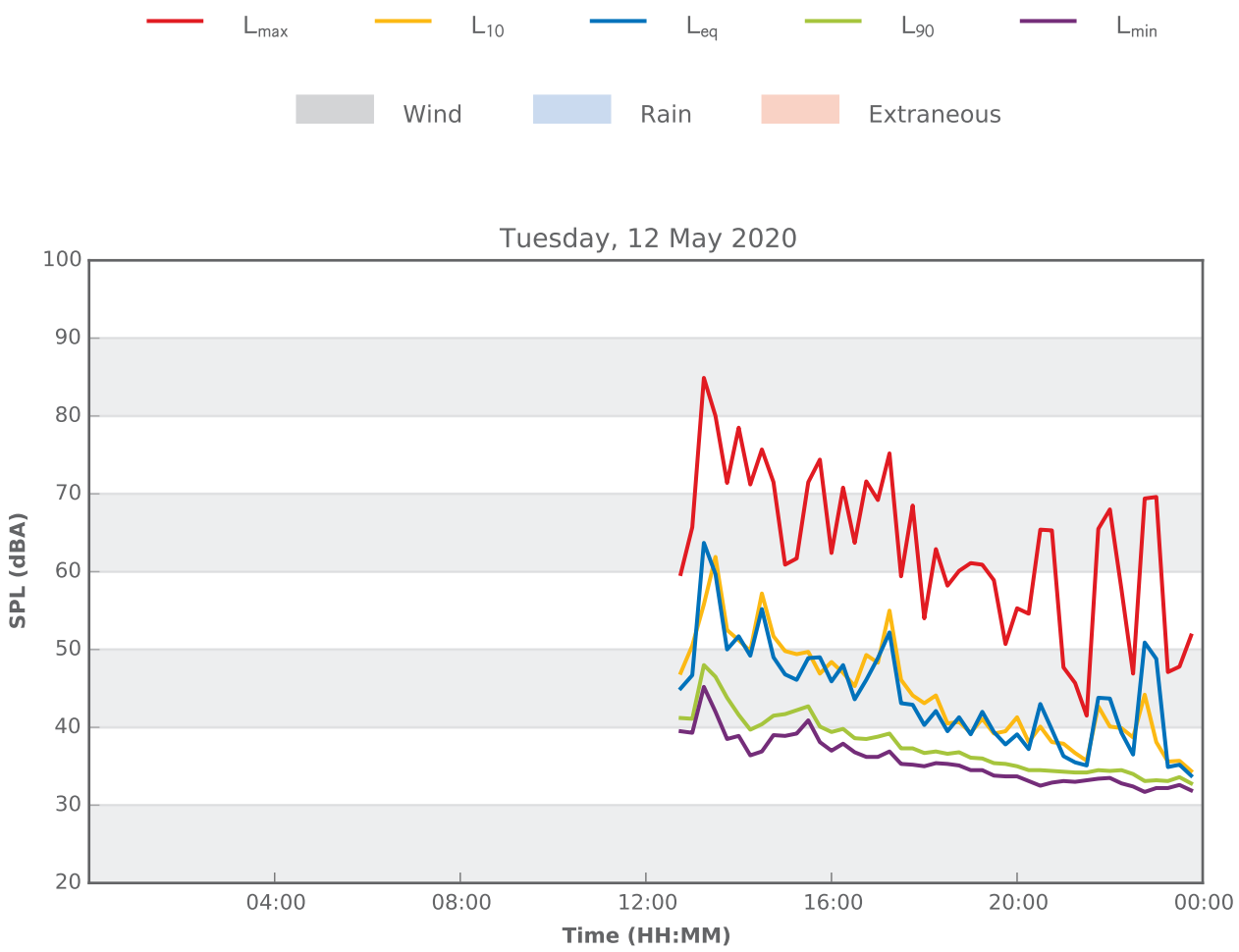
Site-specific operational noise criteria have been determined for the project based on ambient noise monitoring. A review of likely major plant indicates that noise levels can comply with established noise criteria during proposed operation with the inclusion of acoustic treatment. A review of all plant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

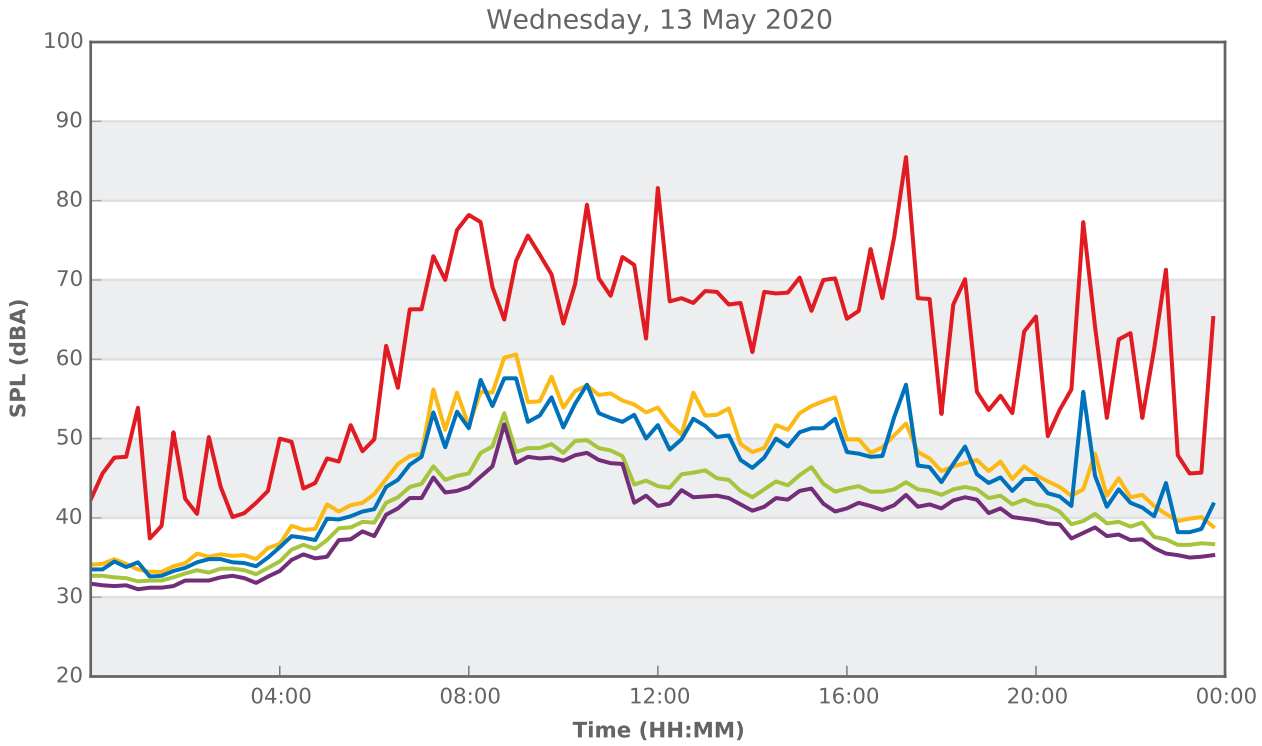
Noise emissions from the proposed new terrace have been assessed and determined to meet site specific noise criteria.

APPENDIX A

NOISE MEASUREMENT RESULTS

5 Bayview Hill Road, Vaucluse





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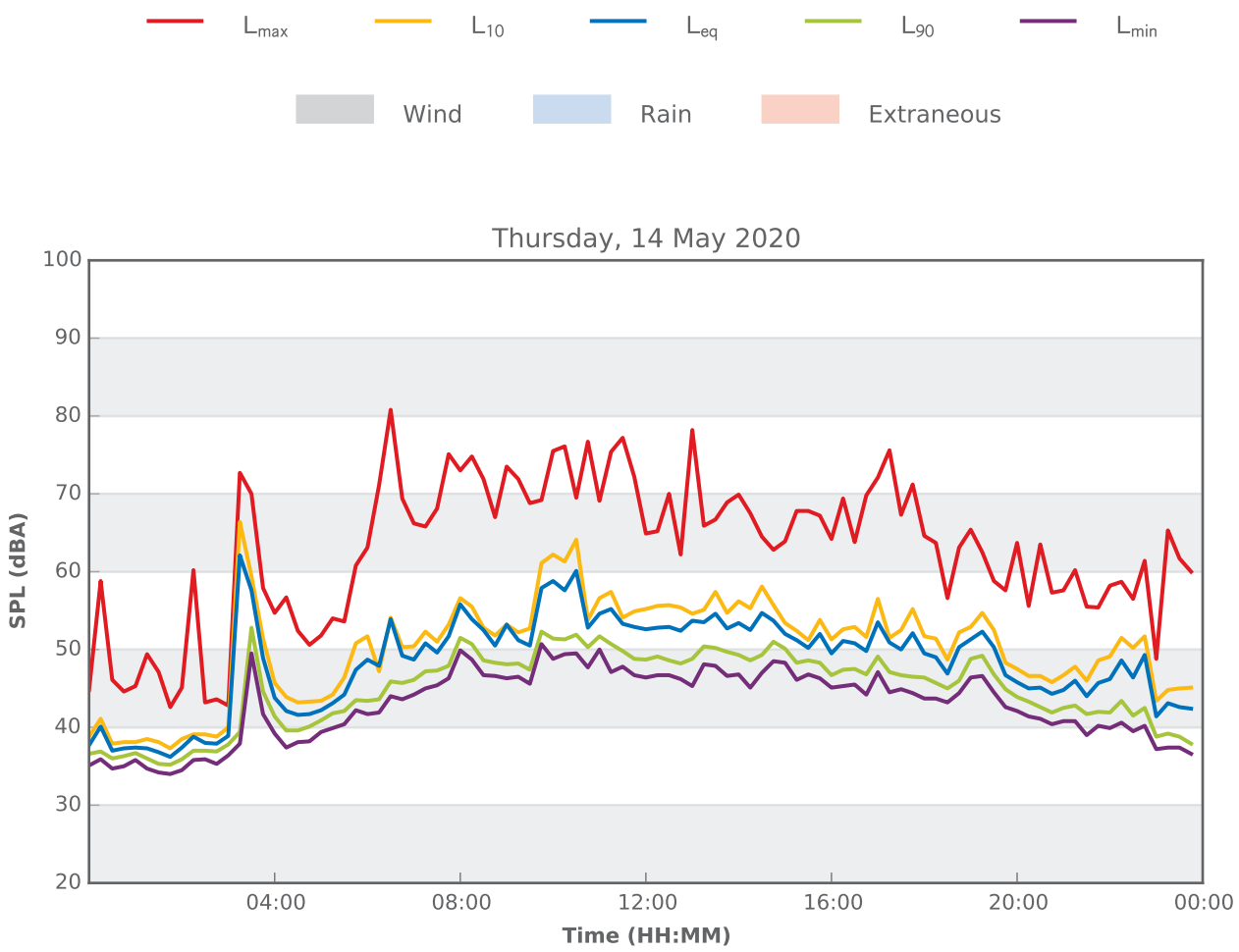
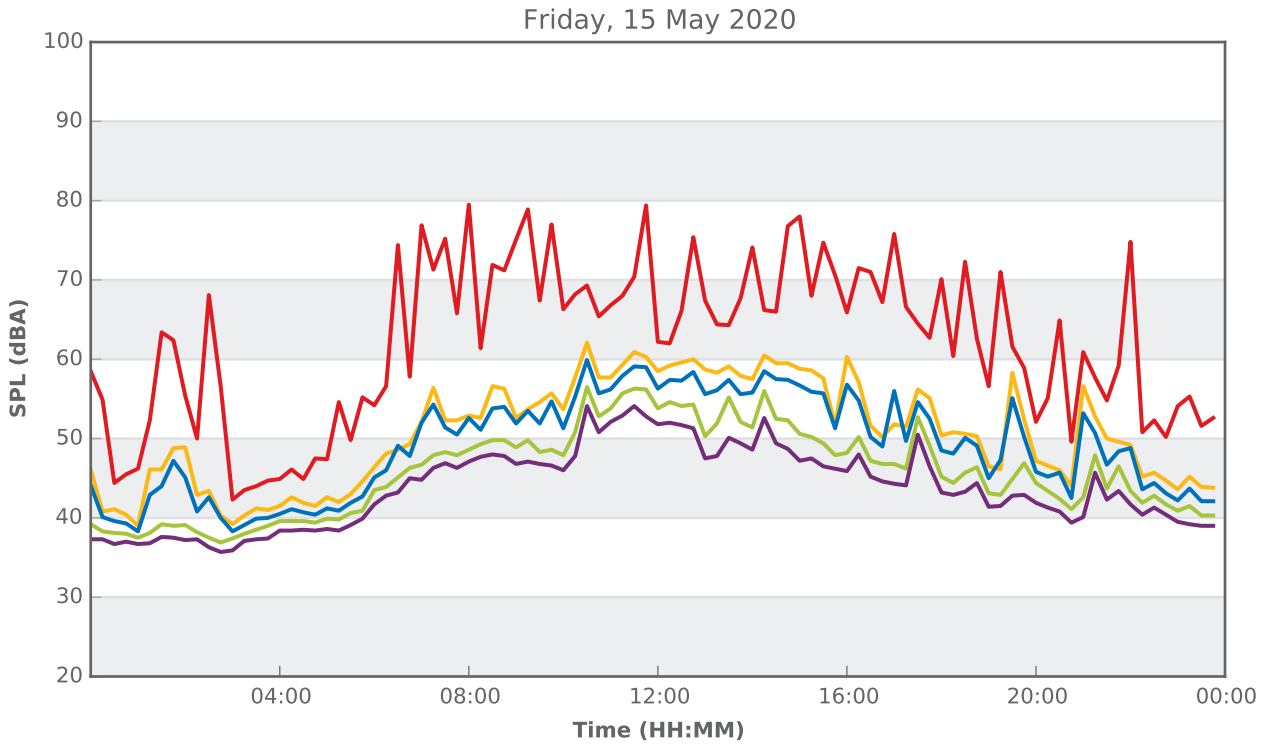
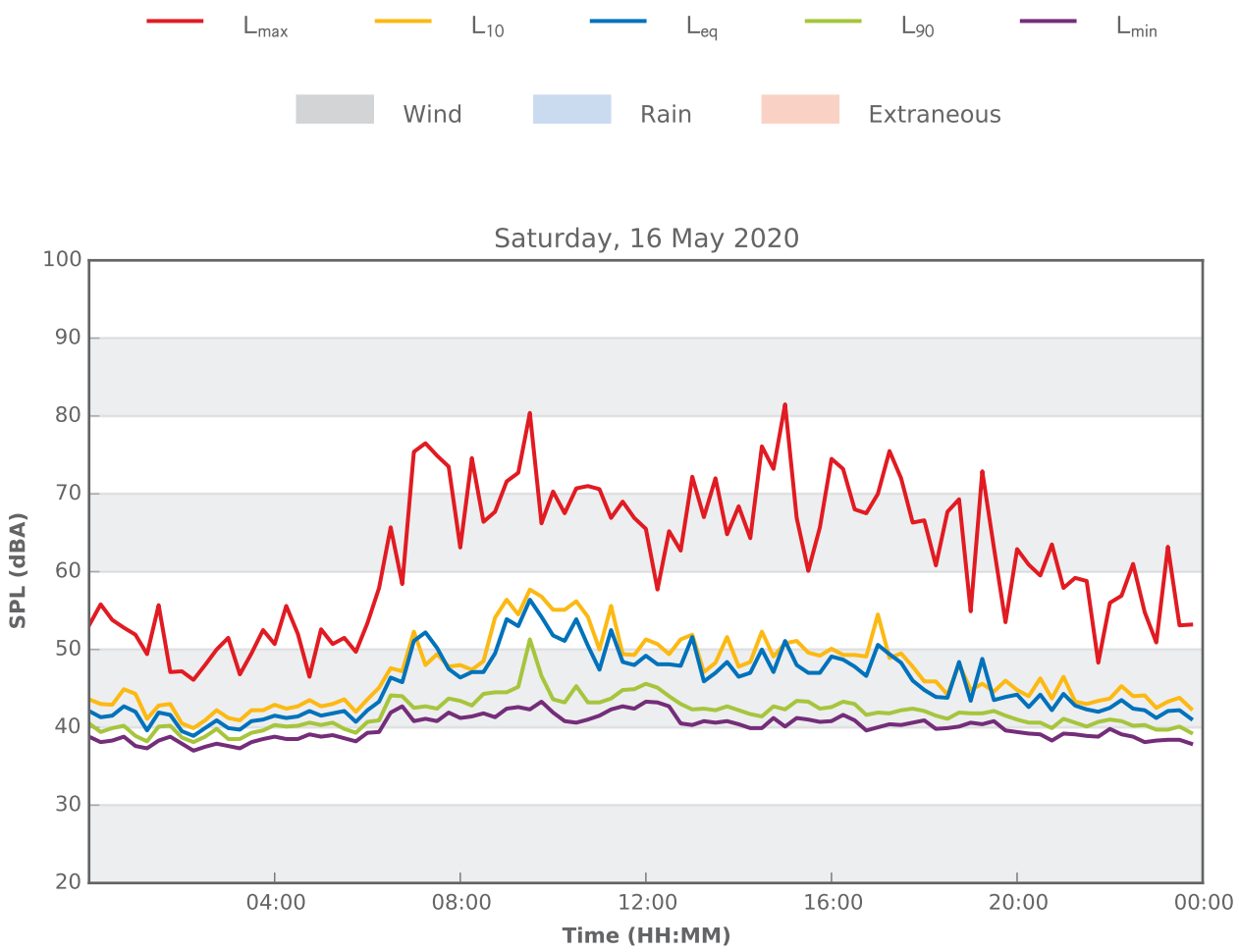
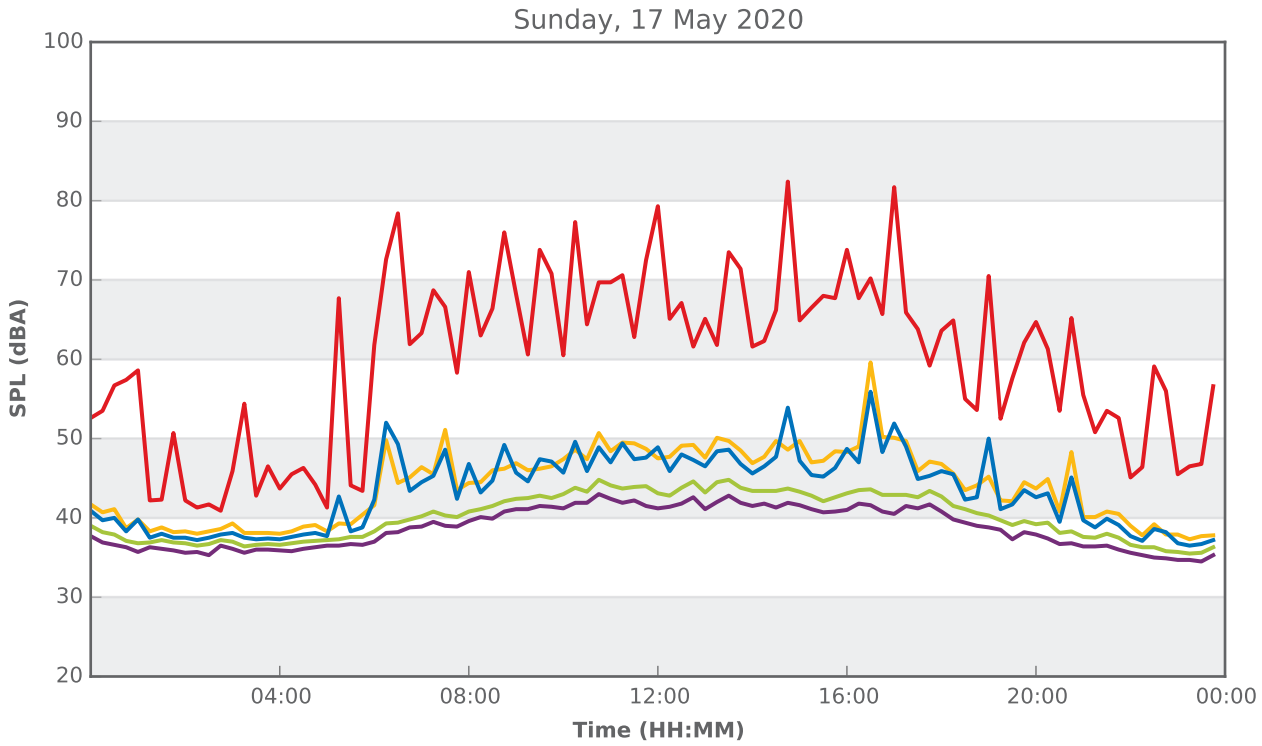




5 Bayview Hill Road, Vaucluse





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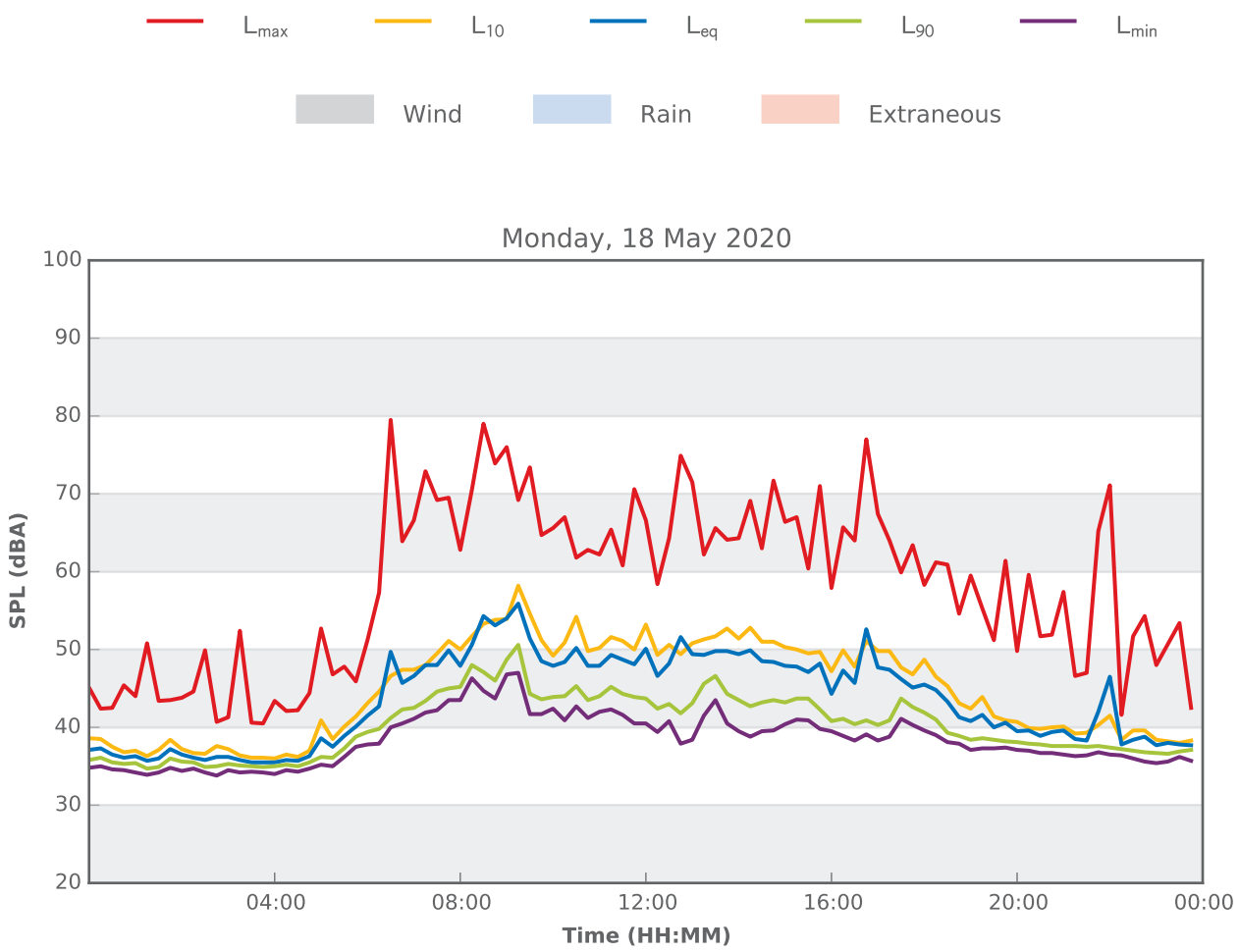

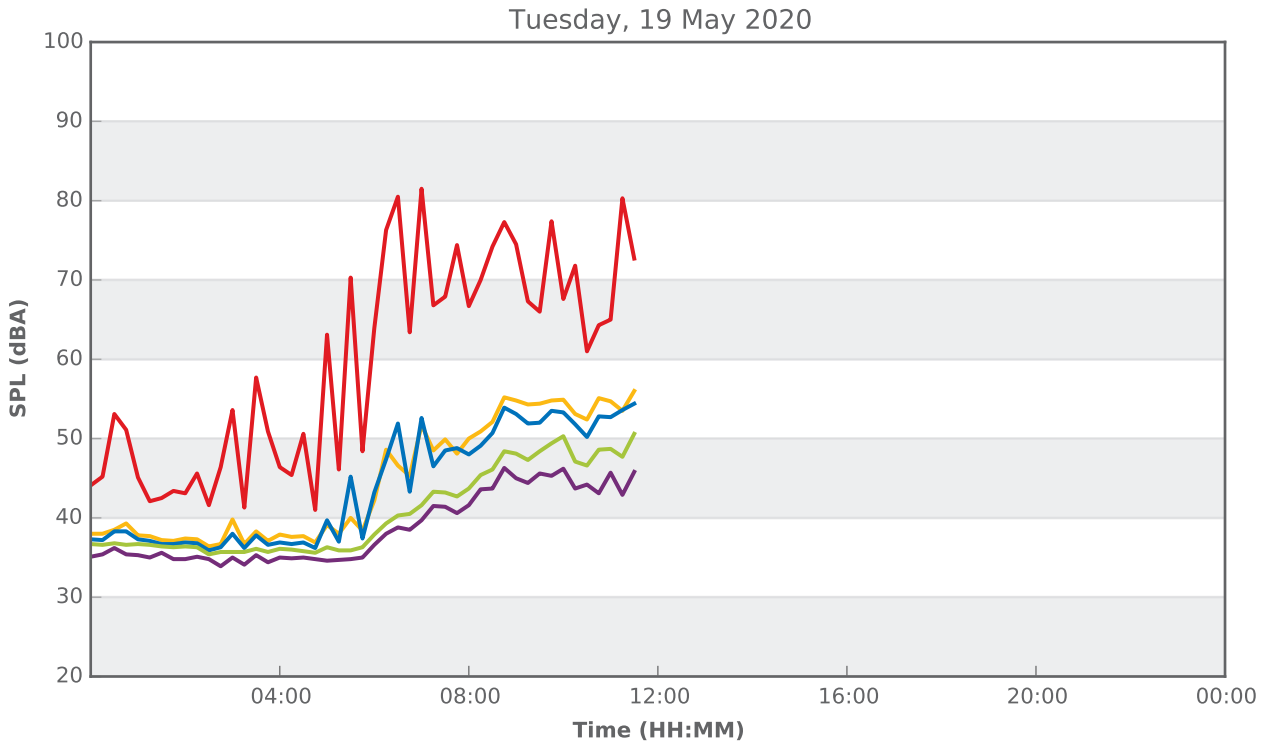

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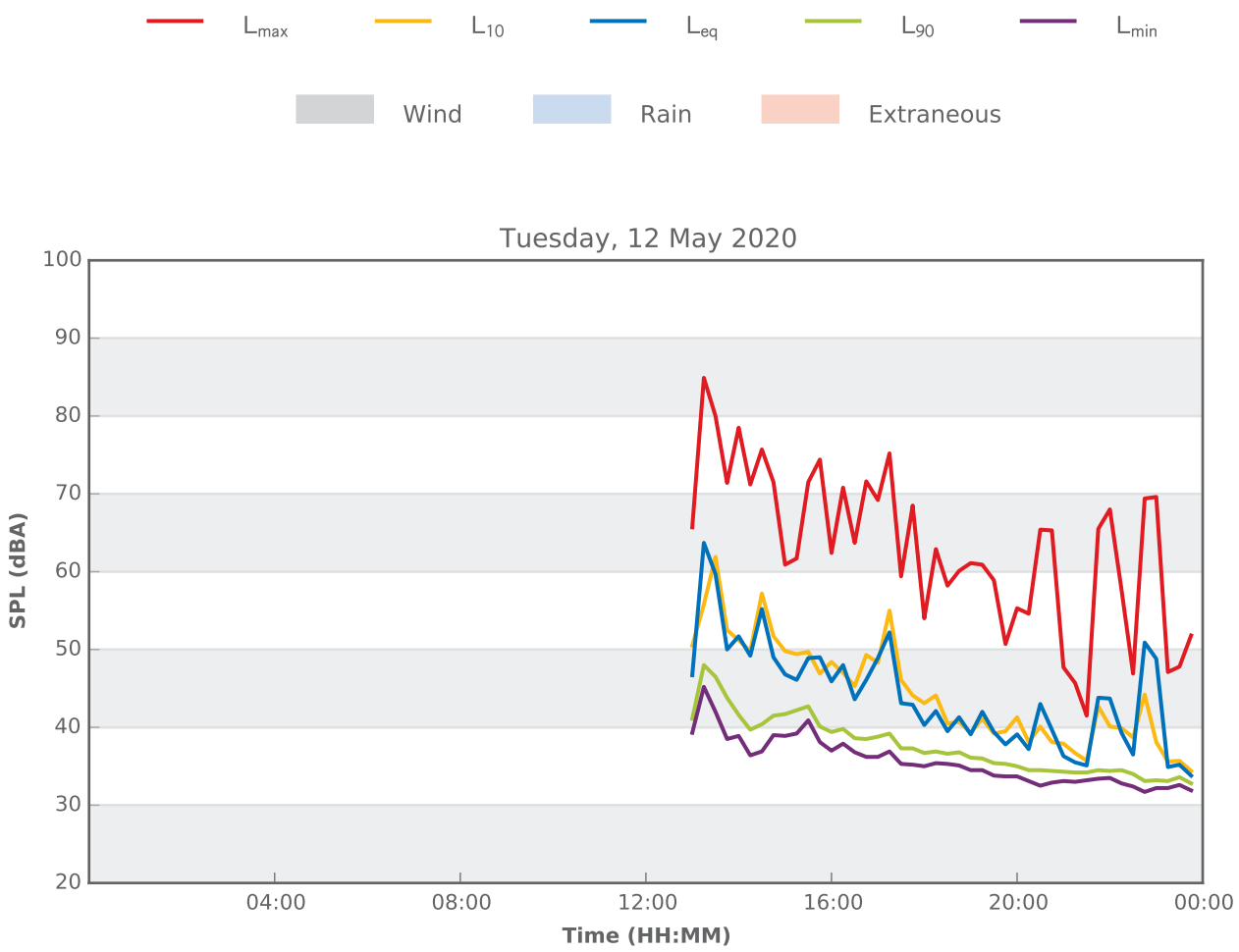

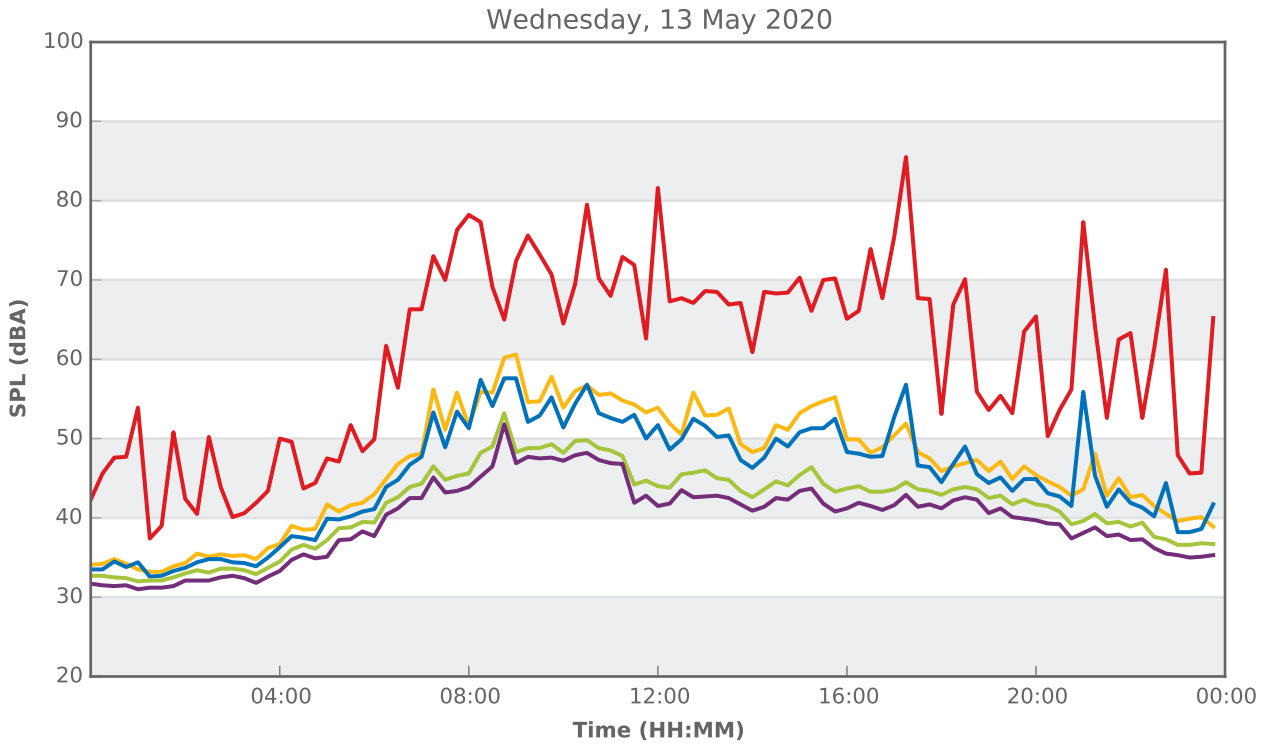

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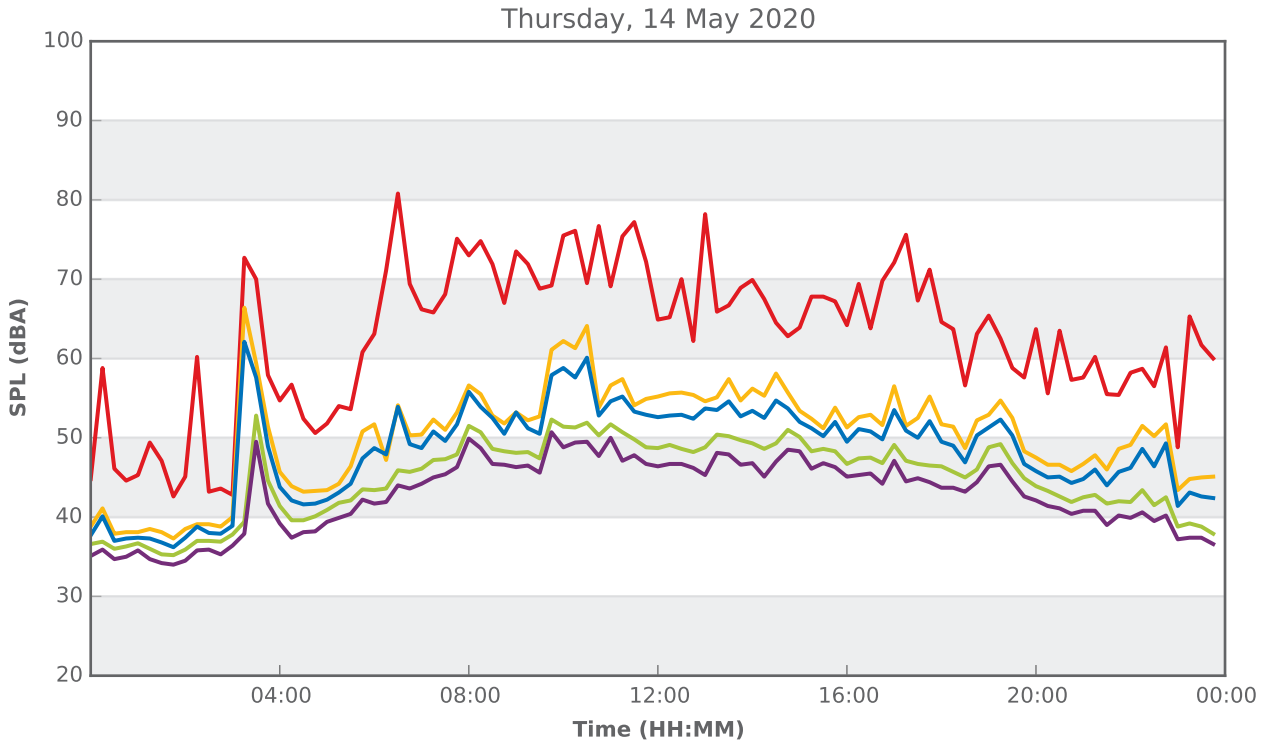
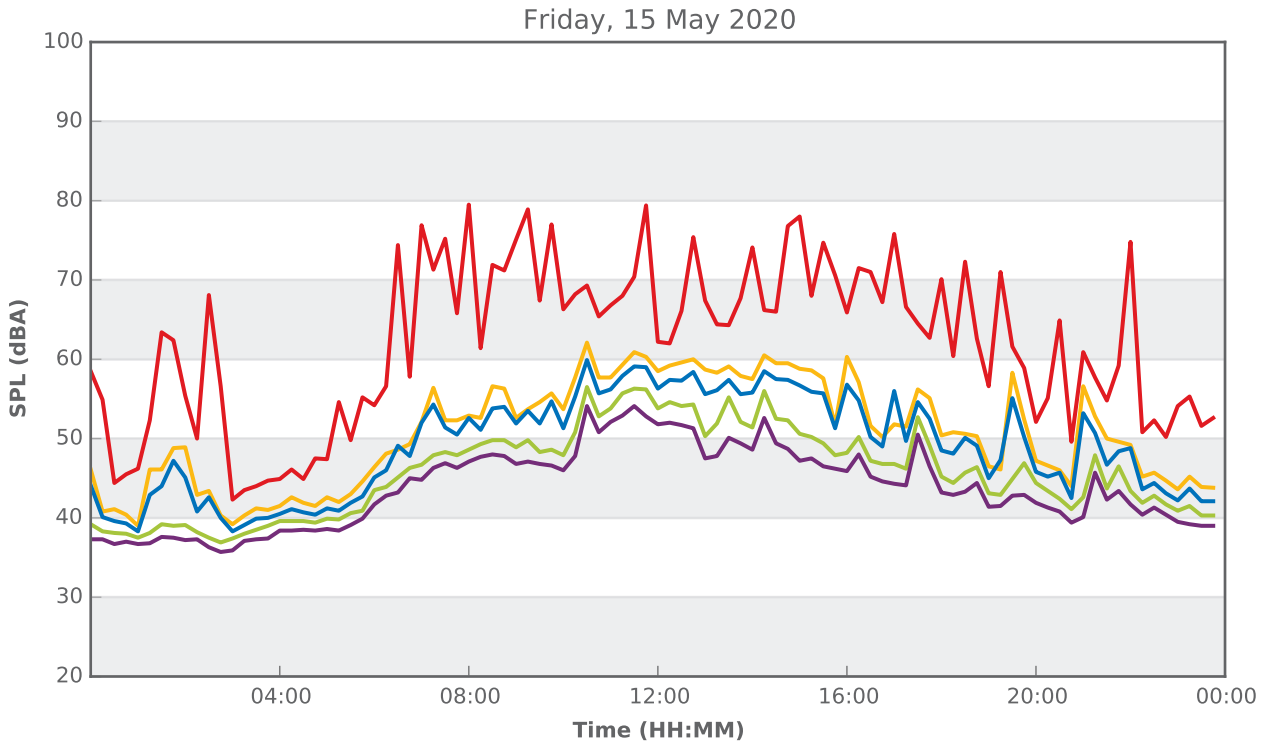
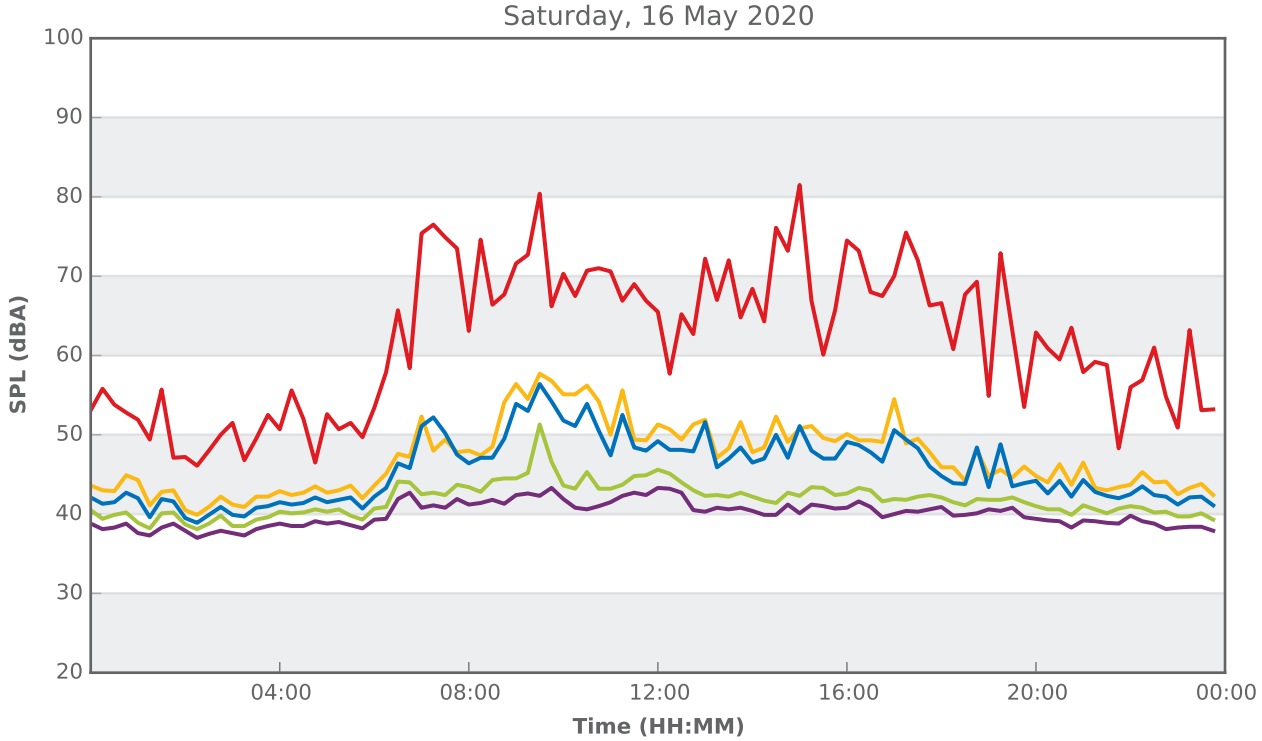




2A Vaucluse Road Vaucluse

Saturday, 16 May 2020



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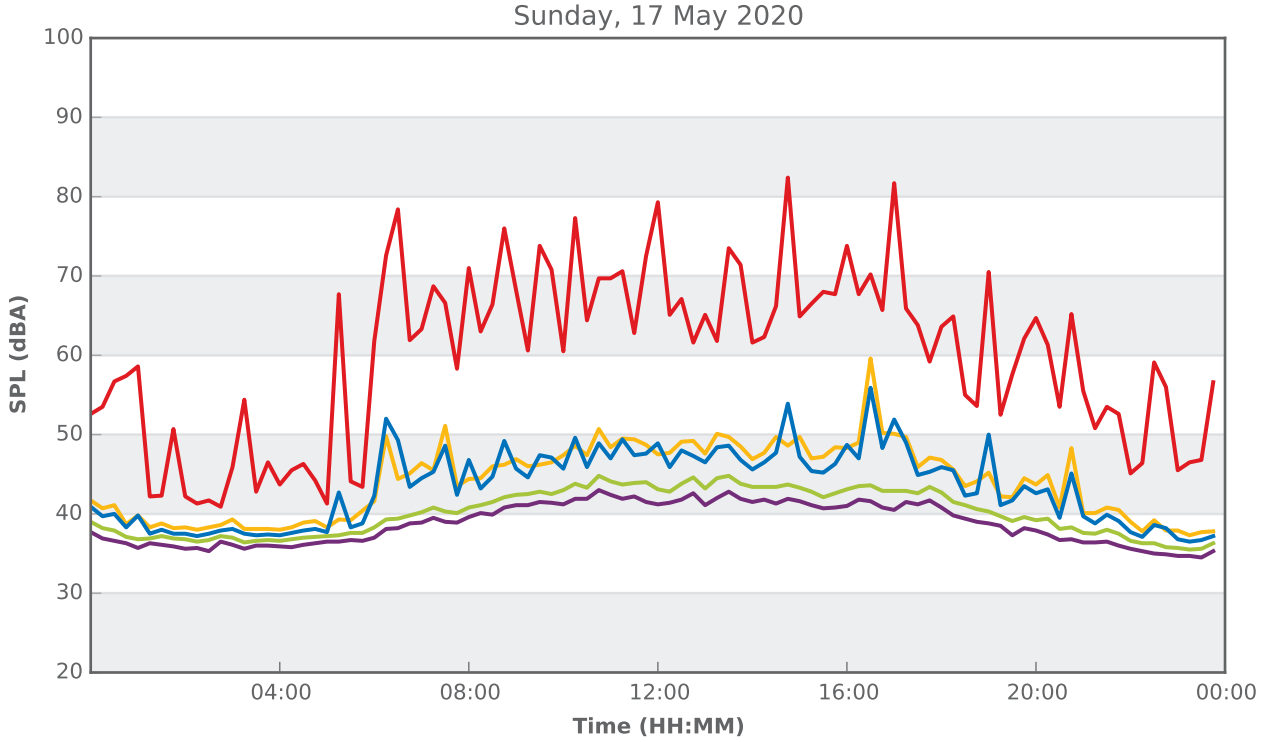

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