Resonate

Gables New Primary School

Noise and Vibration Impact Assessment

S230032RP4 Revision C

Wednesday, 20 November 2024

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Document Information

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Revision Table

Report revision	Date	Description	Author	Reviewer
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A	11 October 2024	Update noise control measure	Alex Salazar	Raymond Sim
B	14 November 2024	Third issue	Alex Salazar	Raymond Sim
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Glossary

AS	Australian Standard
A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Ambient noise	The total noise in a given situation, inclusive of all noise source contributions in the near and far field.
BOM	Bureau of Meteorology
Characteristic	Associated with a noise source, means a tonal, impulsive, low frequency or modulating characteristic of the noise that is determined in accordance with the NSW EPA's *Noise Policy for Industry* to be fundamental to the nature and impact of the noise.
Daytime	Between 7 am and 6 pm as defined in the INP.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	'A' Weighted sound level in dB.
EFSG	Educational Facilities Standards and Guidelines
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
Evening	Between 6 pm and 10 pm as defined in the INP.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. The human ear responds to sound in the frequency range of 20 to 20,000 Hz.
ICNG	Interim Construction Noise Guideline
Intrusive Noise	Noise emission that when assessed at a noise-sensitive receiver (principally the boundary of a residence) is greater than 5 dB(A) above the background noise level.
L_{10}	Noise level exceeded for 10% of the measurement time. The L_{10} level is commonly referred to as the average maximum noise level.
L_{90}	Noise level exceeded for 90% of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	Maximum measured sound pressure level in the time period.
mm/s	Millimetres per second—units of vibration velocity.
$m/s^{1.75}$	Units of VDV.
Night-time	Between 10 pm on one day and 7 am on the following day as defined in the INP.
Noise criteria	The general set of non-mandatory noise levels for protecting against intrusive **noise** (for example, background noise plus 5 dB) and loss of amenity (e.g. noise levels for various land use).

Noise Management Level (NML)	Construction noise management level. Where the construction noise levels are above the NML, additional consideration of feasible and reasonable noise mitigation is required.
Noise source	Premises or a place at which an activity is undertaken, or a machine or device is operated, resulting in the emission of noise
NPI	EPA Noise Policy for Industry 2017
NSW	New South Wales
OOHW	Out-of-Hours Work
OOSH	Outside of Standard Hours
OSHC	Outside of School Hours Care
Peak Particle Velocity (PPV)	The maximum speed of a particle in a particular component direction due to vibration during a measurement.
Rating Background Level (RBL)	Overall single-figure A-weighted background level representing an assessment period (Day/Evening/Night). For the short-term method, the RBL is simply the measured $L_{90,15min}$ noise level. For the long-term method, it is the median value of all measured background levels during the relevant assessment period.
Reverberation Time (RT)	Of a room, for a sound of a given frequency or frequency band, the time that would be required for the reverberantly decaying sound pressure level in the room to decrease by 60 decibels.
RMS	Roads and Maritime Services
RNP	Road Noise Policy
R_W	Weighted Sound Reduction Index—A laboratory measured value of the acoustic separation provided by a single building element (such as a partition). The higher the R_W the better the noise isolation provided by a building element.
$R_W + C_{tr}$	A measure of the sound insulation performance of a building element with a C_{tr} spectrum adaptation term placing greater emphasis on the low frequency performance.
SINSW	School Infrastructure NSW
Sleep disturbance	Awakenings and disturbance of sleep stages.
Sound Pressure Level (SPL)	The level of noise, usually expressed as SPL in *dB(A)*, as measured by a standard sound level meter with a pressure microphone. The sound pressure level in *dB(A)* gives a close indication of the subjective loudness of the noise.
Sound Power Level (SWL)	The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in *dB(A)*.
Vibration	Refers to the oscillation of an object back and forth, normally the ground.
Vibration Dose Value (VDV)	A measure used to assess the level of vibration over a defined time period, such as a day, evening or night. Often used for the assessment of intermittent construction vibration that may rise and fall across a day.
VML	Vibration Management Level

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1 Introduction

1.1 Overview

This noise and vibration impact assessment has been prepared by Resonate Consultants (Resonate) on behalf of Schools Infrastructure NSW (SINSW) (the Applicant) to assess the potential environmental impacts that could arise from the development of The Gables New Primary School at Lot 301 DP 1287967 on Fontana Drive, Gables (the site).

This report has been prepared to assess potential noise and vibration impacts related to the project.

This report accompanies a Review of Environment Factors that seeks approval for the construction and operation of a new primary school at the site, which involves the following works:

- Construction of school buildings, including learning hubs, a school hall and an administration and library building.
- Construction and operation of a public preschool.
- Delivery of a sports court and fields.
- Construction of car parking, waste storage and loading area.
- Associated site landscaping and open space improvements.
- Associated off-site infrastructure works to support the school, including (but not limited to) services, driveways and pedestrian crossings.

For a detailed project description, refer to the Review of Environmental Factors prepared by Ethos Urban.

1.2 REF reporting requirements

Table 1 identifies the REF requirements and relevant references within this report.

Table 1 Response to REF Requirements

Items	REF Requirements	Relevant Section of Report
Provide a noise and vibration assessment prepared in accordance with:		
1	• The relevant NSW Environment Protection Authority (EPA) guidelines.	Section 4
2	• The assessment must detail operational noise (including any public-address system, events, and out of hours use of school facilities)	Section 6
3	• and vibration impacts on nearby sensitive receivers and structures	Section 4.2
4	• Consider noise intrusion and	Section 7
5	• Outline the proposed management and mitigation measure that would be implemented	Section 5.3, 8.2

This report presents Resonate's assessment methodology, noise and vibration criteria, and committed management and mitigation measures in relation to the following:

- Construction noise and vibration impacts.
- Operational noise emissions from outdoor play areas.
- Operational noise emissions from school events.

- Operational noise emissions from onsite mechanical plant and other Project related equipment.
- Noise intrusion impacts from external sources (i.e. traffic noise intrusion)
- Acoustical design requirements (i.e. reverberation time, speech privacy and sound insulation).

Specific acoustic terminology is used in this report. An explanation of common acoustic terms is provided in the Glossary of this report.

2 Project description

2.1 Locality

The site is located on Cataract Road, Gables within The Hills Local Government Area (LGA), approximately 50km northwest of the Sydney CBD and 10km north of the Rouse Hill Town Centre. It comprises one lot, legally described as Lot 301 DP 1287967, that measures approximately 2.2ha in area. The site is bound by Pennant Way to the north, Cataract Road to the east, Fontana Drive to the west and a vacant lot to the south. An aerial image of the site is shown in Figure 1.

Figure 1 Site Aerial (Source: Nearmap, edits by Ethos Urban)

2.2 Noise sensitive receivers

The closest potentially impacted sensitive receivers identified in the vicinity of the Project site are listed in Table 2 and are shown in Figure 2.

Table 2 Nearest noise-sensitive receivers

Receiver ID	Address	Description	Receiver type
R1	114 – 122 Fontana Drive Gables NSW 2765	Two storey residential homes	Residential
R2	104 – 112 Fontana Drive Gables NSW 2765	Two storey residential homes	Residential
R3	96 – 102 Fontana Drive, Gables NSW 2765	Single and two storey residential homes	Residential
R4	2 Moonstone Road Gables NSW 2765	Two storey residential homes	Residential
R5	7 – 17 Travertine Grove, Gables NSW 2765	Two storey residential homes	Residential
R6	19 – 29 Travertine Grove, Gables NSW 2765	Two storey residential homes	Residential
R7	Fontana Drive, Gables NSW 2765	Future residential subdivision (assumed to be two storey residential homes in our assessment)	Residential
R8	Travertine Grove, Gables NSW 2765	Future residential subdivision (assumed to be two storey residential homes in our assessment)	Residential
RE1	99 Fontana Drive Gables NSW 2765	Playing Fields and Associated Amenities Building within Precinct C of Box Hill North (The Gables)	Recreational
E1	95 Fontana Drive Gables NSW2765	Aspect Hills Shire School – Educational Establishment for 80 Students and 30 Staff	Educational

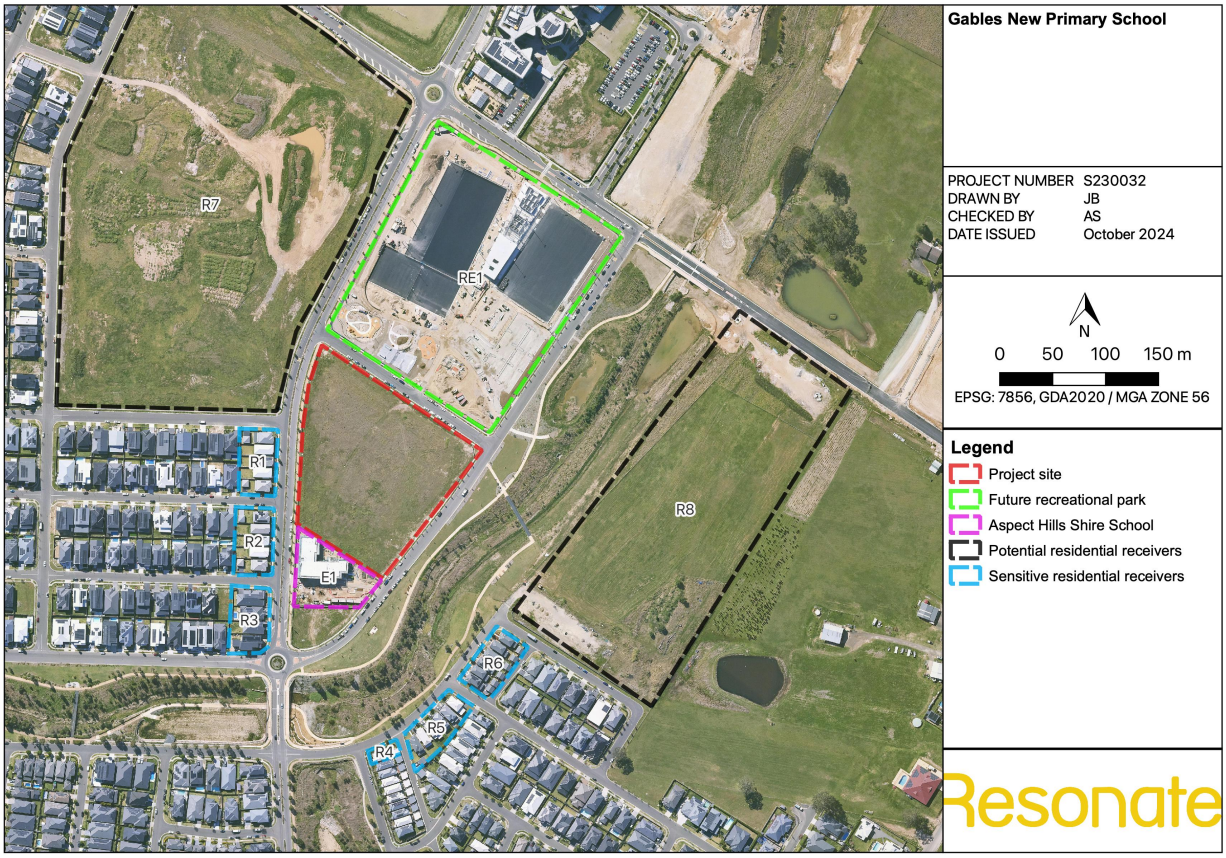

Figure 2 Project site location and surrounding sensitive receivers

2.3 School capacity

The proposed full capacity for the school is presented in Table 3.

Table 3 School's Full Capacity

School	Number of students	Number of staff
Primary	1,000	68
Preschool	60	6
Outside of School Hours Care (OSHC)	150	10

2.4 Hours of operation

2.4.1 Standard hours

The standard hours of operation for the project, are school days Monday to Friday as follows:

- Standard hours of operation: 7:00 am – 6:30 pm (including before and after school care).
- Scholl bell times: 8:50 am – 3:00 pm.
- Outside of school hours care (OSHC): 7:00 am – 8:50 am (Before school), 3:00 pm – 6:30 pm (After school).
- School teaching time: 9:00 am – 3:00 pm.

2.4.2 Outside of standard hours (OOSH)

Outside of standard hours (OOSH) community use may occur on the sports fields and courts, and in the school hall. It is assumed that the use of the sports field and courts and school hall will generally be between 6 pm and 9 pm on weekdays, and between 8 am and 5 pm on weekends.

The types of likely school events to occur throughout the year include:

- Indoor
  - Parent-teacher events
  - Performances & music events
  - Speech days
- Outdoor
  - Interschool sports
  - Outdoor sports carnivals.

It is assumed that loud amplified dance music festivals and rock/pop concerts would not be allowed to take place within the school premises.

2.5 Statement of significance

Based on the identification of potential issues, and an assessment of the nature and extent of the impacts of the proposed development, it is determined that:

- The extent and nature of potential noise and vibration impacts are low to medium and will not have significant adverse effects on the locality, community and the environment.
- Potential noise and vibration impacts can be appropriately mitigated or managed to ensure that there is minimal effect on the locality, community

3 Baseline noise survey

3.1 Noise survey locations

Unattended noise monitoring and attended noise measurements were conducted in accordance with the NSW EPA's *Noise Policy for Industry* (NPI) and has been used to establish existing acoustic conditions surrounding the site. The locations of the measurements and project site is provided in Figure 3.

The project site was selected for the noise monitor installation because it provided a secure location for monitor during the monitoring period. Additionally, access to nearby residences was unavailable at the time of logging. Given the proximity of these residences, the noise levels recorded on-site are considered representative of those experienced by nearby residents.

Resonate has removed any extraneous noise data due to weather effected data (e.g. rain and adverse wind conditions) to determine the rating background noise level (RBL). A minimum of 7 days for each assessment period was used to determine the rating background and ambient noise levels in Table 4.

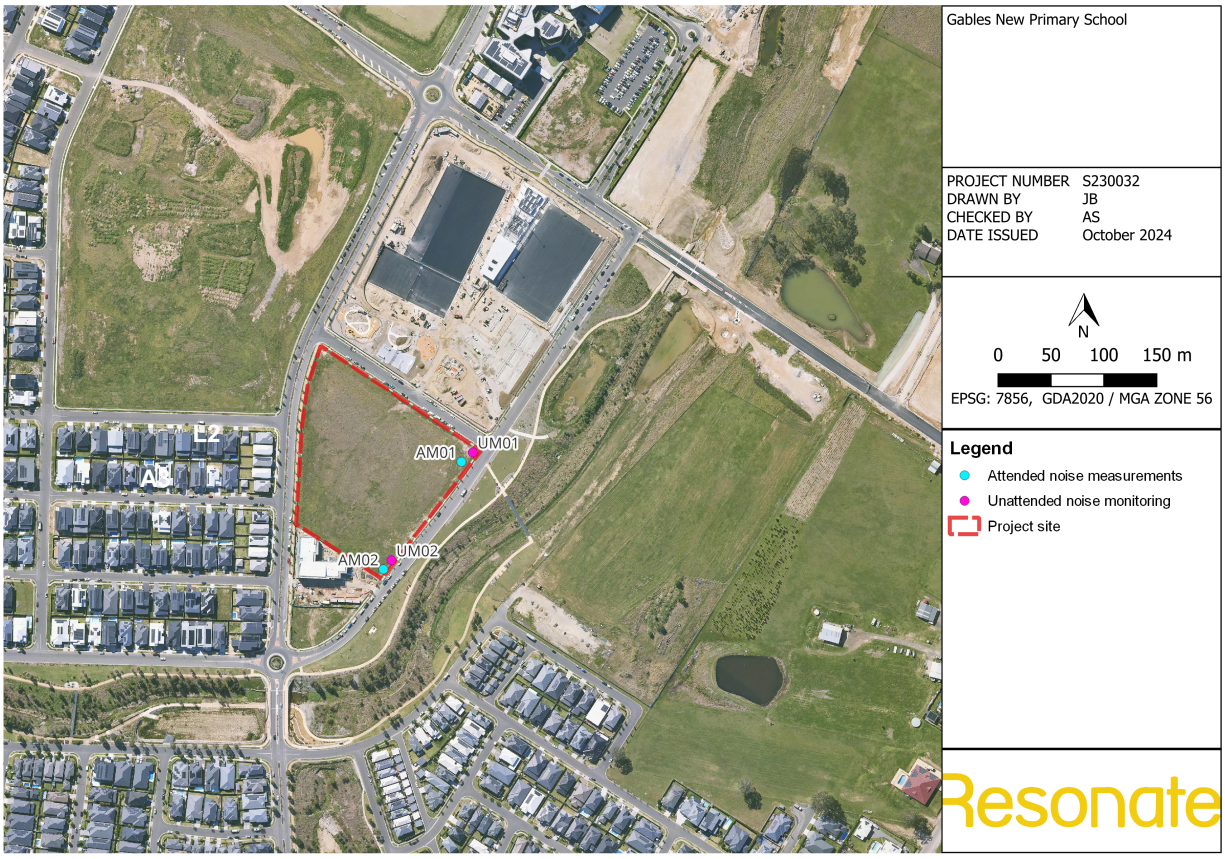

Figure 3 Noise measurement locations

3.2 Instrumentation

Unattended noise monitoring was conducted using a Rion NL 31 and a Rion NL 21 sound level analysers bearing the serial numbers 772983 and 888253 respectively. Field calibration was conducted at the commencement and conclusion of the monitoring period and no significant calibration drift was observed.

The noise loggers were configured to record all relevant noise indices, including background noise level (L_{A90}) and equivalent continuous noise levels (L_{Aeq}). Samples were accumulated at 15-minute intervals. The time response of the logger were set to 'fast'.

3.3 Weather conditions

It is a requirement that noise data is captured during periods of favourable weather conditions avoiding adverse impacts of wind and rain on background noise levels. In order to assess weather conditions for the measurement period, half-hourly weather data was obtained from the Bureau of Meteorology (BOM) weather observation station ID 95753 at Richmond NSW.

Noise data has been excluded from the processed results if:

- Rain was observed during a measurement period, and/or
- Wind speed exceeded 5 m/s (18 km/h) at the measurement height of 1.5 m above ground. Wind data obtained from the BOM is presented as the value at 10 m above ground.

The BOM wind speed data obtained for this report was measured at a height of 10 m above ground level. It is therefore necessary to apply a correction factor in order to estimate the wind speed at the height of the logger (1.5 m).

The methodology to formulate a correction factor has been derived[1]. The correction multiplier for the measured wind speed at 10 m is derived by the following formula:

$$W_{1.5} = W_{10} \times \left(\frac{M_{1.5,cat}}{M_{10,cat}} \right)$$

where:

$W_{1.5}$ = Wind speed at height of 1.5 m
W_{10} = Wind speed at height of 10 m
$M_{1.5,cat}$ = AS 1170 multiplier for receiver height of 1.5 m and terrain category
$W_{10,cat}$ = AS 1170 multiplier for receiver height of 10 m and terrain category

Noise monitoring data that has been excluded due to adverse weather conditions is identified in the overall summary and daily noise monitoring graphs presented in Appendix A.

3.4 Unattended noise monitoring results

The unattended noise monitoring results for the period between Wednesday 24 July 2024 and Wednesday 7 August 2024 are presented in Table 4. Detailed graphs presenting measured noise levels versus time overlaid with weather data for the monitoring period are presented in Appendix A.

It should be noted that during the unattended noise monitoring, there were active construction works to the adjacent north and south of the site unrelated to the project site that influenced the daytime ambient and background noise

[1] Gowen, T., Karantonis, P. & Rofail, T. (2004), *Converting Bureau of Meteorology wind speed data to local wind speeds at 1.5m above ground level*, Proceedings of ACOUSTICS 2004

levels. Resonate has removed any extraneous noise data due to construction activities and weather effected data (e.g. rain and adverse wind conditions) to determine the rating background noise level (RBL). A minimum of 7 days for each assessment period was used to determine the rating background and ambient noise levels in Table 4.

The RBLs are identical between the two noise monitors with the exception of the dayime period ,which UM01 noted as being 1 dB lower. The RBL from UM01 has been chosen as it is considered slightly more conservative to determine the noise emission criteria and construction management levels for the surrounding residential receivers to the project site.

Table 4 Unattended monitoring results

Location[1]	Rating Background Level, dB(A) L_{90}[2]			Ambient noise level, dB(A) L_{eq}		
	Day 7 am–6 pm	Evening 6 pm–10 pm	Night 10 pm–7 am	Day 7 am–6 pm	Evening 6 pm–10 pm	Night 10 pm–7 am
UM01 – Pennant Way & Cataract Road	40	36	32	51[3]	47	44
UM02 – Cataract Road	41	36	32	54[3]	46	46

(1) Refer to Figure 3 for specific locations of the monitoring.

(2) The Rating Background Level is a measure of the typical minimum steady background noise level for each period of the day.

(3) Ambient noise levels in the day were higher due to construction works to the immediate north and south during the monitoring period.

3.5 Attended noise measurement results

Attended noise measurements were conducted at the unattended monitor locations around the site on Wednesday, 7 August 2024. The monitoring was conducted between 1:30 pm and 2:30 pm. The measured noise levels at each location are shown in Table 5, with the measurement locations shown in Figure 3.

Table 5 Attended measurement results on Monday, 6 December 2021

Location	Measured noise level, dB(A)			
	L_{max}	L_{10}	L_{eq}	L_{90}
AM01 – Adjacent to logging location UM01 – Towards NW corner of site	74	61	58	48
AM02 –Adjacent to logging location UM02 – Near the SW corner of site	76	60	57	45

During the attended noise measurements at locations AM01 and AM02 the existing noise environment in the area were observed to be influenced primarily by local road traffic on Fontana Drive and local fauna. However, it was also noted that the attended measurements were influenced by construction activities to the north and south of the project site at receiver locations RE1 and E1 respectively.

4 Noise and Vibration Criteria

4.1 Construction noise

Construction noise in New South Wales is assessed using The NSW Department of Environment & Climate Change's (now NSW EPA) *Interim Construction Noise Guideline* (ICNG).

The ICNG aims to manage noise from construction works regulated by the EPA. It is also intended to provide guidance to other interested parties in the management of construction noise and has therefore been adopted for this construction noise assessment. The ICNG prescribes $L_{eq,15min}$ Noise Management Levels (NML) for sensitive receivers as part of a quantitative construction noise assessment. Where the predicted or measured construction noise level exceeds these management levels, then all feasible and reasonable work practices must be implemented to reduce construction noise, and community consultation regarding construction noise is required to be undertaken.

4.1.1 Standard working hours

The ICNG recommends standard working hours for construction as follows:

- Monday to Friday, 7 am to 6 pm
- Saturday, 8 am to 1 pm
- No work on Sundays or Public Holidays

To encourage work during the Standard Working Hours, and to reflect the lower impact of work at these times, the ICNG prescribes less stringent Standard Working Hours NMLs.

It should be noted that the Standard Working Hours are only applicable to residential (or similar) land uses. At educational or recreational land uses, where evening amenity and sleeping is not a concern, the impact of construction noise is assessed based on the times that the land use operates.

4.1.2 Residential land uses

The NMLs prescribed for residential land uses by the ICNG are presented in Table 6. The levels apply at the most exposed property boundary of the noise sensitive receiver at a height of 1.5 metres above ground level.

4.1.3 Other sensitive land uses

The ICNG also prescribes NMLs for other sensitive land uses, including educational buildings and offices. The NMLs for relevant land uses are summarised in Table 7 and apply only when those land uses are in use.

For those receivers where an internal NML applies, it is common to assume an outdoor-to-indoor noise reduction of 10 dB(A). This is based on a standard residential building facade with windows kept open.

Table 6 ICNG noise management levels for residential land uses

Time of day	NML, $L_{eq,15min}$	Application notes
Recommended standard hours: • Monday to Friday 7 am to 6 pm • Saturday 8 am to 1 pm • No work on Sundays or Public Holidays	Noise affected Rating Background Level (RBL) + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{eq,\ 15\ minute}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • 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 75 dB(A)	The highly noise affected level represents the point above which there may be a strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected Rating Background Level (RBL) + 5 dB(A)	• 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 5 dB(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.

(1) Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence

Table 7 ICNG noise management levels for other sensitive land uses

Land use	NML $L_{eq,15min}$ (applies when property in use)
Classrooms at schools and other educational institutions	Internal noise level of 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion).	External noise level of 65 dB(A)

Land use	NML $L_{eq,15min}$ (applies when property in use)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation).	External noise level of 60 dB(A)
Offices, retail outlets	External noise level of 70 dB(A)

(1) Where some nearby receivers may operate as more than one land use for example commercial/industrial and residential land uses, the more stringent NML should be applied.

4.1.4 Construction noise management levels

The project-specific construction "Noise Management Levels" (NML), for works within and outside the recommended standard hours for construction, are presented in Table 8 below.

These NMLs have been established with due regard to the requirements of the ICNG for all identified residential (dwelling) and other noise sensitive (non-residential) receptors. NML for all periods are provided for completeness despite construction works limited to the recommended standard hours for construction presented in the ICNG.

For residential (dwelling) receptors the NML are based on the RBL values presented in Section 3.4.

Table 8 Project specific construction noise management levels

Receiver[1]	Receiver Type	Construction Noise Management Levels, $L_{eq,\ 15\ minute}$, dB(A)				High Noise Affected, $L_{eq,\ 15\ minute}$, dB(A)
		Standard Hours	Out-of-Hours			
			Day	Evening	Night	
R1	Residential	50	45	41	37	75
R2	Residential	50	45	41	37	75
R3	Residential	50	45	41	37	75
R4	Residential	50	45	41	37	75
R5	Residential	50	45	41	37	75
R6	Residential	50	45	41	37	75
R7	Residential	50	45	41	37	75
R8	Residential	50	45	41	37	75
RE1	Passive Recreational	60	60	60	60	-
E1	Educational[2,3]	55	55	55	55	-

(1) Receivers are identified in Section 2.2.

(2) NML only applies to classroom and when they are in use.

(3) An additional 10 dB has been applied to the internal NMLs to convert to an external NML which assumes windows are open for ventilation in accordance with the Building Code of Australia.

Construction activities would only be carried out during standard daytime period. Therefore, construction noise impacts will only be assessed against the standard daytime NMLs.

4.2 Construction vibration

The effects of vibration on buildings can be divided into three main categories: human comfort (annoyance), building damage (cosmetic/structural) and sensitive equipment (scientific/medical). An overview of the applicable standards and guidelines is provided below.

- **Human Comfort (annoyance)**: The NSW Vibration Guideline provides guidance for assessing human exposure (comfort or annoyance issues) to vibration. The publication is based on British Standard (BS 6472–1992) – Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz), dated 1992.

- **Cosmetic and Structural Damage**: There is currently no Australian policy or guideline for assessing the potential for building damage (cosmetic and structural) from vibration. The British Standard BS 7385 Part 2-1993 'Evaluation and measurement for vibration in buildings Part 2' has been considered for project works where applicable. BS 7385 provides safe limit guideline values, below which vibration is considered insufficient to cause structural or cosmetic damage to buildings. If a heritage building or structure is found to be structurally unsound a more conservative standard has been adopted i.e. German Standard DIN4150 Part 3-1999 (DIN4150-3) – Structural Vibration - Effects of Vibration on Structures, dated 1999. DIN4150-3 presents a set of safe limit values below which cosmetic or structural damage is unlikely to occur.

  The NSW Vibration Guideline, BS7385 and DIN 4150-3 criteria vary based on vibration type, receptor type and are dependent on the component frequency of the vibration event. The criteria values from the NSW Vibration Guideline, BS7385 and DIN 4150-3 were considered in the assessment of potential impacts but are not reproduced here.

- **Sensitive Scientific and Medical Equipment**: Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

  Where manufacturer's data for the identified vibration sensitive scientific and/or medical instruments are not available, generic vibration criterion (VC) curves will be adopted as vibration goals.

  However, as there is no sensitive scientific and medical equipment housed in nearby buildings, the assessment of vibration impacts on sensitive scientific and medical equipment is not relevant and will not be conducted in this study.

Given the distance between the proposed works and the nearest residential noise sensitive receiver, the potential vibration impacts during construction are more concerned with the impact on Human Comfort.

4.2.1 Construction vibration management levels

Impacts from vibration can be considered both in terms of effects on building occupants (human comfort) and the effects on the building structure (building damage). Of these considerations, the human comfort limits are the most stringent. Therefore, for occupied buildings, if compliance with human comfort limits are achieved, it will follow that compliance will be achieved with the building damage objectives.

Human Comfort

The NSW Vibration Guideline provides guidance for assessing human exposure to vibration. These documents are based on *British Standard (BS 6472–1992) – Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) dated 1992*. The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in Table 9.

Table 9 Human Comfort

Location	Assessment Period	Preferred Values		Maximum Values	
		z axis	x and y axes	z axis	x and y axes
Continuous Vibration (m/s^2)					
Critical Areas	Daytime or Night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Daytime or Night-time	0.020	0.014	0.040	0.028
Workshops	Daytime or Night-time	0.040	0.029	0.080	0.058
Impulsive Vibration (m/s^2)					
Critical Areas	Daytime or Night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Daytime or Night-time	0.64	0.46	1.28	0.92
Workshops	Daytime or Night-time	0.64	0.46	1.28	0.92
Intermittent Vibration (m/s$^{1.75}$)					
Critical Areas	Daytime or Night-time	0.10		0.20	
Residences	Daytime	0.20		0.40	
	Night-time	0.13		0.26	
Offices, schools, educational institutions and places of worship	Daytime or Night-time	0.40		0.80	
Workshops	Daytime or Night-time	0.80		1.60	

(1) Daytime is 7am-10pm and Night-time is 10pm-7am.

(2) For continuous and impulsive vibration, the preferred and maximum values are weighted acceleration values (Wg for z-axis and Wd for x and y-axis)

(3) For intermittent vibration, the preferred and maximum values are Vibration Dose Values (VDVs), based on the weighted acceleration values

Building Damage

German Standard DIN 4150-3-1999 Structural Vibration – Part 3 Effects of vibration on structures provides methods for evaluating the effects of vibration on structures in the absence of an Australian Standard.

The recommended limits (guide values) from DIN 4150 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented in Table 10.

Table 10 Guideline Vibration Values for Short Term Vibration on Structures (mm/s)

Type of Building	Guideline values for velocity (mm/s)			
	1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	Vibration at horizontal plane of highest floor at all frequencies
Commercial and Industrial Building	20	20-40	40-50	40
Dwellings and buildings of similar occupancy or design	5	5-15	15-20	15
Structures that, because of their particular sensitivity to vibration cannot be classified under lines 1 and 2 and are of great intrinsic value	3	3-8	8-10	8

4.3 Operational noise

At the current time there is no standard process or guideline in NSW to derive noise criteria for the assessment of potential noise impacts from proposed educational facilities (excluding the NSW EPA's *Noise Policy for* Industry (NPI) for the industrial noise source component). As such, different criteria have been nominated to assess potential operational noise impacts from the proposed development accompanied by a discussion of their suitability.

4.3.1 Internal noise emission criteria

The NSW Department of Planning and Environment (DoPE) published the State Environmental Planning Policy (SEPP) (Educational Establishments and Child Care Facilities) 2017 on September 2017. 'Schedule 2 Schools – complying development' of the SEPP requires the following:

> **6 Noise**
>
> A new building of (if the development is an alteration or addition to an existing building for the purpose of changing its use) an existing building that is to be used for the purpose of a school or school-based child care must be designed so as not to emit noise exceeding an LAeq of 5 dB(A) above background noise when measured at any lot boundary.

Based on the Education SEPP, operational noise emissions from within the buildings of the school will be required to achieve the project specific noise criteria presented in Table 11.

Table 11 Internal operational noise criteria (Education SEPP)

Receivers	Period	Recommended criteria	Project specific criteria $L_{eq,15min}$ – dB(A)
R1 to R8	Daytime 7 am to 6 pm	$L_{Aeq,15min}$ must not exceed RBL + 5 dB	45
	Evening 6 pm to 10 pm	$L_{Aeq,15min}$ must not exceed RBL + 5 dB	41
	Night-time 10 pm to 7 am	$L_{Aeq,15min}$ must not exceed RBL + 5 dB	37

4.3.2 Outdoor play areas noise criteria (standard school hours)

Given the similarities between educational facilities and Child Care Centres in terms of land use, business hours and general operations (i.e. playtime hours etc), the duration of exposure to potential noise impacts at nearby noise-sensitive receivers is predicted to be similar. For this reason, the AAAC's "Guideline for Child Care Centre Acoustic Assessment" has been adopted to assess potential noise impacts from the Project's proposed outdoor play areas for the following reasons:

- For most Child Care Centres, as the duration of time that children are allowed to play outside is reduced then the overall noise impact reduces.
- A total time limit of approximately 4 hours outdoor play per day is regarded as reasonable grounds for the allowance of an additional 5 dB emergence above the background level.

The noise criteria for outdoor play areas within school are summarised in Table 12.

Table 12 Outdoor play areas noise criteria for residential receivers

Receiver location(1)	Duration	Time of day	Measured RBL – dB(A)	Criteria $L_{eq,15min}$ – dB(A)	Comments
R1 to R8 residential receivers	Up to 4 hours (total) per day	Daytime	40	50	The L_{Aeq} noise level emitted from the outdoor play area shall not exceed the background noise level by more than 10 dB.
	More than 4 hours per day	Daytime	40	45	The L_{Aeq} noise level emitted from the outdoor play area shall not exceed the background noise level by more than 5 dB.

(1) The assessment location is defined as the most affected point on or within any residential receiver property boundary.

Outdoor play areas $L_{eq,15min}$ noise criteria for non-residential receivers are as follow:

- School – 45 dB(A) (internal) or 55 dB(A) (at external facade)
- Commercial premises – 65 dB(A)

4.3.3 Outside of standard hours events (OOSH) and outside of school care (OSHC) noise criteria

After a comprehensive review of criteria historically used to characterise and assess potential noise impacts from school care and events outside of standard school hours, in conjunction with past experience in State Significant educational facility acoustic assessments, Resonate recommends the following criteria presented in Table 13.

This is based upon noise goals outlined in the EPA "*Noise Guide for Local Government*" and other known similar assessments that have been approved within the Sydney Metropolitan area.

Table 13 OOSH events noise criteria to residences

Receiver location	Period	Recommended criteria	Project specific criteria $L_{eq,15min}$ – dB(A)
R1 to R8 residential receivers	Daytime 7 am to 6 pm	$L_{Aeq,15min}$ must not exceed RBL + 5 dB	45
	Evening 6 pm to 10 pm	$L_{Aeq,15min}$ must not exceed RBL + 5 dB	41
	Night-time 10 pm to 7 am	$L_{Aeq,15min}$ must not exceed RBL	37

As the OOSH and OSHC are not expected to operate after 10 pm, noise impacts from OOSH and OSHC will only be assessed against the daytime and evening criteria specified in Table 13.

4.3.4 Carpark noise criteria

At the current time there is no standard process or guideline in NSW to derive noise criteria for the assessment of potential noise impacts from carparks. Based on a comprehensive review of criteria historically used to characterise and assess potential noise impacts from carparks, Resonate recommends the following criteria presented in Table 13.

This is based upon noise goals outlined in the EPA "*Noise Guide for Local Government*" and other known similar assessments that have been approved within the Sydney Metropolitan area.

Table 14 Carpark intrusive noise criteria

Receiver location	Period	Recommended criteria	Project criteria $L_{eq,15min}$ – dB(A)
Nearby residential receivers	Daytime 7 am to 6 pm	$L_{Aeq,15min}$ must not exceed RBL$^{(1)}$ + 5 dB	45
	Evening 6 pm to 10 pm	$L_{Aeq,15min}$ must not exceed RBL$^{(1)}$ + 5 dB	41
	Night-time 10 pm to 7 am	$L_{Aeq,15min}$ must not exceed RBL$^{(1)}$ + 5 dB	37

(1) The lowest measured RBL between the two noise logger locations have been used as the RBLs.

The carparks are note expected to be used during the night time therefore the carpark noise assessment will be based on daytime and evening period project criteria.

4.3.5 External mechanical services noise criteria

Mechanical services noise impacts associated with Gables New Primary School will be assessed against the NPI. The NPI was released in 2017 and sets out the EPA's requirements for the assessment and management of noise from industry in NSW.

The NPI is designed for large and complex industrial noise sources and outlines processes designed to strike a feasible and reasonable balance between the operations of industrial activities and the protection of the community from noise levels that may be intrusive or unpleasant.

The NPI measurement and evaluation methodology to quantify existing ambient and background noise levels has been adopted for this assessment.

Trigger levels

The NPI describes 'trigger levels' which indicate the noise level at which feasible and reasonable noise management measures should be considered. Two forms of noise criteria are provided – one to account for 'intrusive' noise impacts and one to protect the 'amenity' of particular land uses.

- The intrusiveness of an industrial noise source is generally considered acceptable if the L_{Aeq} noise level of the source, measured over a period of 15 minutes, does not exceed the background noise level by more than 5 dB. Intrusive noise levels are only applied to residential receivers. For other receiver types, only the amenity levels apply.
- To limit continual increases in noise levels from the use of the intrusiveness level alone, the ambient noise level within an area from all industrial sources should remain below the recommended amenity levels specified in the NPI for that particular land use.

For this assessment, the area surrounding the proposal is considered to be 'suburban'.

Project specific noise criteria

The criteria for industrial noise generated by the facility are provided in Table 15. The Project Noise Trigger Level (PNTL) is the lowest value of the intrusiveness or project amenity noise level for each assessment period and are shown below in bold.

Table 15 NPI noise criteria (suburban amenity area)

Receiver	Period	Noise level – dB(A)			
		Recommended amenity noise level L_{eq}	Measured RBL	Project noise trigger level $L_{eq(15minute)}$	
			RBL[1]	Intrusiveness	Project Amenity[2]
R1 to R8 Residential	Daytime	55	40	**45**	53
	Evening	45	36	**41**	43
	Night-time	40	32	**37**	38
RE1 Passive recreation	When in use	50 (external)	n/a	n/a	**48**
E1 School classrooms	Nosiest 1 hour When in use	45 (External)	n/a	n/a	**43**

(1) RBL = Rating Background Level

(2) The Project amenity noise level has been determined by reducing the amenity noise level by 5 dB to account for other industrial noise sources and then converted to a 15-minute level by adding 3 dB

(3) A +10 dB correction has been applied to the internal criterion to convert the level to an external criterion.

4.3.6 Public address and school bell noise criteria

Given that there are currently no criteria specifically relating to noise emissions from public address (PA) system and bell, the NPI would be used referred to for the assessment of noise emissions from public address (PA) system and bell. The project specific NPI criteria for the development are presented in Section 4.3.5, which have been established for assessing external mechanical services noise impacts associated with the development.

4.3.7 Sleep disturbance noise criteria

The NPI also recommends criteria for the assessment of potential sleep disturbance, for the period between 10 pm and 7 am. The school is not expected to operate during this time period, therefore potential sleep disturbance is not being considered.

4.4 Road traffic noise intrusion criteria

The Department of Planning's *Development near Rail Corridors and Busy Road – Interim Guideline* aims to assist in the planning, design and assessment of both residential and non-residential developments in, or adjacent to rail corridors and busy roads and supports the specific provisions of the *State Environmental Planning Policy (Transport and Infrastructure) 2021* (TISEPP) in relation to rail and road traffic noise. The guideline also specifies recommended maximum internal noise levels for educational establishments adjacent to rail corridors and busy roads which are presented in Table 16.

Table 16 TISEPP internal noise criteria

Type of Occupancy	Recommended Max Level – dB(A)
Educational Institutions including child care centres	40

The NSW Department of Education's *Educational Facilities Standards and Guidelines* (EFSGs) also stipulates that road noise shall be assessed in accordance with the TISEPP requirements. However, the EFSGs sets lower internal noise levels for some spaces depending on their use and sensitivity.

Table 17 summarises the internal noise levels for the project in line with the EFSGs, which include contribution from steady-state noise sources such as road traffic and mechanical noise.

Table 17 EFSG internal noise criteria

Spaces	Maximum internal background noise levels for normal operations: includes building services and steady-state external noise sources	
	EFSG equivalent category	Design sound level $L_{eq,1\ hour}$ – dB(A)
Canteen	Dining rooms	45
Canteen office	Office areas	40
Clerical	Office areas	40
Comms room	-	-
Communal Hall	Assembly halls	35
Circulation	Corridors and lobbies	45
Deputy principal	Professional and administrative offices	35
Homebase	Open plan teaching area	40

Spaces	Maximum internal background noise levels for normal operations: includes building services and steady-state external noise sources	
	EFSG equivalent category	Design sound level $L_{eq,1\ hour}$ – dB(A)
Interview room	Interview / counselling rooms	35
Library – general areas	Library – general areas	40
Library – reading areas	Library – reading areas	35
Library – stack areas	Library – stack areas	45
Plantroom	-	-
Practical activities area	Open plan teaching area	40
Principal's office	Professional and administrative offices	35
Security	Office areas	40
Shared office / workroom	Office areas	40
Sick bay	Medical rooms (first aid)	40
Special programs rooms	Teaching spaces – primary schools	35
Staff room	Staff common rooms	40
Storage	-	55
Toilets	Toilet / change / showers	50
Withdrawal room	Teaching spaces – primary schools	35

The internal airborne noise criteria are generally achieved through a sealed building. Ideally, where natural ventilation is to be provided, the same criteria would also be achieved, particularly for critical spaces, where higher ambient noise levels may otherwise impact on speech intelligibility or unduly impact concentration. However, for some uses, research has indicated that occupants are willing to accept trade-offs in the ambient noise levels where natural ventilation is provided.

The TISEPP guideline allows for a + 10 dB concession for the open windows condition, and while this could be applied to educational uses, it is considered that such a decision should be made by the end users and/or relevant development stakeholders. The desire for natural ventilation may be an important feature of the design but will leave the teaching areas vulnerable to noise intrusion, potentially exacerbating the listening issues associated with open plan classrooms.

4.5 Internal acoustic design criteria

This internal acoustics of the school should be designed to the criteria presented in this section. The EFSG outlines the acoustic criteria for schools in Section DG11 Acoustics. Internal design sound levels and reverberation time criteria have been determined by Table 11.06.1 of the EFSG and relevant criteria are summarised in Table 18 below. Internal design sound levels are a combination of building services noise operating normally and typical noise ingress from the external environment.

Table 18 Recommended internal design sound levels and reverberation time criteria

Spaces	EFSG equivalent category	Design sound level $L_{eq,1\ hour}$ – dB(A)	Recommended Reverberation Time (T), s(1)
Canteen	Dining rooms	45	< 1
Canteen office	Office areas	40	< 0.8
Clerical	Office areas	40	< 0.8
Comms room	-	-	-
Communal Hall	Assembly halls	35	See Note (2)
Circulation	Corridors and lobbies	45	Minimise
Deputy principal	Professional and administrative offices	35	< 0.8
Homebase	Open plan teaching area	40	< 0.8
Interview room	Interview / counselling rooms	35	< 0.6
Library – general areas	Library – general areas	40	< 0.6
Library – reading areas	Library – reading areas	35	< 0.6
Library – stack areas	Library – stack areas	45	< 0.6
Plantroom	-	-	-
Practical activities area	Open plan teaching area	40	< 0.8
Principal's office	Professional and administrative offices	35	< 0.8
Security	Office areas	40	< 0.8
Shared office / workroom	Office areas	40	< 0.8
Sick bay	Medical rooms (first aid)	40	< 0.8
Special programs rooms	Teaching spaces – primary schools	35	< 0.5
Staff room	Staff common rooms	40	< 0.6
Storage	-	55	-
Toilets	Toilet / change / showers	50	-
Withdrawal room	Teaching spaces – primary schools	35	< 0.5

(1) Mid-frequency reverberation refers to the reverberation time at the medium frequencies, that is at 500 Hz or 1000 Hz.

(2) Reverberation time should be minimised as far as practical for noise control.

Table 19 shows a list of each space/room that requires a rated acoustic separation along with the expected activity noise and noise tolerance for each room. By comparing these room characteristics in conjunction with the sound insulation performance matrix for adjoining spaces shown in Table 20, acoustic separation criteria have been determined for each partition.

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Table 19 Guideline airborne and impact sound insulation requirements

Spaces	EFSG equivalent category	Source room activity noise	Receiving Space noise tolerance
Canteen	Dining rooms	High	Medium
Canteen office	Office areas	Low	Low
Clerical	Office areas	Low	Low
Comms room	-	High	High
Communal Hall	Assembly halls	High	Low
Circulation	Corridors and lobbies	Average	High
Deputy principal	Professional and administrative offices	Low	Low
Homebase	Open plan teaching area	Average	Medium
Interview room	Interview / counselling rooms	Average	Low
Library – general areas	Library – general areas	Low	Low
Library – reading areas	Library – reading areas	Low	Low
Library – stack areas	Library – stack areas	Average	Medium
Plantroom	-	High	High
Practical activities area	Open plan teaching area	Average	Medium
Principal's office	Professional and administrative offices	Low	Low
Security	Office areas	Low	Low
Shared office / workroom	Office areas	Low	Low
Sick bay	Medical rooms (first aid)	Average	Low
Special programs rooms	Teaching spaces – primary schools	Average	Low
Staff room	Staff common rooms	Average	Medium
Storage	-	Low	High
Toilets	Toilet / change / showers	Average	High
Withdrawal room	Teaching spaces – primary schools	Average	Low

Based on a room's source activity level and the adjacent room's noise tolerance levels, an appropriate D_W for the separating wall may be determined in accordance with Table 20. When a combination of rooms is compared, the higher of the two ratings would be the minimum D_W rating required for acceptable acoustic separation between those two spaces.

Table 20 Sound insulation ratings for partitions without pass doors(1), D_W dB

Noise tolerance in receiving room	Source room activity noise			
	Low	Average	High	Very High
High	D_W 30	D_W 35	D_W 40	D_W 45
Medium	D_W 35	D_W 40	D_W 45	D_W 50
Low	D_W 40	D_W 45	D_W 50	D_W 55
Very Low	D_W 45	D_W 50	D_W 55	D_W 60

(1) Where doors are proposed between spaces consideration must be given to the placement and performance requirements of the door since ratings for doors with no acoustic treatment are not likely to exceed D_W 20 dB while standard solid core doors with full perimeter acoustic seals could achieve a rating up to D_W 30 dB

Note that the above does not take into consideration the presence of doors or glazing. Where there is a door or glazing incorporated into the separating partition, we have downgraded the rating of the partition as the separation will be controlled by the acoustic performance of the door and/or the glazing which are limited (for operational, constructability and cost reasons).

Rain noise requirement

The EFSG states:

'Rain noise is to be assessed only for general learning areas, music, drama, movement studios and halls or as otherwise directed. Rain is to be assessed using the one-year annual recurrence, one-hour event for the region as reported by the Bureau of Meteorology. A recognised rain noise calculation procedure (such as Dubout, 1969 or Griffin, Ballagh, 2012) shall be used.'

Prescriptive constructions

The following elements have prescriptive acoustic performance or construction requirements as specified in the EFSG guidelines:

- Operable walls (between general learning areas, all schools): R_W 45
- Entry doors to occupied teaching, music, drama and sports spaces: Solid core, minimum 35 mm thick with acoustic weather (where external) seals on all rebated closing faces. Gap at floor to be minimized.
- Internal glazed sections in walls and vision panels in or adjacent to internal doors: minimum 10.38 mm laminated glass. In some situations, acoustic windows may be needed for satisfactory noise separation.
- Construction separating wastewater pipework from occupied spaces: R_W 40
- Where adjacent to an occupied space (and not serving that space), hydraulic supply pipework and wastewater pipework shall be separated from the adjacent occupied space. Construction between the adjacent spaces in this instance shall be a 'staggered stud' arrangement or otherwise discontinuous.

5 Construction Noise and Vibration Assessment

This section details the assessment of the construction noise and vibration impacts from the Project. Construction noise impacts predicted at the nearest residential receivers have been assessed against the adopted ICNG Noise Management Levels.

5.1 Construction noise

5.1.1 Noise catchment areas

Based on the results of the noise monitoring and observations conducted around the site, four noise catchment areas (NCAs) have been defined to aid in the discussions of predicted construction noise levels and potential impacts around the site. Receivers directly adjacent to the site are resident, educational and passive/active recreation land uses (see Figure 3).

5.1.2 Construction noise sources

To assess the potential noise and vibration impacts during construction, a number of scenarios comprising typical plant and equipment have been developed based on Resonate's past project experiences.

Table 21 summarises the assumed sound power levels (L_W) for the major construction noise sources which we expect would be on site during each phase.

It is understood that all construction works are proposed to be carried out during standard daytime periods (7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturdays).

The sound power levels have been based on data obtained from previous measurements conducted by Resonate and those within the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*. An overall sound power level for each phase has also been assumed based on the loudest typical source(s) operating for each works phase.

Table 21 Construction noise source sound power levels

Stage	Typical plant items	Assumed sound power level, dB(A)
Stage 1 – Site establishment and enabling works	Large excavator	111
	Vibratory roller(1)	107
	Concrete truck	109
	Concrete pump	107
	Large truck	108
	Chainsaw	114
	Typical overall sound power level	**112**
Stage 2 – Demolition	Large excavator	111
	Rockbreaker(1)	121
	Crane	106

Stage	Typical plant items	Assumed sound power level, dB(A)
	Pneumatic jackhammer(1)	109
	Large truck	108
	Typical overall sound power level	**118**
Stage 3 – Retaining piles and excavation	Bored piling rig	111
	Large excavator	111
	Crane	106
	Large truck	108
	Typical overall sound power level	**112**
Stage 4 – Substructure	Crane	106
	Large excavator	111
	Pneumatic jackhammer(1)	109
	Concrete truck	109
	Concrete pump	107
	Large truck	108
	Typical overall sound power level	**114**
Stage 5 – Frame	Concrete truck	109
	Concrete pump	107
	Crane	106
	General hand tools	98
	Large truck	108
	Typical overall sound power level	**111**
Stage 6 – Facade works	Crane	106
	General hand tools	98
	Large truck	108
	Typical overall sound power level	**107**
Stage 7 – Internal works and fitout	General hand tools	98
	Compressor	94
	Portable generator	95
	Typical overall sound power level	**84(2)**

(1) Denotes “annoying” item of equipment as defined in the ICNG (i.e. contains characteristics such as impulsiveness, tonality etc.), and as such includes a +5 dB penalty adjustment to predictions.

(2) Includes a 15 dB(A) indoor-to-outdoor reduction in noise levels for internal works.

5.1.3 Construction noise assessment methodology

Prediction of construction noise impacts from the Project has been undertaken through the use of the SoundPLAN noise propagation modelling software (version 9.0).

The most significant factors in determining the level of noise received from construction activities are the receiver's distance from the Project site, shielding, ground absorption and noise source heights. The parameters used and values adopted in the noise modelling are presented in Table 22 below.

Table 22 Construction noise modelling parameters

Parameter	Input data
Receivers	• Receivers provided by project team in shapefile format and imported into SoundPLAN • Receivers have been modelled as point receivers • Height of receivers modelled as 1.5 m
Terrain	1 metre ground contours from Geoscience Australia.
Ground surface / absorption	The agricultural land surrounding the site has been conservatively modelled with a ground cover factor of 0.5 representative of 'mixed' ground.
Source heights	Construction plant and equipment heights are modelled to be 1.5 m above ground
Sources	All equipment has been modelled as point sources and all equipment have been modelled to operate simultaneously.
SoundPLAN module	ISO 9613 algorithm industrial module
Meteorological conditions	Neutral meteorological condition has been modelled as construction activities will only be conducted during standard daytime period.

5.1.4 Predicted construction noise levels

Typical worst-case predicted noise levels are shown in Table 23 for each receiver location and each stage of works. Predicted noise levels were calculated using distance attenuation.

Based on the predictions, it can be seen that construction noise from the site is likely to exceed the Category 1 noise criteria at all locations.

It is important to note that these predictions are typical worst-case predictions as they assume that:

- The receiver is located at the boundary of each receiver property.
- All plant/equipment within each stage are operating concurrently.

Table 23 Typical worst-case external construction noise levels for Standard Working Hours

Receiver	Receiver type	NML – dB(A)	Typical worst-case external construction noise level for each stage during Standard Hours L_{eq} – dB(A)						
			Stage 1 - Site establishment	Stage 2 - Demolition	Stage 3 - Retaining piles and excavation	Stage 4 - Substructure	Stage 5 - Frame	Stage 6 - Facade works	Stage 7 - Internal works and fitout
R1	Residential	50	75	81	75	77	74	70	47
R2	Residential	50	75	81	75	77	74	70	47
R3	Residential	50	62	68	62	64	61	57	34
R4	Residential	50	55	61	55	57	54	50	27
R5	Residential	50	57	63	57	59	56	52	29
R6	Residential	50	58	64	58	60	57	53	30
R7	Residential	50	76	82	76	78	75	71	48
R8	Residential	50	58	64	58	60	57	53	30
RE1	Passive Recreation	60	79	85	79	81	78	74	51
E1	Educational	55	91	97	91	93	90	86	63

(1) Predicted levels that exceed the respective NML have been **BOLD**.

Discussion

The worst-case predicted construction noise impacts presented in Table 23, indicate the following:

- **R1 and R2 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 31 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 81 dB(A) is during Stage 2 demolition works. Construction noise impacts at all these residential receivers have been predicted to comply with the highly noise affected NML for all construction stages except for Stage 2 works.
- **R3 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 18 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 68 dB(A) is during Stage 2 demolition works. Construction noise impacts at all residential receivers have been predicted to comply with the highly noise affected NML for all construction stages.
- **R3 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 11 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 61 dB(A) is during Stage 2 demolition works. Construction noise impacts at all residential receivers have been predicted to comply with the highly noise affected NML for all construction stages.
- **R4 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 13 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 63 dB(A) is during Stage 2 demolition works.

Construction noise impacts at all residential receivers have been predicted to comply with the highly noise affected NML for all construction stages.

- **R5 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 13 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 63 dB(A) is during Stage 2 demolition works. Construction noise impacts at all residential receivers have been predicted to comply with the highly noise affected NML for all construction stages.
- **R6 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 14 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 64 dB(A) is during Stage 2 demolition works. Construction noise impacts at all residential receivers have been predicted to comply with the highly noise affected NML for all construction stages.
- **R7 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 32 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 82 dB(A) is during Stage 2 demolition works. Construction noise impacts at all these residential receivers have been predicted to comply with the highly noise affected NML for all construction stages except for Stage 2 works.
- **R8 residential receivers** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 14 dB(A). Stage 7 works have been predicted to comply with the NML at all residential receivers. The predicted worst-case construction noise impact of 64 dB(A) is during Stage 2 demolition works. Construction noise impacts at all residential receivers have been predicted to comply with the highly noise affected NML for all construction stages.
- **RE1 Passive Recreation** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 25 dB(A). Stage 7 works have been predicted to comply with the NML. The predicted worst-case construction noise impact of 85 dB(A) is during Stage 2 demolition works.
- **E1 educational facilities** – Construction noise impacts during Stages 1 to 6 works are likely to exceed the NML by up to 15 dB(A). Stage 7 works have been predicted to comply with the NML. The predicted worst-case construction noise impact of 85 dB(A) is during Stage 2 demolition works.

Based on the above predicted exceedances of construction activities at surrounding receivers, noise management and mitigation measures have been recommended in Section 5.3.

5.2 Construction vibration

5.2.1 Minimum working distances

The Transport for NSW's (TfNSW) *Construction Noise and Vibration Guideline* (CNVG) provides guidelines for minimum working distances for vibration-intensive activities with respect to the stated standards and guidelines. The minimum working distances for building damage must be complied with at all times. The distances are noted as being indicative and are likely to vary depending on the particular item of plant and local geotechnical conditions. The minimum working distances apply to addressing the risk of cosmetic (minor – easily reparable) damage of typical buildings under typical geotechnical conditions.

Where vibration intensive works are required to be undertaken within the specified minimum working distances, vibration monitoring shall be undertaken to ensure acceptable levels of vibration are satisfied.

In relation to human comfort, the minimum working distances relate to continuous vibration. For most construction activities, vibration emissions would be intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods may be allowed.

Table 24 presents the recommended minimum working distances for vibration intensive plant.

Table 24 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Minimum Working Distance – Cosmetic Damage (BS7385)(1)	Minimum Working Distance – Human Response (OH&E Guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 metres	15 metres to 20 metres
	< 100 kN (Typically 2-4 tonnes)	6 metres	20 metres
	< 200 kN (Typically 4-6 tonnes)	12 metres	40 metres
	< 300 kN (Typically 7-13 tonnes)	15 metres	100 metres
	> 300 kN (Typically 13-18 tonnes)	20 metres	100 metres
	> 300 kN (> 18 tonnes)	25 metres	100 metres
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 metres	7 metres
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 metres	23 metres
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 metres	73 metres
Vibratory Pile Driver	Sheet piles	2 metres to 20 metres	20 metres
Pile Boring	≤ 800 mm	2 metres (nominal)	4 metres
Jackhammer	Hand held	1 metres (nominal)	2 metres

(1) Based on residential structures.

The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the minimum working distances at specific sites and once plant selection has been confirmed.

5.2.2 Residential buildings

The nearest residential buildings to the development site have been identified to be the residences to the east of the development site, across from Fontana Drive. The nearest residential buildings are approximately 25 metres from the eastern boundary of the project site.

Based on the safe working distances in Table 24, cosmetic or structural damage to nearby residential buildings are considered unlikely. However, construction vibration impacting on human comfort is likely where larger equipment such as vibratory roller more than 4 tonnes or hydraulic hammer 18 tonnes or more are utilised during the construction of the development. It is recommended that smaller equipment is used where the safe working distances listed in Table 24 cannot be maintained.

5.2.3 Non-residential buildings

The nearest non-residential buildings have been identified to be the Aspect Hills Shire School (Receiver E1) which is located immediately to the south approximately 3 metres from the southern boundary of the project site. Due to the close proximity of these buildings to the project site, it is recommended that smaller vibration intensive plant such as vibratory roller and hydraulic hammer be utilised during construction and the safe working distances be adhered to.

This is to ensure that construction vibration levels are maintained below the cosmetic damage and human comfort vibration limits .

5.3 Construction noise and vibration management

To manage the potential impact of noise and vibration during construction, reasonable and feasible management measures and work practices must be implemented as detailed below.

5.3.1 Construction Noise and Vibration Management Plan

Prior to the commencement of major construction works, the contractor must develop a Construction Noise and Vibration Management Plan (CNVMP). The CNVMP shall:

- identify relevant construction noise and vibration criteria as detailed in this report
- identify neighbouring sensitive land uses for noise and vibration
- summarise key noise- and vibration-generating construction activities and the associated predicted levels at neighbouring land uses
- identify reasonable and feasible work practices to be implemented during the works
- summarise stakeholder consultation and complaints handling procedures for noise and vibration.

5.3.2 Stakeholder consultation

Nearby stakeholders must be consulted prior to the works and kept regularly informed of potential noise and vibration impacts from the works. Specifically, this would involve consulting the nearby sensitive receivers identified in Table 2 and shown in Figure 2.

A noise and vibration complaints handling procedure and register must be developed and implemented during construction.

5.3.3 Work programming

Work shall be programmed such that particularly noisy works occur during Standard Working Hours wherever feasible, namely:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays.

If high noise works are to occur outside of the Standard Working Hours and later than 1 pm on a Saturday, then the CNVMP must define an approval process for undertaking out of hours works and for identifying reasonable and feasible mitigation measures to be implemented.

Opportunities for respite periods for works associated with the construction of the preschool and new southern carpark will be explored with the Aspect Hills Shire School should the works adjacent are found to be impacting student use of the outdoor areas or classrooms.

5.3.4 Truck movements and site access

Truck movements during long term construction projects have the potential to cause annoyance for sensitive receivers, even where trucks may be travelling on sealed roads. The design and selection of site access routes shall consider the potential disturbance to residents. In particular:

- site access and delivery points shall be located as far away from residences as possible
- truck movements shall use arterial roads and be diverted away from residential streets where feasible
- deliveries to/from site shall not occur during the night time period where possible.

5.3.5 Site management

Site management procedures must include the following:

- regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise
- site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied
- processes that generate lower noise levels must be selected where feasible
- noisy plant must be located as far away from residences as is practical to allow efficient and safe completion of the task
- the potential shielding provided by site topography and intervening buildings must be taken into account in locating equipment
- site compounds must be located as far away as possible from residences
- equipment that is used intermittently must be shut down or throttled down to a minimum during periods where it is not in use
- works must be planned to minimise the reduce the noise from reversing signals
- warning horns must not be used as signalling devices
- two way radios must be set to the minimum effective volume
- noise associated with packing up plant and equipment at the end of works must be minimised
- avoid the use of radios or stereos outdoors
- avoid the overuse of public address systems
- avoid shouting, and minimise talking loudly and slamming vehicle doors
- turn off all plant and equipment when not in use
- install noise barriers (blankets) / hoardings along the southern boundary of the project site.

5.3.6 Equipment management

Equipment management must include the following:

- selection of low-noise plant and equipment where possible
- equipment must be well maintained
- equipment must have quality mufflers and silencers installed where relevant
- equipment not in use on site must be shut down
- tasks must be completed using the minimum feasible power and equipment.

5.3.7 Noise monitoring

Unattended noise monitoring will be undertaken along the northern boundary of the Aspect Hills Shire School (i.e. boundary of the play area and/or classroom) during the construction works associated with the preschool and new southern car park due to their close proximity.

Detailed procedures and reporting of the noise monitoring must be outlined in the project's construction noise and vibration management plan.

6 Operational Noise Impact Assessment

This section details the assessment of the operational noise and vibration impacts from the Project. Operational noise impacts predicted at nearest residential receivers have been assessed against the noise criteria set out in Section 4.3.

6.1 Operational noise assessment methodology

Prediction of operational noise impacts from the development has been undertaken through the use of the SoundPLAN noise propagation modelling software (version 9.0).

Potential noise impacts from the following three operational scenarios were predicted at the surrounding noise-sensitive receivers using a site specific SoundPLAN 3D noise model:

- Noise impacts from standard operations (i.e. noise from outdoor play areas during standard school hours).
- Noise impacts from OOSH outdoor operations (i.e. noise from outside of school hours events located outdoors in the outdoor areas of the development site).
- Noise impacts from OOSH indoor operations (i.e. noise from out-of-school-hours events located within the school hall.
- Noise from the use of the Public Address (PA) system.

The most significant factors in determining the level of noise received from operational activities are the receiver's distance from the development site, shielding, ground absorption and noise source heights. The parameters used and values adopted in the noise modelling are presented in Table 25 below.

Table 25 Operational noise modelling parameters

Parameter	Input data
Receivers	• Receivers provided by project team in shapefile format and imported into SoundPLAN • Receivers have been modelled as point receivers • Height of receivers modelled as 1.5 m
Terrain	1 metre ground contours from Geoscience Australia.
Ground surface / absorption	The agricultural land surrounding the site has been conservatively modelled with a ground cover factor of 0.5 representative of 'mixed' ground.
Source heights	Operational source heights are modelled to be as follows: • 1 m above ground to simulate student noise sources • 4 m above ground to for PA speakers
Sources	• Outdoor activities have been modelled as area sources • School hall activities have been modelled as an industrial building with area sources for the openings. • PA speakers have been modelled as point sources. • Noise levels for the carpark modelled as a parking lot.
SoundPLAN module	ISO 9613 algorithm industrial module for industrial, point and area sources. ISO 9613-2:1996 algorithm parking lot (Parkplatzlärmstudie 2007) noise module for parking lot.
Meteorological conditions	Neutral meteorological condition has been modelled as operational activities will only be conducted during daytime and evening periods.

6.2 Standard hours operational noise impacts

6.2.1 Standard hours outdoor activities

The outdoor activities during standard hours of the school operation are considered to be the worst-case scenario and have been modelled as an area source covering the all outdoor areas within the school compound as shown in Figure 4. Internal activities within classrooms and the library are not considered to be noise intensive activities and are unlikely to adversely impact on surrounding receivers due to the existing daytime background noise levels in the area and the façade constructions of the classrooms.

As the operational management plan is not available at the time of conducting this assessment, the following assumptions for standard school hours operations for outdoor activities have been made:

- It is assumed that a maximum of 1,060 students (1,000 Primary and 60 Preschool) will be playing in the outdoor areas at any one time. This is based on the assumption that any outdoor activities will have all 1,060 students in the outdoor areas at any one time.
- Of the 1,060 students in the outdoor areas, it is assumed that 50% of the students (i.e. 530 students) would be undertaking outdoor activities with raised vocal effort.
- Based on sound pressure level (SPL) of 67 dB(A) @ 1 m for raised vocal effort of one person, the sound power level (SWL) for 530 students have been calculated to be 102 dB(A). The SPL for raised vocal effort has been derived from the noise data presented in the AAAC's "*Licensed Premises Noise Assessment Technical Guideline Version 2.0*" document.

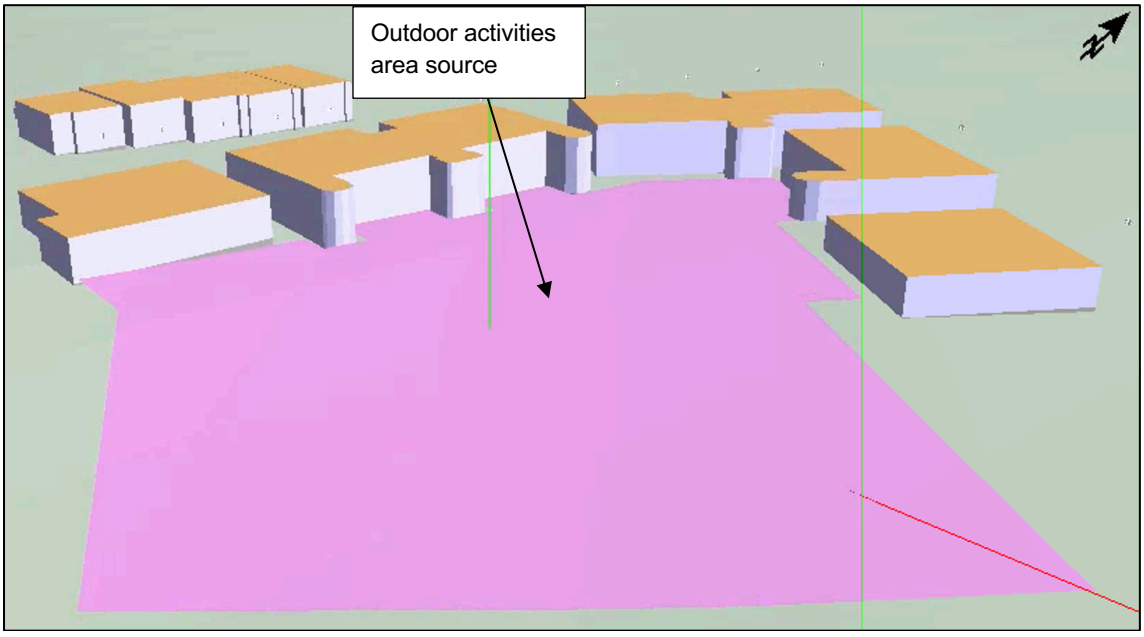


Figure 4 SoundPLAN 3D noise model standard hours outdoor activities

6.2.2 Standard hours noise assessment

The most affected noise-sensitive receivers, their corresponding project noise criteria and the predicted operational noise levels from standard operations are presented in Table 26.

Table 26 Predicted standard hours outdoor activities noise levels

Receiver	Receiver type	Worst case predicted outdoor activities dB(A) L_{eq} noise level at façade[1]	Daytime Noise Criteria dB(A)[2]		Comments
			Up to 4 hours (total) per day	More than 4 hours per day	
R1	Residential	45	50	45	Compliance of both criteria are achieved
R2	Residential	**48**	50	45	Compliance achieved only where outdoor activities are restricted to up to 4 hours per day
R3	Residential	44	50	45	Compliance of both criteria are achieved
R4	Residential	44	50	45	Compliance of both criteria are achieved
R5	Residential	**46**	50	45	Compliance achieved only where outdoor activities are restricted to up to 4 hours per day
R6	Residential	**48**	50	45	Compliance achieved only where outdoor activities are restricted to up to 4 hours per day
R7	Residential	**46**	50	45	Compliance achieved only where outdoor activities are restricted to up to 4 hours per day
R8	Residential	**48**	50	45	Compliance achieved only where outdoor activities are restricted to up to 4 hours per day
RE1	Passive Recreational	53	60	60	Compliance achieved.
E1	Educational	**56**	55	55	An exceedance 2 dB(A) is predicted at this receiver.

(1) Operational noise levels from the proposed school were calculated at 1 m from the receiver's facade, in line with relevant standards.

(2) Operational noise goals and assessment methodology have been derived from the Association of Australian Acoustical Consultants (AAAC) "Guideline for Child Care Centre Acoustic Assessment" as outlined in Section 4.3.1.

(3) Predicted noise level that exceeds the noise criteria/criterion have been **BOLD**.

(4) Surrounding educational premises are not in-used during evening period. Therefore, only the daytime criteria would apply for the education and commercial receivers.

The results presented in Table 26 show that where outdoor activities are restricted to not more than 4 hours per day, the school's standard hours operational noise levels are expected to achieve compliance with the noise criteria at all

surrounding residential receivers. Where outdoor activities are to occur for more than 4 hours per day, the standard hours operational noise levels have been predicted to comply with the noise criteria at receivers R1, R3 and R4 but expected to exceed the noise criterion at R2, R5, R6, R7 and R8 residences.

Additionally, for non-residential receivers, the outdoor activities are expected to comply at RE1, however, are expected to exceed the criterion by 1 dB at E1. It is noted that a 1 dB exceedance would not be discernible by the average listener and therefore would not warrant receiver-based treatments and controls for this receiver.

Based on this assessment, the project's requirements for outdoor activities can be met by implementing an operational control that limits the use of the outdoor play area to a total of 4 hours per day. This control is achievable due to the fact that children typically play outside only during recess and lunch, which equates to approximately 1.5 hours in total. However, this operational management control should be documented in the school's operational management plan and should be considered when planning any additional outdoor activities on the same day that would involve a majority of the students.

6.3 OOSH and OSHC outdoor events

6.3.1 OOSH and OSHC outdoor events

OOSH and OSHC outdoor events such as outdoor play, interschool sports, outdoor carnivals etc, has been modelled as an area source covering the entire outdoor areas within the school compound as shown in Figure 4.

As the operational management plan for OOSH and OSHC is not available at the time of conducting this assessment, the following assumptions for OOSH and OSHC operations for outdoor events have been made:

- The sound power level (SWL) assumed for the OOSH and OSHC outdoor activities area source in the noise model is 95 dB(A).
- This SWL has been derived from Resonate's noise database for outdoor events such as school sports day and outdoor carnivals and activities outdoor play activities relating to OSHC.

6.3.2 OOSH and OSHC outdoor events noise assessment

The most affected noise-sensitive receivers, their corresponding project noise criteria and the predicted operational noise levels from standard operations are presented in Table 27.

Table 27 Predicted OOSH outdoor events noise levels

NCA	Receiver type	Worst case predicted outdoor activities dB(A) L_{eq} noise level at façade[1]	OOSH Noise Criteria dB(A)		Comments
			Daytime	Evening	
R1	Residential	36	45	41	Compliance of both criteria are achieved
R2	Residential	39	45	41	Compliance of both criteria are achieved
R3	Residential	36	45	41	Compliance of both criteria are achieved
R4	Residential	35	45	41	Compliance of both criteria are achieved

NCA	Receiver type	Worst case predicted outdoor activities dB(A) L_{eq} noise level at façade(1)	OOSH Noise Criteria dB(A)		Comments
			Daytime	Evening	
R5	Residential	37	45	41	Compliance of both criteria are achieved
R6	Residential	39	45	41	Compliance of both criteria are achieved
R7	Residential	37	45	41	Compliance of both criteria are achieved
R8	Residential	39	45	41	Compliance of both criteria are achieved
RE1	Passive Recreational	44	60	60	Compliance of both criteria are achieved
E1	Educational	48	55	55	Compliance of both criteria are achieved

(1) Operational noise levels from the proposed school were calculated at 1 m from the receiver's facade, in line with relevant standards.

The results presented in Table 27 show that OOSH and OSHC outdoor events noise levels are expected to achieve compliance with the daytime and evening noise criteria at all surrounding noise sensitive receivers.

Based on this assessment, noise mitigation measures will not be required to ensure that the OOSH and OSHC outdoor events noise levels achieve compliance with the OOSH and OSHC noise criterion at all surrounding noise sensitive receivers.

6.4 OOSH and OSHC indoor events operational noise impacts

6.4.1 OOSH indoor events

OOSH and OSHC indoor events such as indoor playing, parent-teacher events, performance and music events, speech days have been modelled. These indoor events are assumed to be held within the School Hall. These indoor events have the potential to result in noise impacts at the surrounding noise sensitive receivers. The area source openings from the two buildings are shown in Figure 5.

As the operational management plan is not available at the time of conducting this assessment, the following assumptions for OOSH and OSHC operations for indoor events have been made:

- The reverberant sound power level assumed for the school hall OOSH indoor events in the noise model is 98 dB(A).
- The reverberant sound power levels have been derived from Resonate's noise database for indoor events such as indoor sports and cultural concerts.
- The proposed glazing façade (i.e. windows and doors) are to achieve a minimum Rw 35 acoustic rated construction acoustically equivalent to an aluminium framed 10.38 mm laminated glass system.
- The external door openings are to achieve a minimum Rw 30 acoustically rated construction acoustically equivalent to a 40mm solid core door with acoustic perimeter seals.

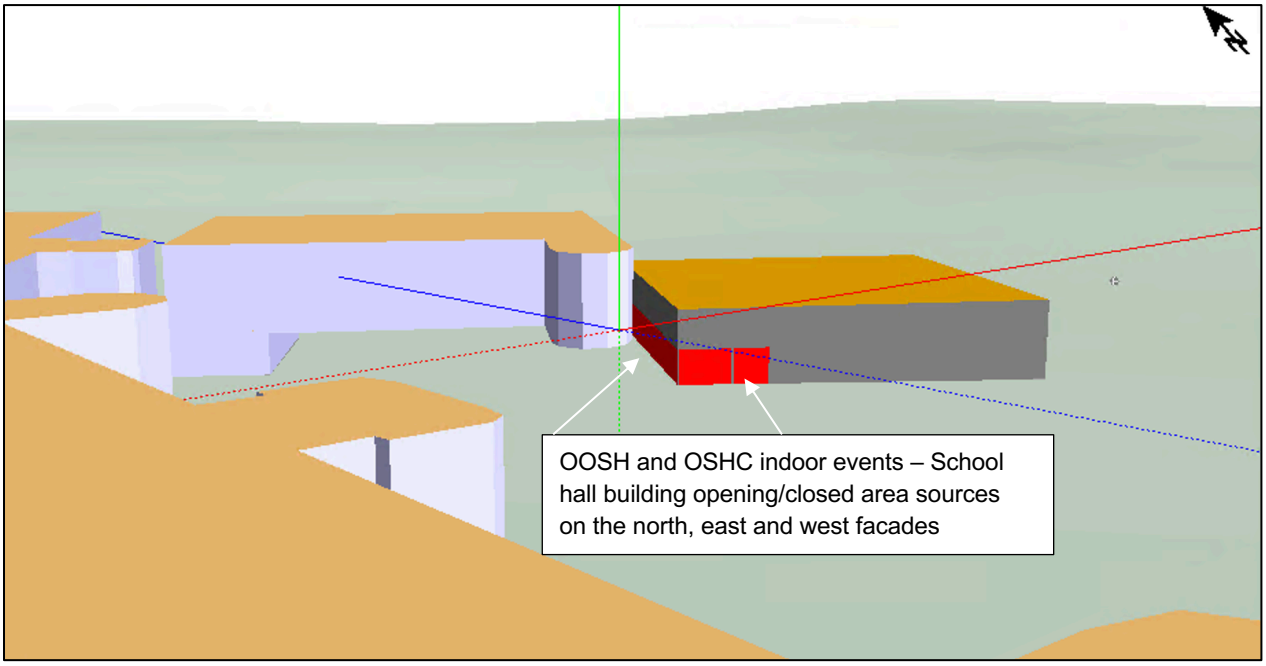


Figure 5 OOSH and OSHC indoor events at school hall opening area sources

6.4.2 OOSH and OSHC indoor events noise assessment

The most affected noise-sensitive receivers, their corresponding project noise criteria and the predicted operational noise levels from typical operations are presented in Table 28.

Table 28 Predicted noise emission from indoor OOSH school hall activities

NCA	Receiver type	Worst case predicted outdoor activities L_{eq} noise level at facade (1)	Noise Criteria dB(A)		Comments
			Daytime	Evening	
R1	Residential	31	45	41	Compliance of both criteria are achieved
R2	Residential	31	45	41	Compliance of both criteria are achieved
R3	Residential	27	45	41	Compliance of both criteria are achieved
R4	Residential	26	45	41	Compliance of both criteria are achieved
R5	Residential	27	45	41	Compliance of both criteria are achieved
R6	Residential	30	45	41	Compliance of both criteria are achieved
R7	Residential	35	45	41	Compliance of both criteria are achieved

NCA	Receiver type	Worst case predicted outdoor activities L_{eq} noise level at facade (1)	Noise Criteria dB(A)		Comments
			Daytime	Evening	
R8	Residential	31	45	41	Compliance of both criteria are achieved
RE1	Passive Recreational	49	60	60	Compliance of both criteria are achieved
E1	Educational	35	55	-(3)	Compliance of both criteria are achieved

(1) Operational noise levels from the proposed school were calculated at 1 m from the receiver's facade, in line with relevant standards.

(2) Predicted noise level that exceeds the noise criteria/criterion have been **BOLD**.

(3) Surrounding educational premises are not in-used during evening period. Therefore, only the daytime criteria would apply for the education and commercial receivers.

Indoor events noise levels at the school hall buildings have been predicted to achieve compliance with the established OOSH and OSHC noise criteria at all noise sensitive receivers.

However it is noted that noise levels depending on the use of the school should also be controlled in the evening period (6pm-10pm) by closing all opening external doors and windows when a noisy activity is occurring within the school hall. This noise management measure is a project commitment to ensure that the use of the school hall complies with the OOSH and OSHC noise criteria at all surrounding receivers.

6.5 Public address system and school bell noise assessment

Public address (PA) system and school bell has the potential to impact on surrounding residential receivers. Therefore, the PA/school bell system has been modelled. As the placement of the speakers for the PA/school bell system has not been determined, speaker locations and directionality within the development site as indicated in Figure 6 have been assumed for this assessment. A total of six speakers have been modelled to establish the maximum allowable sound power level of each speaker so that the PA/school bell system would achieve the NPI daytime noise criteria at the surrounding noise sensitive receivers.

Figure 6 Assumed speaker locations and directionality

Based on the SoundPLAN noise modelling of six speakers in the locations indicated in Figure 6, in order to achieve compliance with the NPI daytime and evening criteria at all surrounding noise sensitive receivers, the sound power level of each speaker should not be more than 95 dB(A).

That said, PA/bell system would be assessed in more detail (in accordance with the noise criteria outlined in Section 4.3.5) during the detailed design stage of the development.

The PA/school bell system to be installed in the proposed development should minimise noise spill to nearby properties by adopting the following principles.

- Speaker positioning/selection:
  - Speaker location and direction can be used to reduce noise spill to neighbouring properties while still maintaining suitable noise levels within the school grounds (typically 70-75 dB(A)).
  - Broadly speaking, more speakers, closer to the receiver is a more effective way to provide coverage of the external areas while reducing noise spill to neighbouring properties.
  - Similarly, highly directional speakers (angled downwards) will also reduce noise spill. Speakers with a drop of at least 5 dB(A) for mid-frequencies noise for each 10 degrees in the horizontal plane outside of the coverage area should be considered.
- Use of noise limiter system:

- By limiting the maximum possible signal sent to a speaker, this can reduce intermittent increased noise generation as a result of the system user excessively raising their voice or holding the microphone too close.
- In all likelihood, the limiter system would require that the system be installed, and volume adjusted such that the school is satisfied that a sufficient noise level has been reached in the assembly area, and the noise limit than set based on that.

- Duration:
  - Limiting the duration of PA school bells and announcements with any 15-minute period. A shorter noise duration would be considered less impactful to nearby noise sensitive receivers. Recommend limiting PA announcements to no greater than 1 minute duration.

6.6 Carpark noise assessment

Operational noise emissions from the carparks associated with the development have been modelled as parking lots within SoundPLAN covering the entire northern and southern carparks of the development based on the number of carparking spots in a parking lot and the amount of car movements into each parking space per hour.

The most affected noise-sensitive receivers, their corresponding project noise criteria and the predicted operational noise levels from typical operations are presented in Table 28.

Table 29 Predicted noise emission from indoor OOSH school hall activities

NCA	Receiver type	Worst case predicted outdoor activities L_{eq} noise level at facade (1)	Noise Criteria dB(A)		Comments
			Daytime	Evening	
R1	Residential	21	45	41	Compliance of both criteria are achieved
R2	Residential	29	45	41	Compliance of both criteria are achieved
R3	Residential	28	45	41	Compliance of both criteria are achieved
R4	Residential	25	45	41	Compliance of both criteria are achieved
R5	Residential	27	45	41	Compliance of both criteria are achieved
R6	Residential	29	45	41	Compliance of both criteria are achieved
R7	Residential	25	45	41	Compliance of both criteria are achieved
R8	Residential	31	45	41	Compliance of both criteria are achieved
RE1	Passive Recreational	44	60(4)	60	Compliance of both criteria are achieved
E1	Educational	41	55(4)	-(3)	Compliance of both criteria are achieved

(1) Operational noise levels from the carpark were calculated at 1 m from the receiver's façade in line with relevant standards.

(2) Predicted noise level that exceeds the noise criteria/criterion have been **BOLD**.

(3) Surrounding educational premises are not in-use during evening period. Therefore, only the daytime criteria would apply for the education and commercial receivers.

(4) The NPI noise emission criteria have been used for non-residential noise sensitive receivers.

Carpark noise associated with the development have been predicted to achieve compliance with the established noise criteria at all noise sensitive receivers.

6.7 Mechanical plant noise assessment

A review of externally located or externally discharging mechanical plant and equipment noise levels has been undertaken in order to demonstrate that the requirements of the NPI can be met at nearby noise sensitive receivers. It should be noted that plant and equipment with different sound power levels may be selected as part of the detailed design process. It may be necessary to incorporate additional noise control measures such as internally lined (acoustically absorptive) duct work, use of attenuators or additional noise barriers as necessary to meet the NPI requirements.

Operational noise emissions from mechanical plant and other equipment associated with the development should be designed and located to reduce potential noise impacts from the development at nearby noise-sensitive receivers. While further assessment must be carried out during the detailed design phase, a preliminary review of the mechanical plant schematic drawings provided by the project's mechanical engineer indicates that the proposed mechanical plant located on the ground level and roof of the school is considered suitable. It is envisaged that compliance with the industrial noise criteria presented in Section 4.3.5 can be achieved through common engineering methods and typical in-principle acoustic treatment options that may consist of:

- Selection of low-noise mechanical plant and other noise generating equipment.
- Judicious location of mechanical plant and equipment with respect to nearby noise-sensitive receivers.
- Barriers/enclosures (e.g. plant rooms).
- Silencers and acoustically lined ductwork.

Location and selection of mechanical plant would be assessed in greater depth (in accordance with the noise criteria outlined in Section 4.3.5) during the detailed design stage of the development.

7 Road Traffic Noise Intrusion

This assessment predicts road traffic noise impacts from Fontana Drive to the internal areas of the school buildings. To assess noise intrusion into the proposed residential apartments, the data obtained from the logger at location L1 (shown in Figure 3) has been processed to establish representative ambient noise levels at the facades most exposed to Fontana Drive. The daytime (7 am to 10 pm) ambient noise level measured at logger location UM02 is 54 dB(A) $L_{eq,15hour}$.

Standard window glazing of a building will typically attenuate these noise levels by 20 dB(A) with windows closed and 10 dB(A) with windows open (allowing for natural ventilation). The predicted internal noise levels for standard facade glazing are presented in Table 30 for the windows open and windows closed scenarios. Standard window system (4 mm thick glass with aluminium frame) has been assumed for this prediction.

Table 30 Predicted road traffic noise levels - standard glazing

Location	Noise Level L_{Aeq} – dB(A) re 20 µPa		
	Daytime (0700 hrs – 2200 hrs)		
	Existing External	Windows Open	Windows Closed
Classroom/Office	55	45	35
TISEPP Criteria(1)	N/A	50(3)	40
TISEPP Exceedance	N/A	-	-
Most stringent EFSG criteria(2)	N/A	50(3)	35
EFSG exceedance	N/A	-	-

TISEPP internal noise criteria presented in in Table 16.

(1) Table 16.

(2) EFSG internal noise criteria presented in Table 17.

(3) The TISEPP guideline allows for a + 10 dB concession for the open windows condition. Therefore, a +10dB has been applied to the TISEPP criteria for opened windows.

The predicted internal noise levels indicate that road traffic noise levels from Fontana Drive inside the classrooms are likely to comply with the criteria with windows open and with windows closed.

Based on this assessment, noise mitigation measures would not be required.

8 Conclusion

8.1 Overview

Resonate has conducted a noise and vibration impact assessment associated with the Gables New Primary School development at Lot 301 DP 1287967 on Fontana Drive, Gables. This assessment report accompanies a Review of Environment Factors that seeks approval for the construction and operation of a new primary school at the site

The scope of the assessment involved a survey of the existing noise environment; derivation and establishment of project specific noise criteria through consultation with various NSW and Australian guidelines; a noise impact assessment with respect to the appropriate criteria; and, where required, commitments for noise control measures.

Regarding construction noise and vibration, the proposed development may result in some exceedances of the relevant noise management levels and, accordingly, mitigation and management procedures will need to be considered for the works. It is expected that a detailed Construction Noise and Vibration Management Plan would be prepared by the contractor prior to the commencement of works.

Regarding the proposed operations, the assessment concludes that the proposed development is capable of satisfying the established criteria, provided that:

- An operational control that limits the use of the outdoor play area to a total of 4 hours per day. This operational noise management control should be documented in the school's operational management plan and should be considered when planning any additional outdoor activities on the same day (See Section 6.2.2).
- The school hall façade has external solid core doors with minimum acoustic rating of Rw 30 doors and all glazing façade elements are minimum Rw 35. Also the school hall door and window openings are closed when OOSH and/or OSHC activities are occurring in the school hall (See Section 6.4).

The above mitigation and management measures are commitments which will be implemented to ensure that the operations of the school achieves compliance with the project noise criteria.

Notwithstanding, further detailed acoustic assessment is warranted during the design development, particularly with regard to building services noise control, and noise control from the school’s PA/bell system.

Based on our assessment the proposed development is deemed to not cause “Offensive Noise” to neighbouring residences and compliance with the pending acoustic requirements is expected provided that the noise control measures committed in this report are implemented. It is therefore recommended that planning approval be granted for the proposed development on the basis of acoustics.

8.2 Mitigation Measures

An overall summary is provided below to outline the mitigation measures to be implemented as part of this SSD to mitigate potential noise and vibration impacts.

Table 31 Response to REF requirements

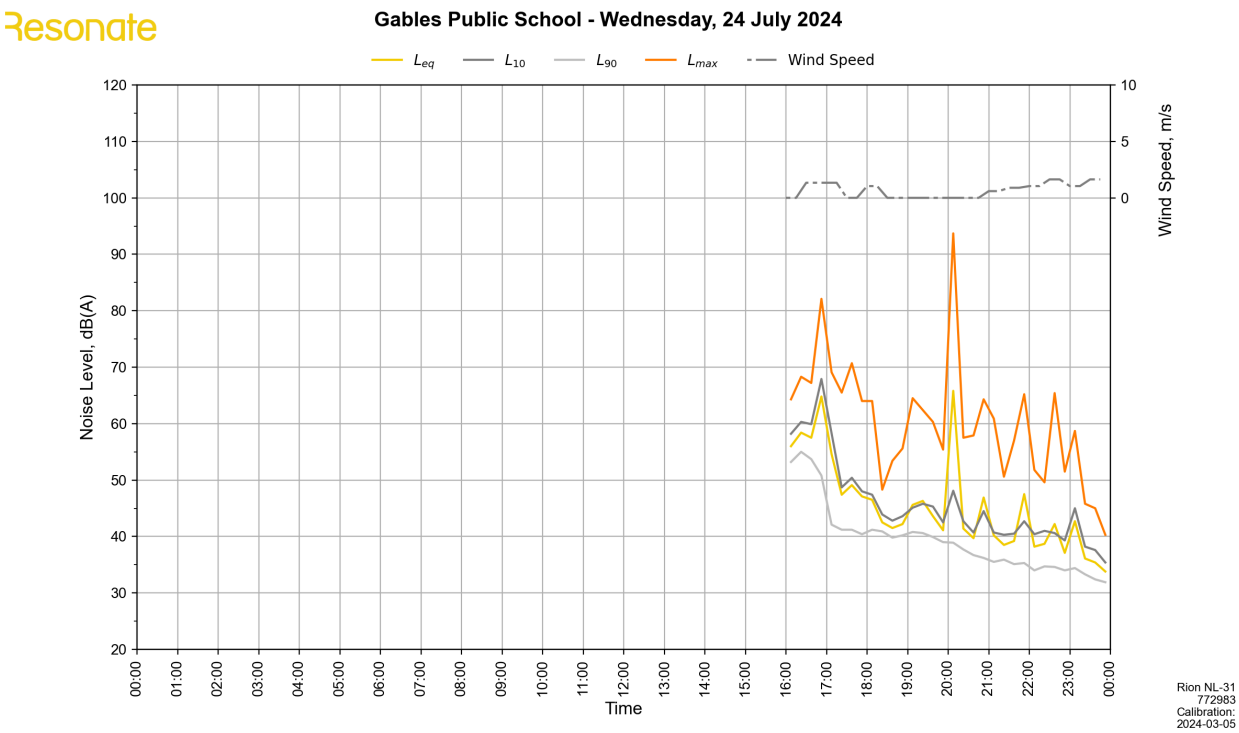
Project Stage Design (D) Construction (C) Operation (O)	Mitigation Measures	Relevant Section of Report
C	Construction noise and vibration management plan prior to commencement of major construction works	Section 5.3.1
O	Noise from outdoor school activities will need to be mitigated with an operational noise management control that limits the use of the outdoor play area to a total of 4 hours per day.	Section 6.2.2
D / O	Noise from OOSH and OSHC indoor events at the school hall will need acoustically rated external door and glazing elements. Operationally the school hall should not be used in the night time period 10pm - 7am. Also all window and door external openings should remain closed during a event in the evening period (6pm-10pm)	Section 6.4.1 and 6.4.2
D / O	Public address system noise. Minimise noise spill and impact to nearby noise sensitive receivers through speaker position/selection, the use of a limiter and controlling duration of bells and announcements.	Section 6.5
D	Location and selection of mechanical plant to be assessed in accordance with the NPI during the detailed design stage of the development.	Section 6.7

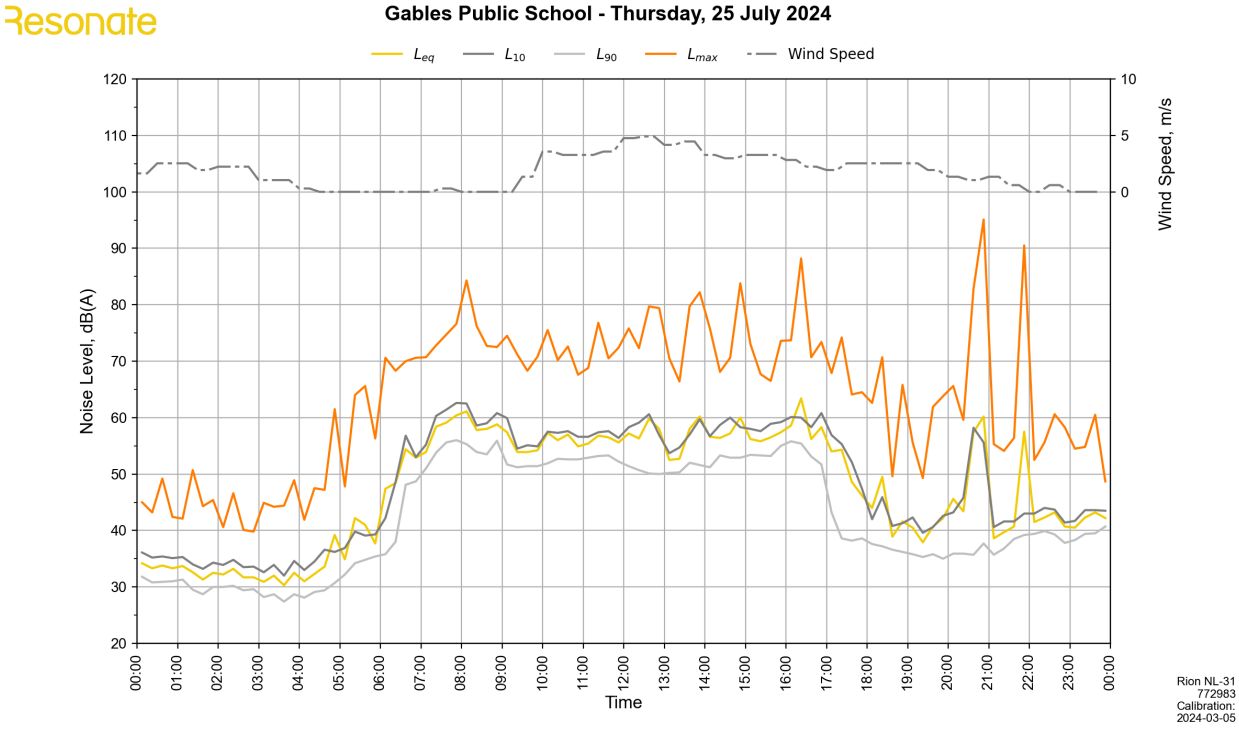
Appendix A – Unattended Noise Monitoring Graphs

An initial unattended environmental noise survey was conducted during the period 24 July 2024 to 7 August 2024. The noise logging was conducted at two locations, with positions shown in Figure 3.

For reference, a daily chart showing the graphed noise logging results is shown below for each noise logging location. The noise monitoring equipment model and serial number are shown in the bottom right corner of the graphs.

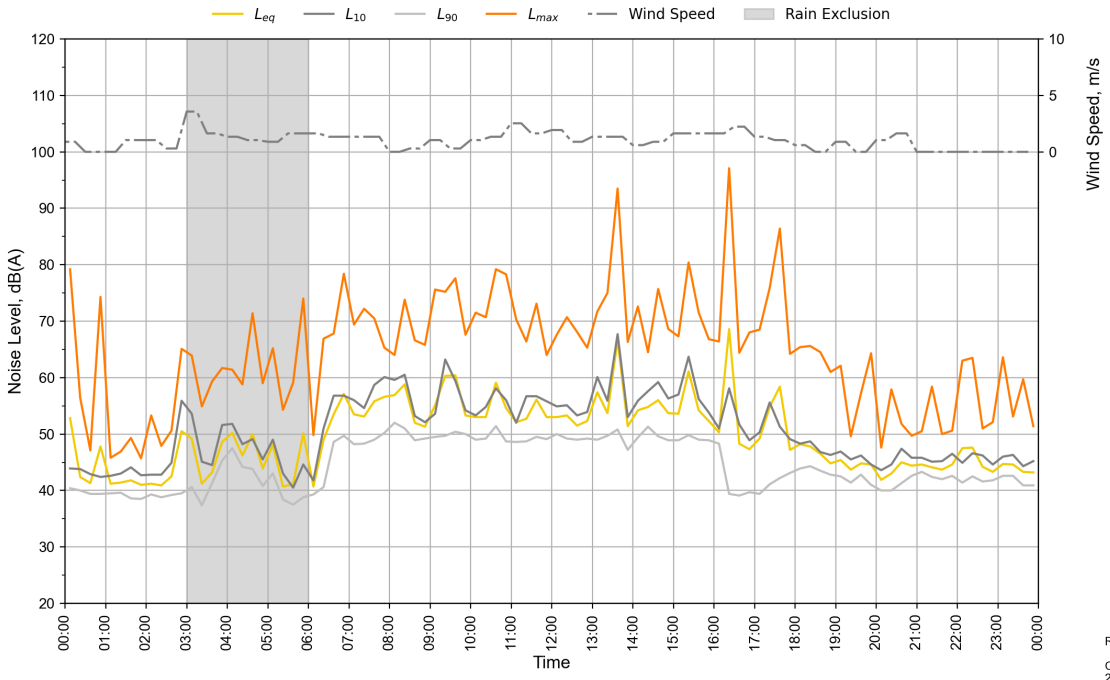
Unattended noise monitor 1 – Pennant Way and Cataract Road





Resonate

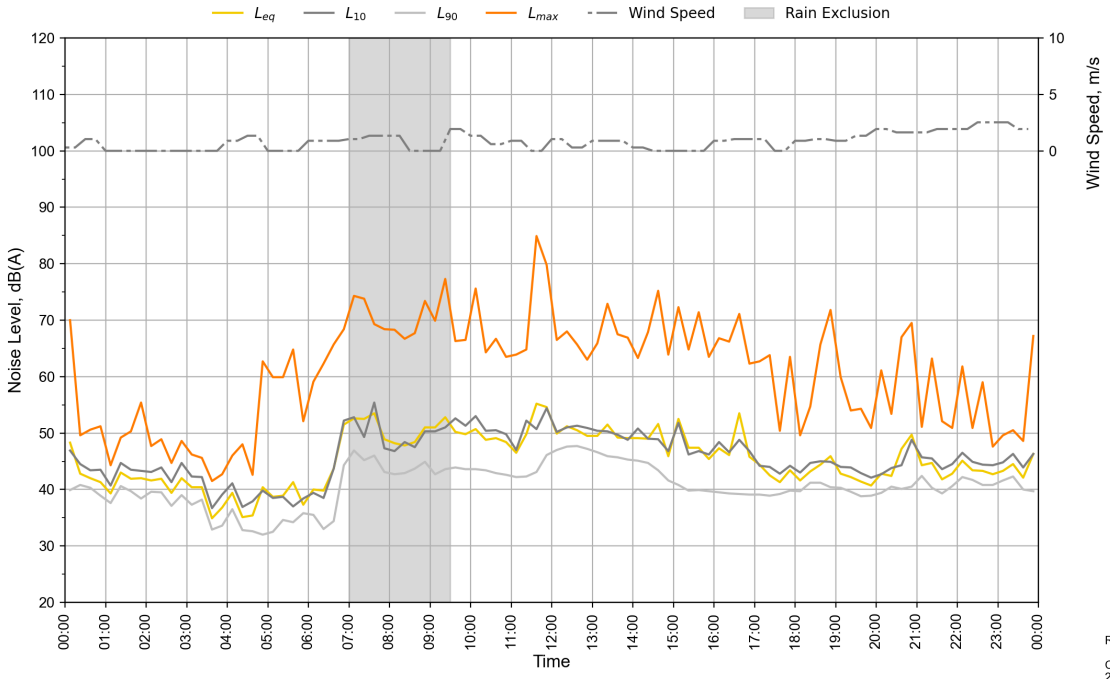
Gables Public School - Friday, 26 July 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

Gables Public School - Saturday, 27 July 2024



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Calibration:
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Resonate

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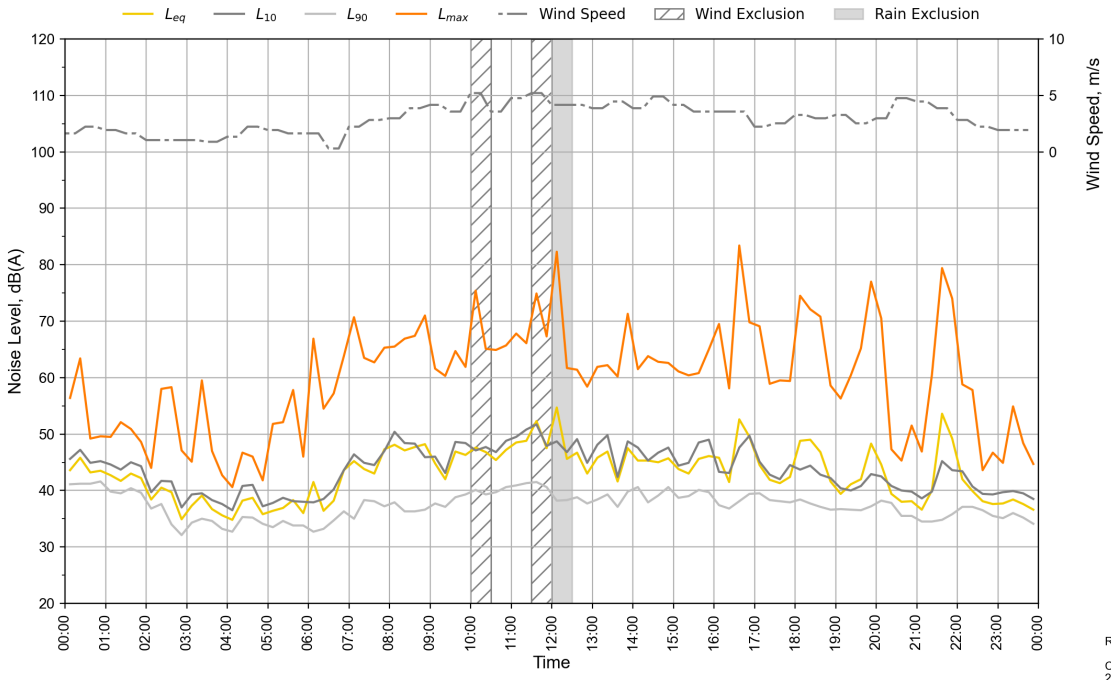

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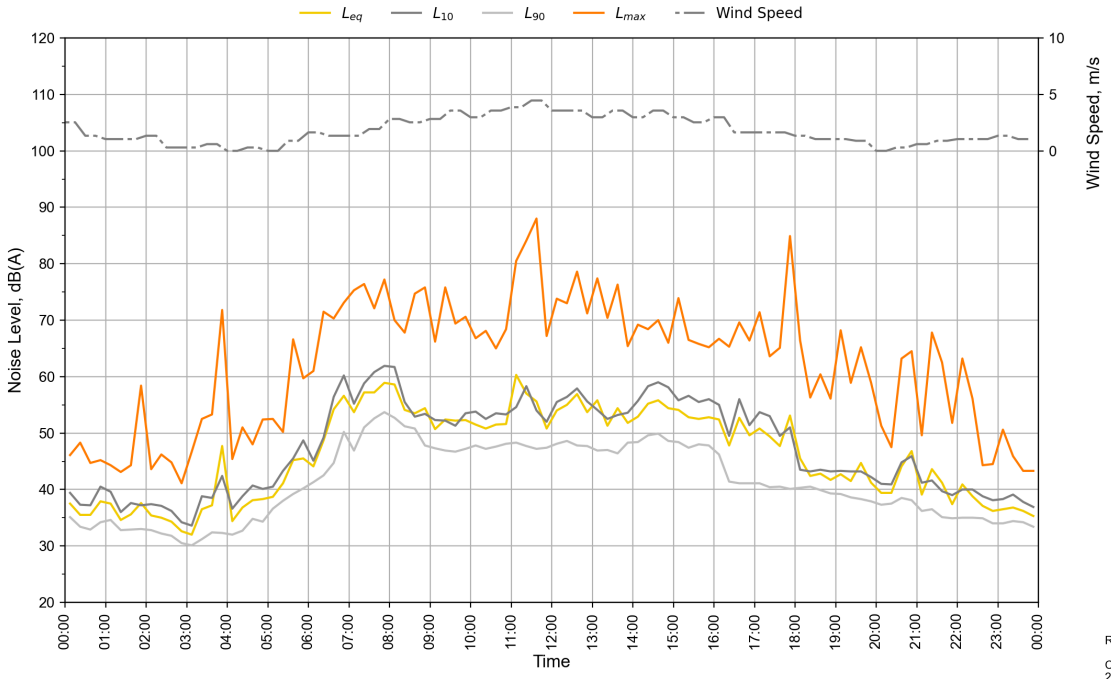
2024-03-05

Resonate

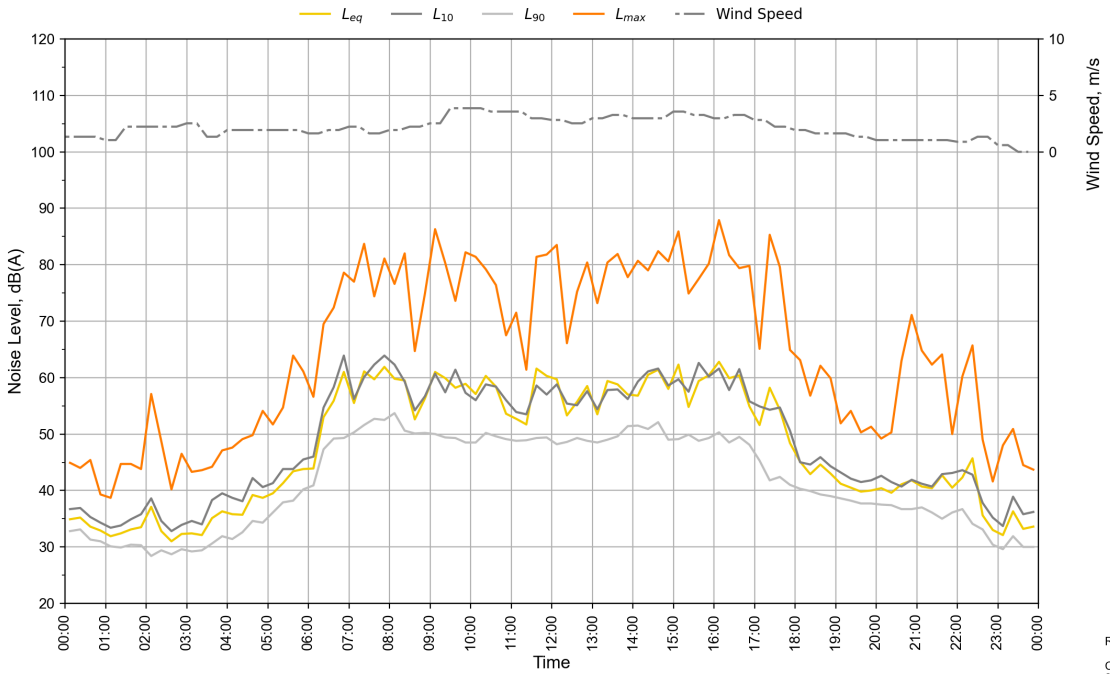
Gables Public School - Monday, 29 July 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

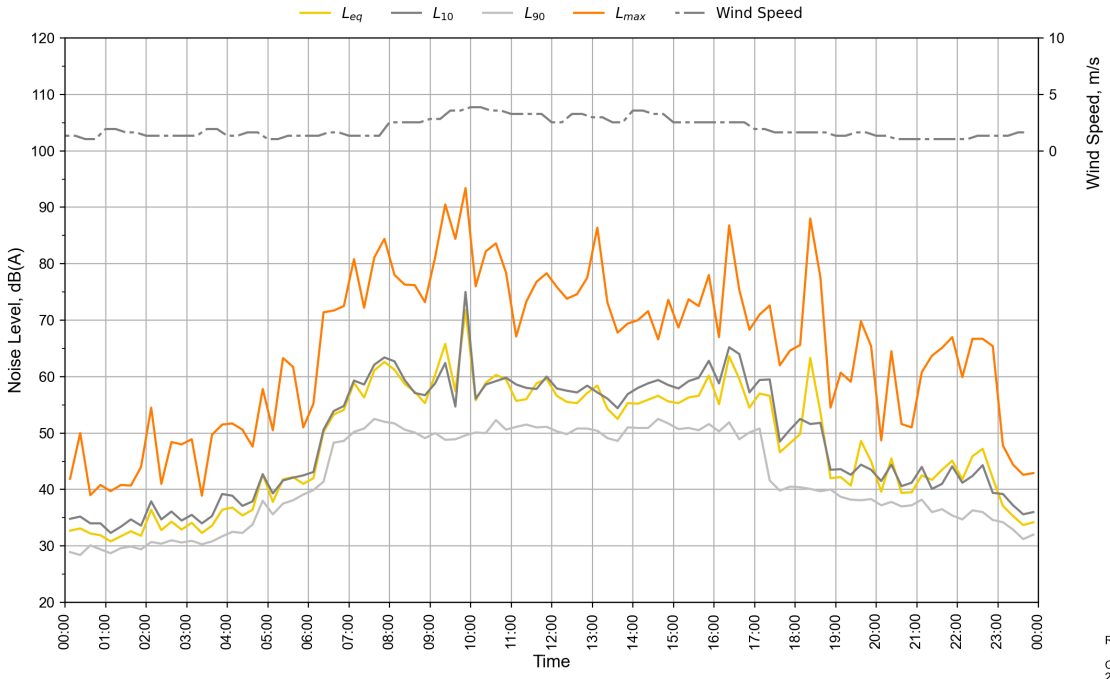
Gables Public School - Tuesday, 30 July 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

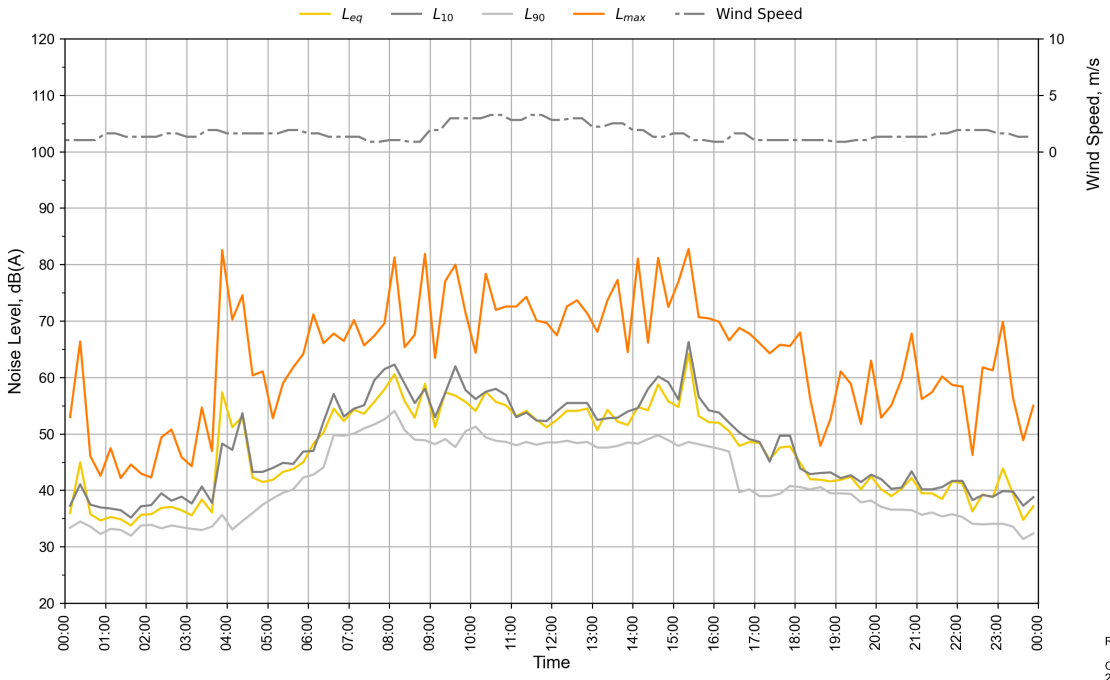
Gables Public School - Wednesday, 31 July 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

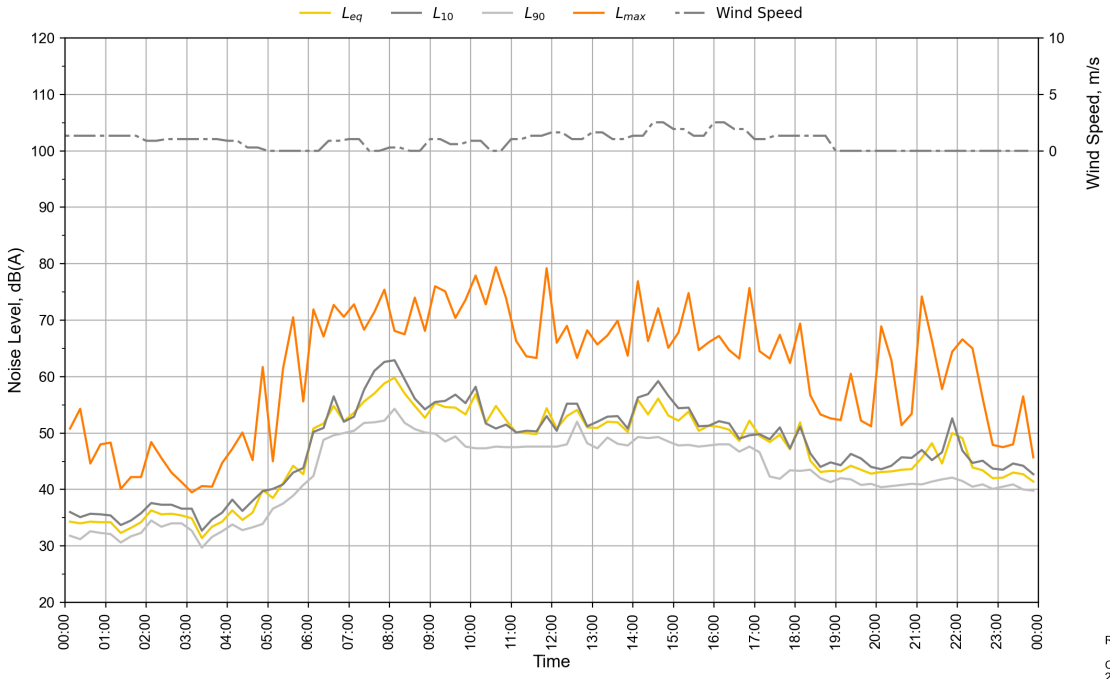
Gables Public School - Thursday, 1 August 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

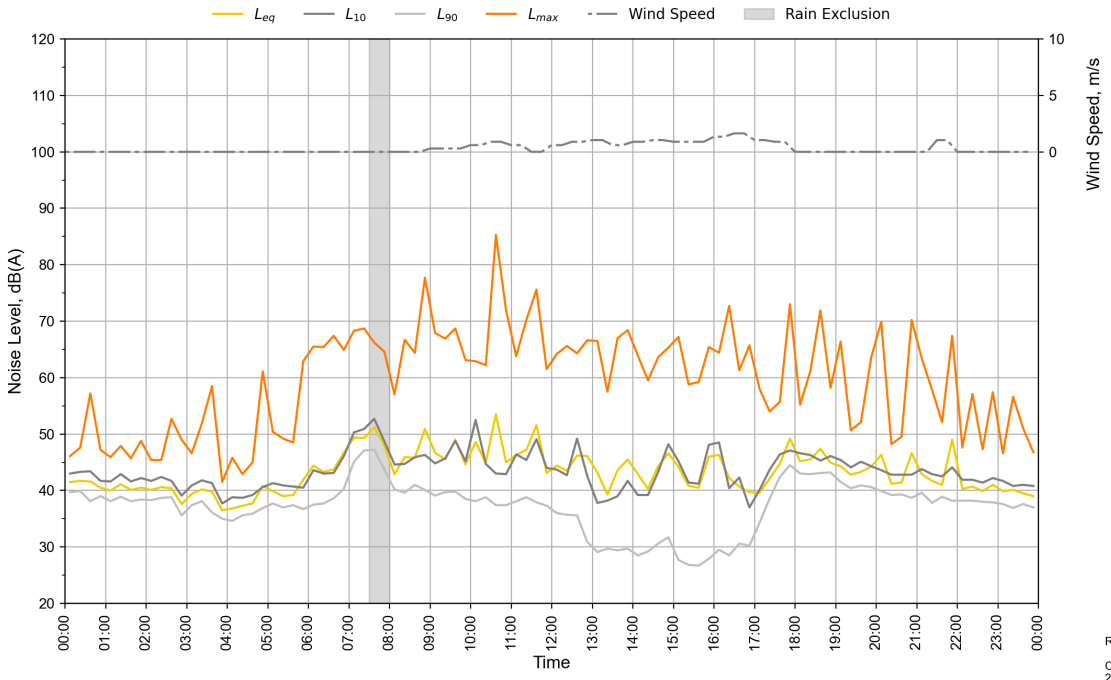
Gables Public School - Friday, 2 August 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

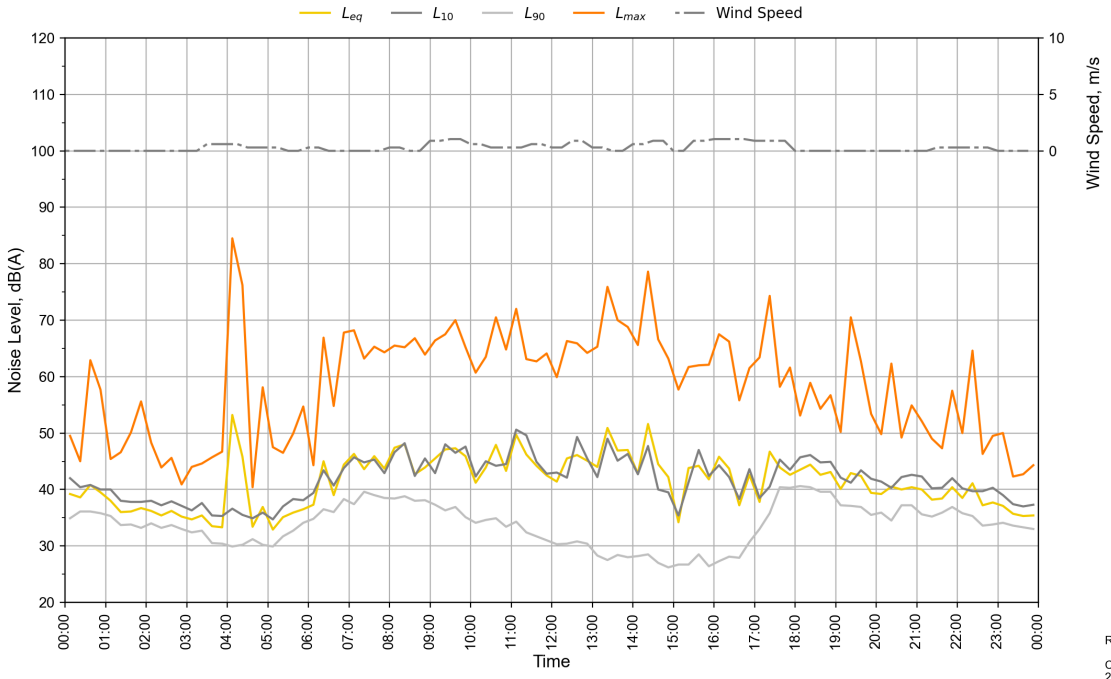
Gables Public School - Saturday, 3 August 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

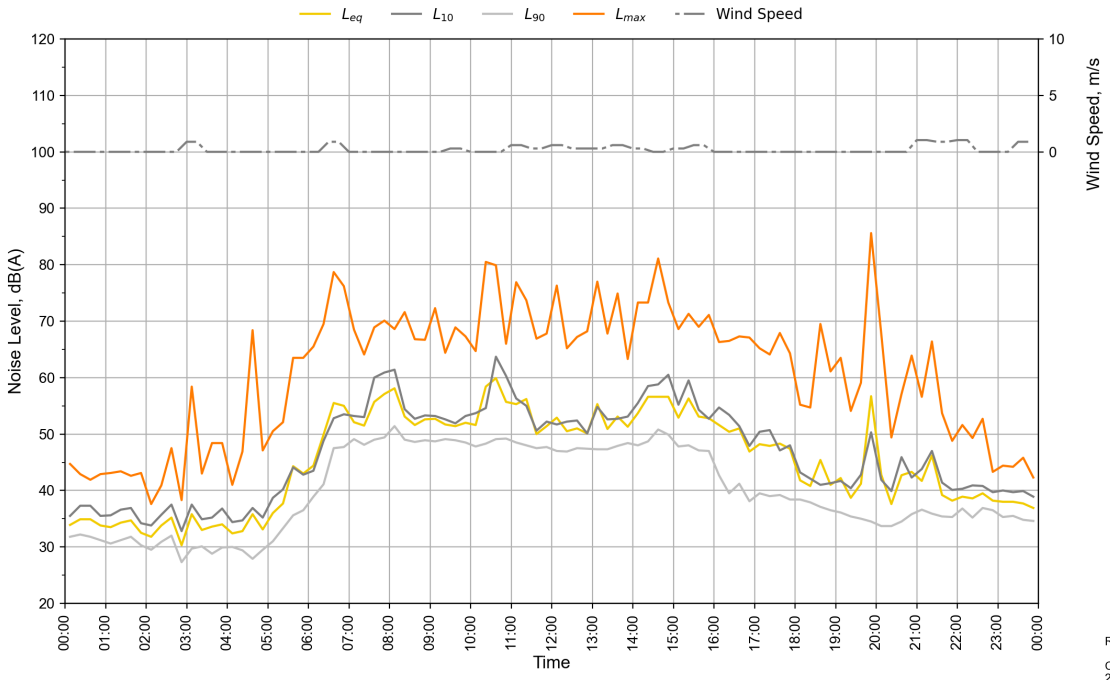
Gables Public School - Sunday, 4 August 2024



Rion NL-31
772983
Calibration:
2024-03-05

Resonate

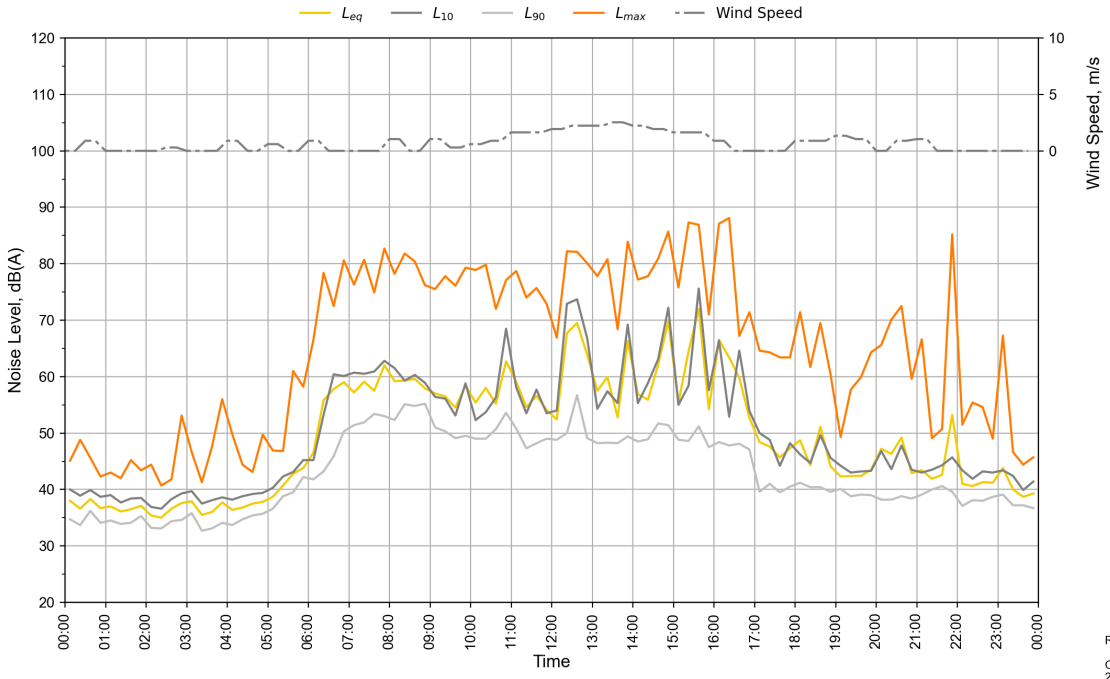
Gables Public School - Monday, 5 August 2024



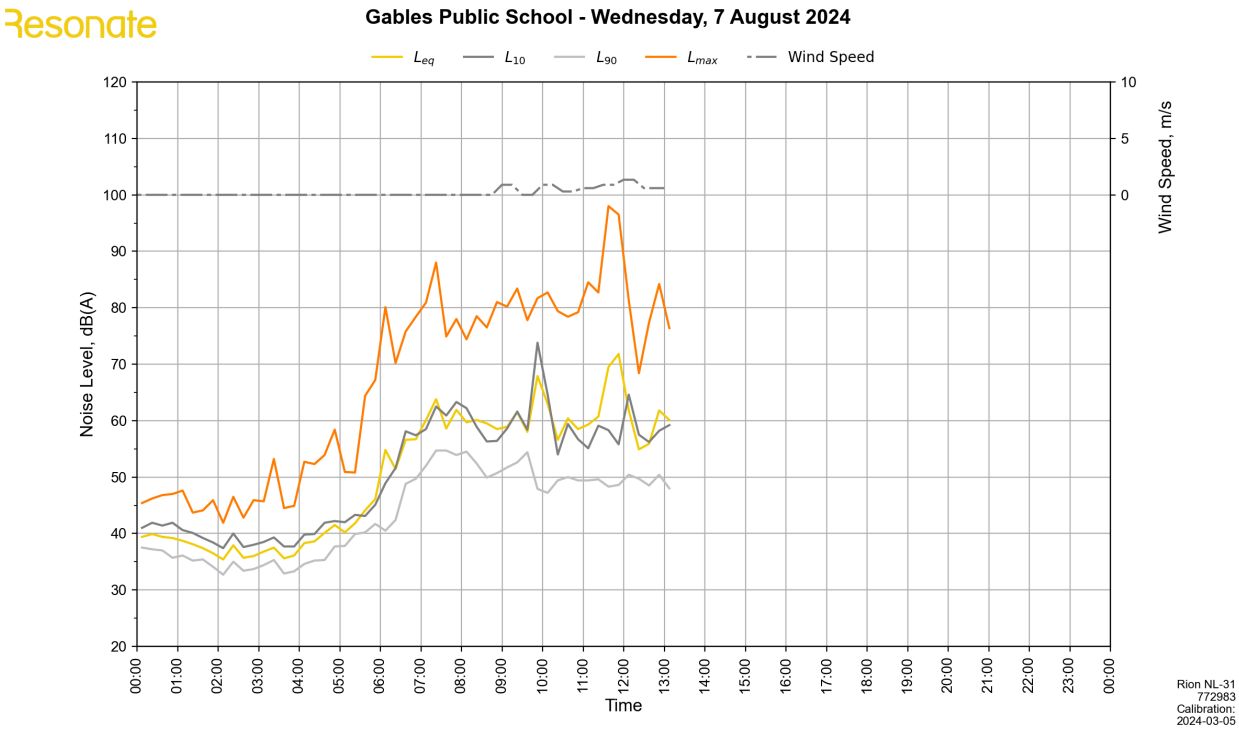
Rion NL-31
772983
Calibration:
2024-03-05

Resonate

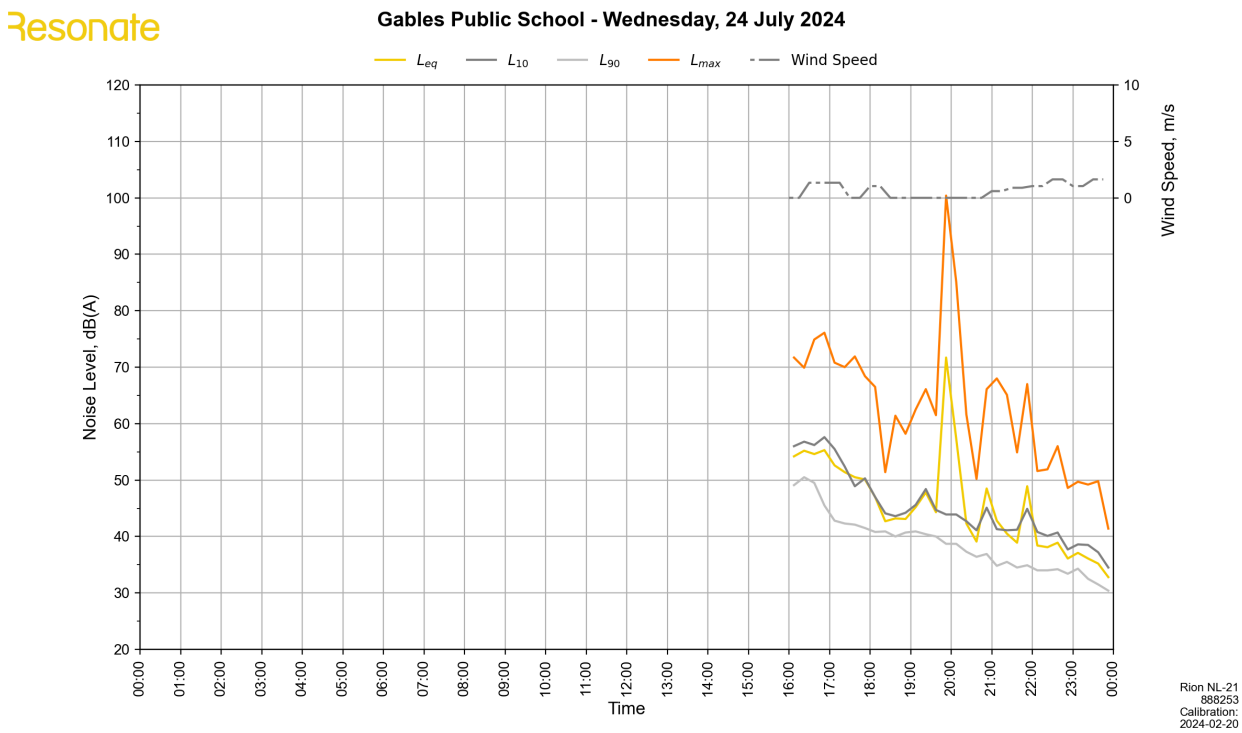
Gables Public School - Tuesday, 6 August 2024

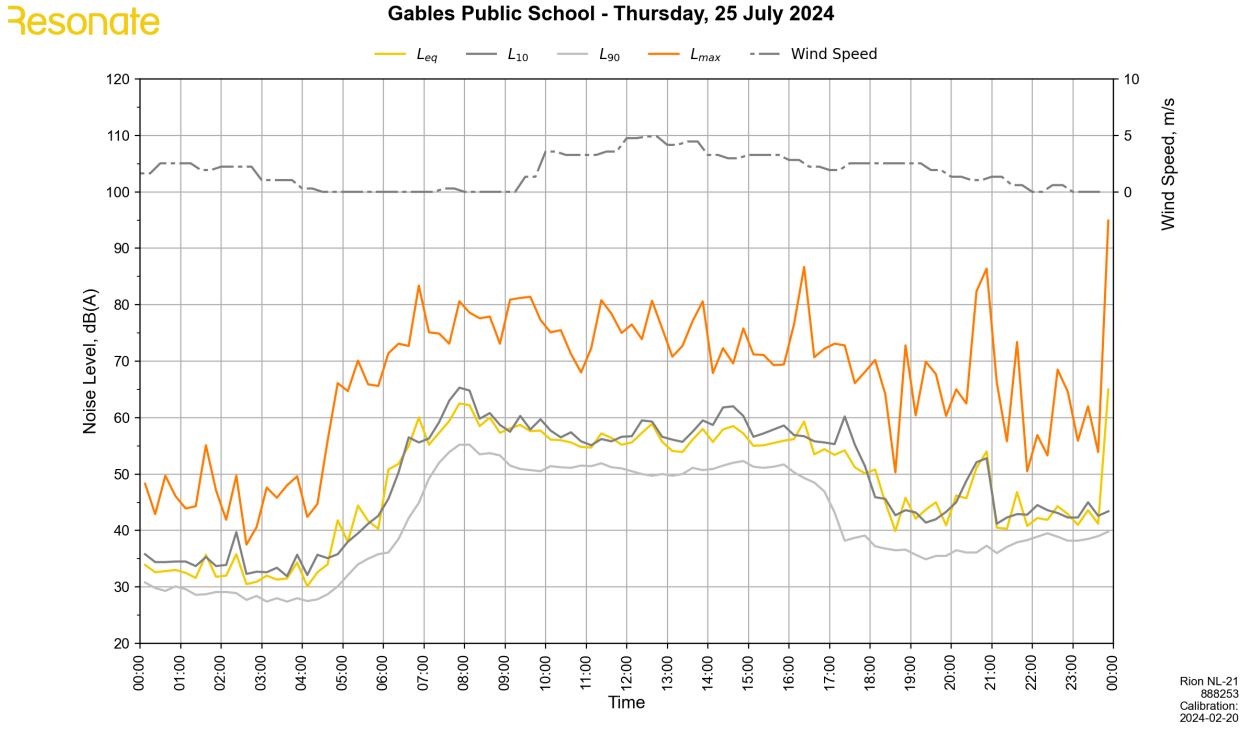


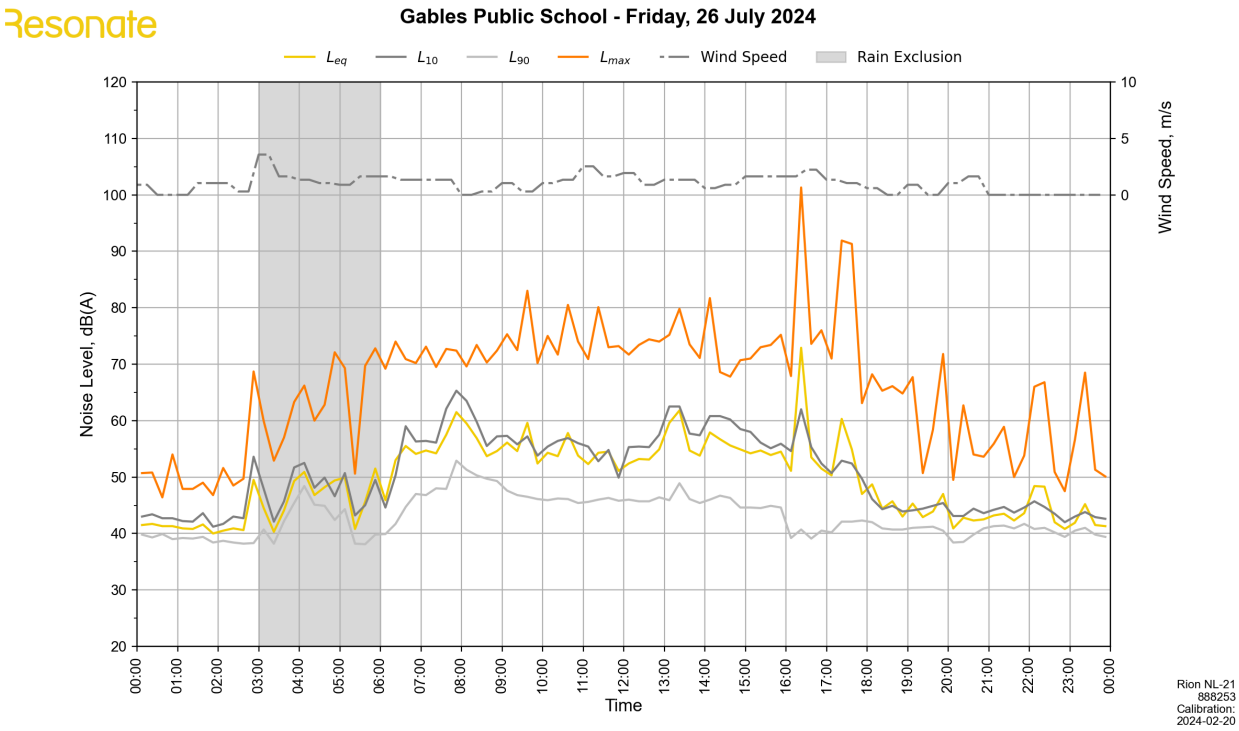
Rion NL-31
772983
Calibration:
2024-03-05

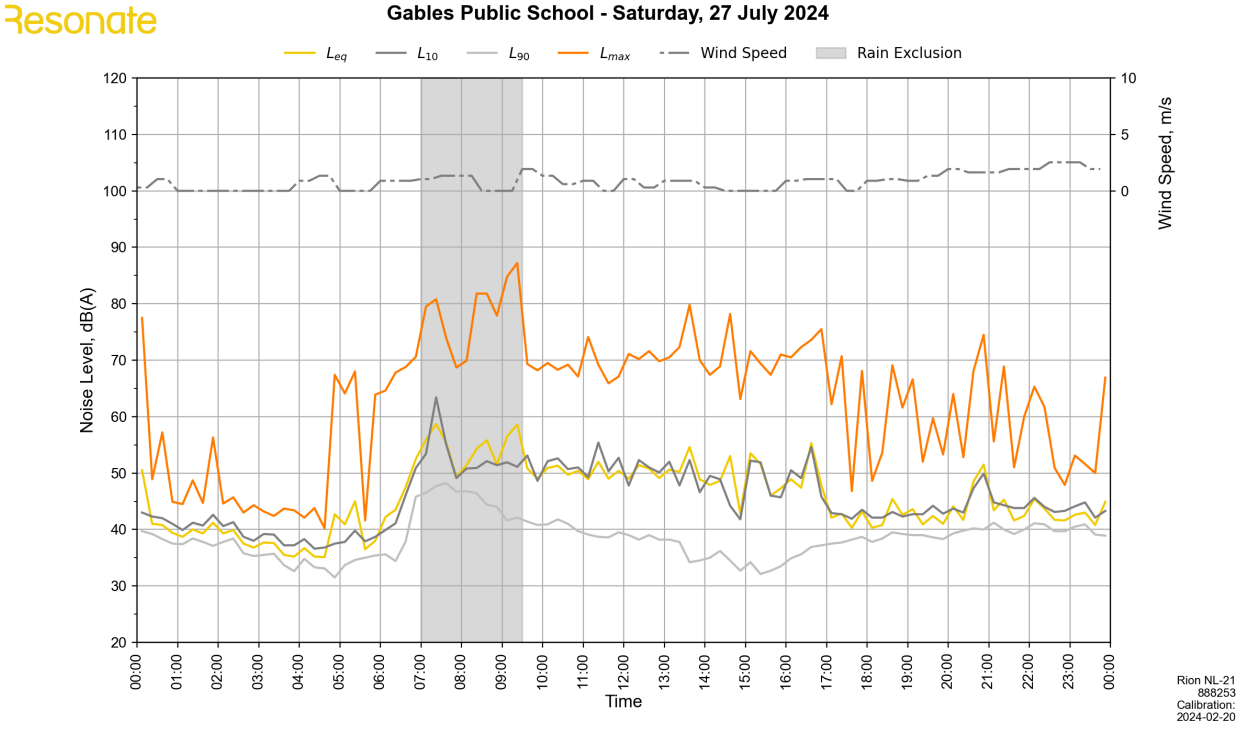

Resonate
Gables Public School - Wednesday, 7 August 2024
L_{eq}
L_{10}
L_{90}
L_{max}
Wind Speed
Noise Level, dB(A)
Wind Speed, m/s
Time
Rion NL-31
772983
Calibration:
2024-03-05

Unattended noise monitor 2 – Cataract Road



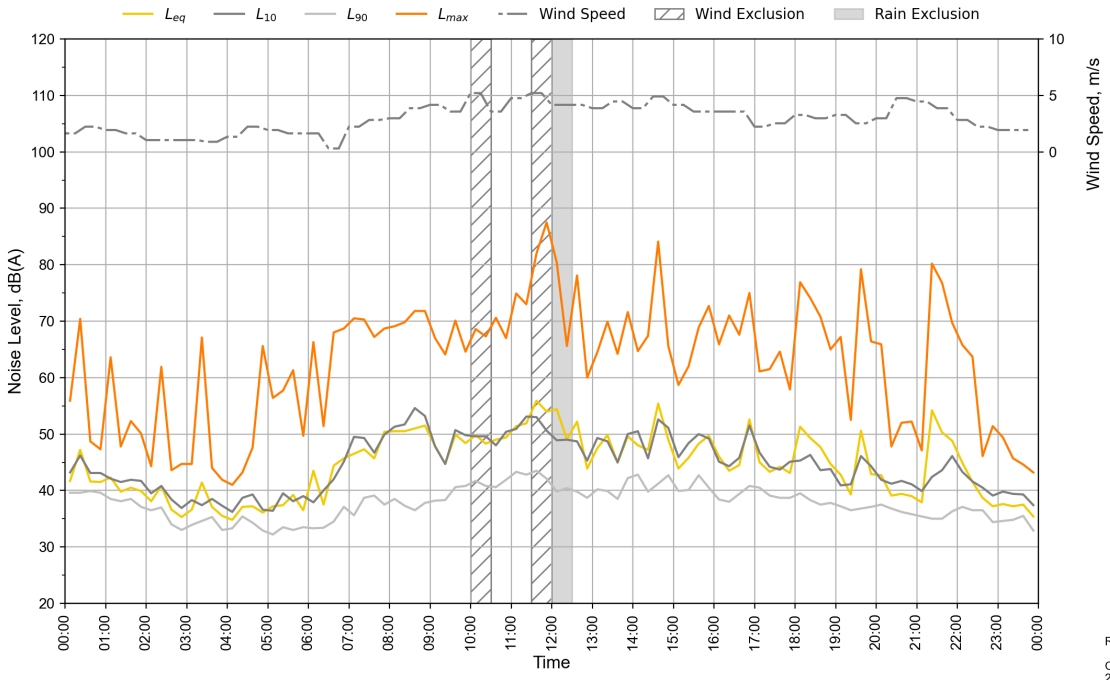



Resonate
Gables Public School - Friday, 26 July 2024
L_{eq}
L_{10}
L_{90}
L_{max}
Wind Speed
Rain Exclusion
Noise Level, dB(A)
Wind Speed, m/s
Time
Rion NL-21
888253
Calibration:
2024-02-20


Resonate
Gables Public School - Saturday, 27 July 2024
L_{eq}
L_{10}
L_{90}
L_{max}
Wind Speed
Rain Exclusion
Noise Level, dB(A)
Wind Speed, m/s
Time
Rion NL-21
888253
Calibration:
2024-02-20

Resonate

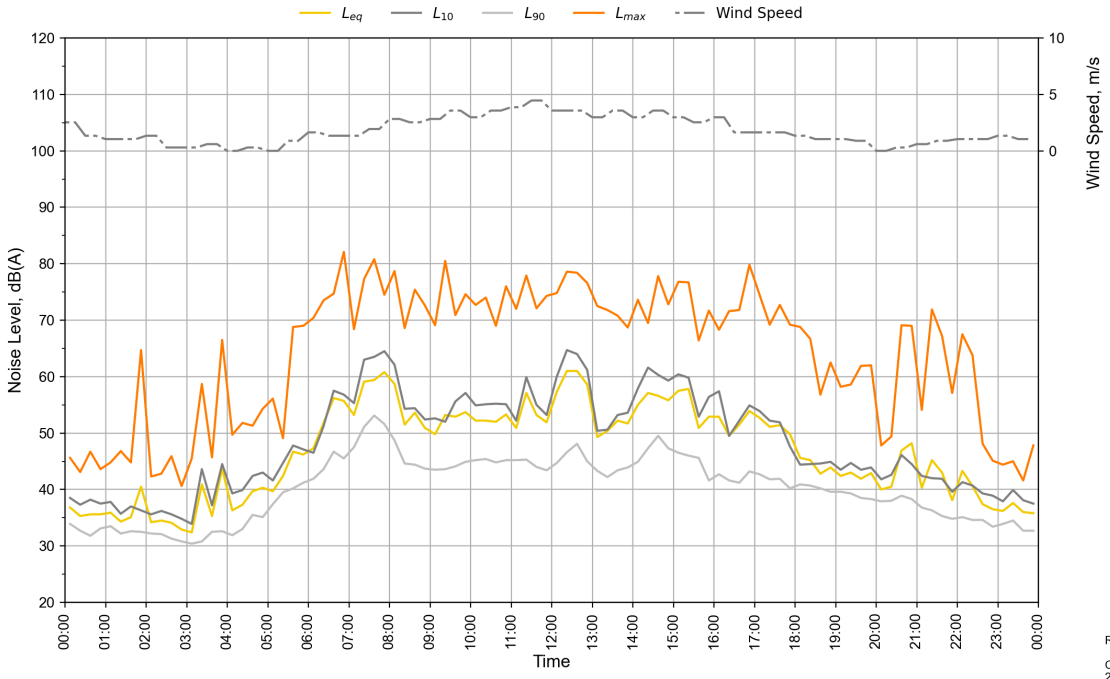
Gables Public School - Sunday, 28 July 2024



Rion NL-21
888253
Calibration:
2024-02-20

Resonate

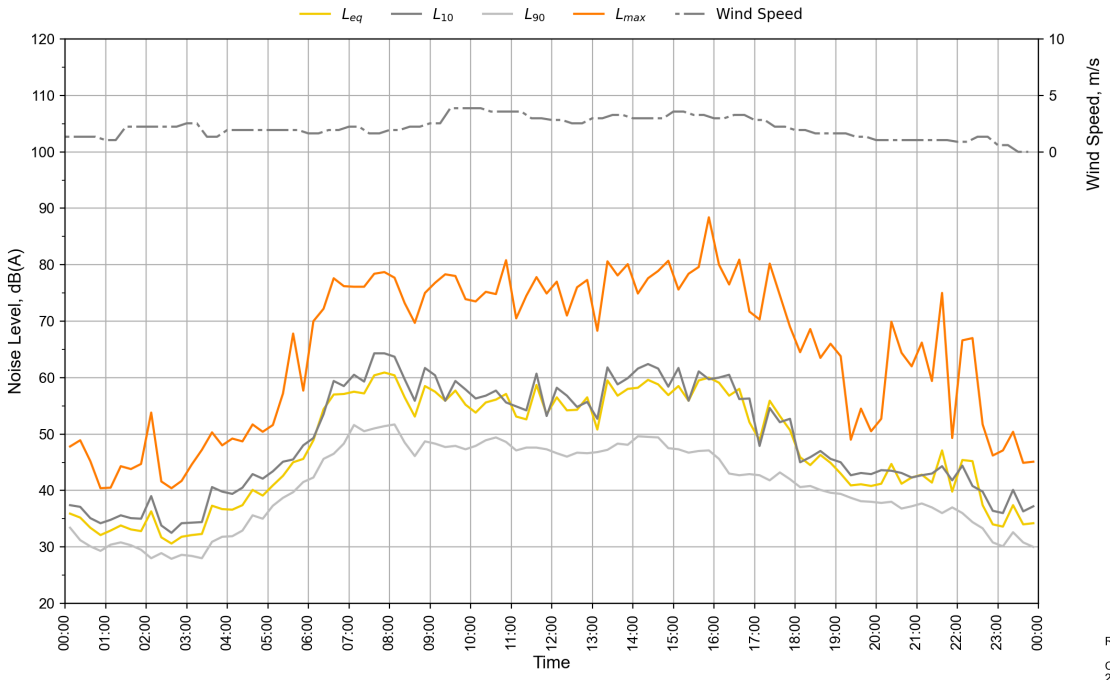
Gables Public School - Monday, 29 July 2024



Rion NL-21
888253
Calibration:
2024-02-20

Resonate

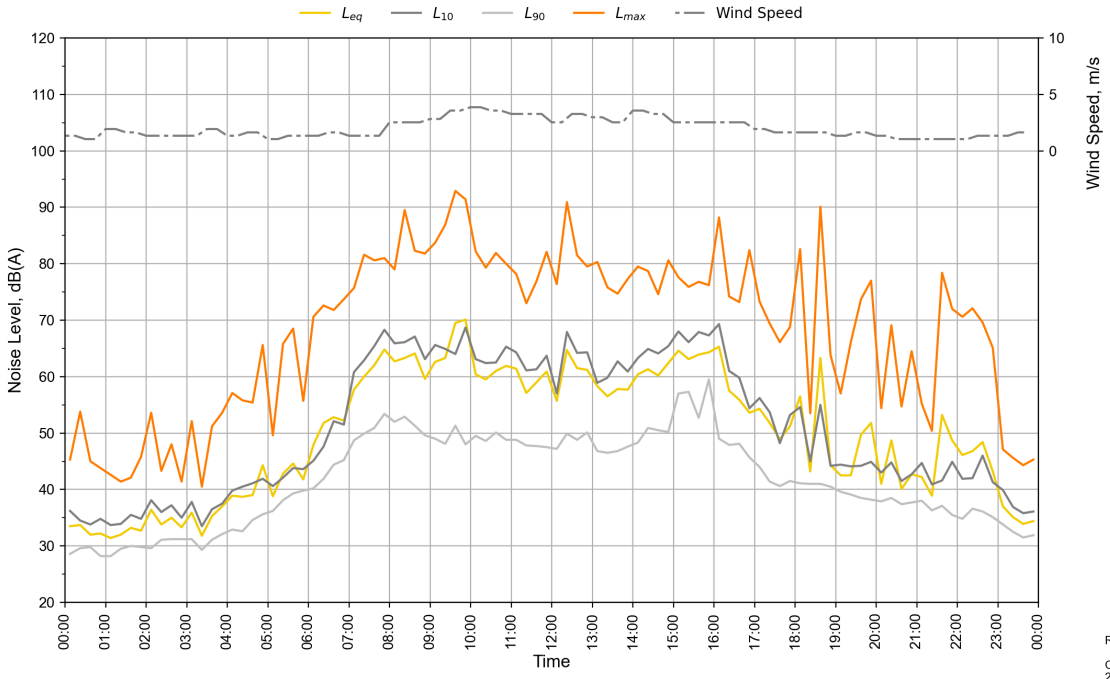
Gables Public School - Tuesday, 30 July 2024



Rion NL-21
888253
Calibration:
2024-02-20

Resonate

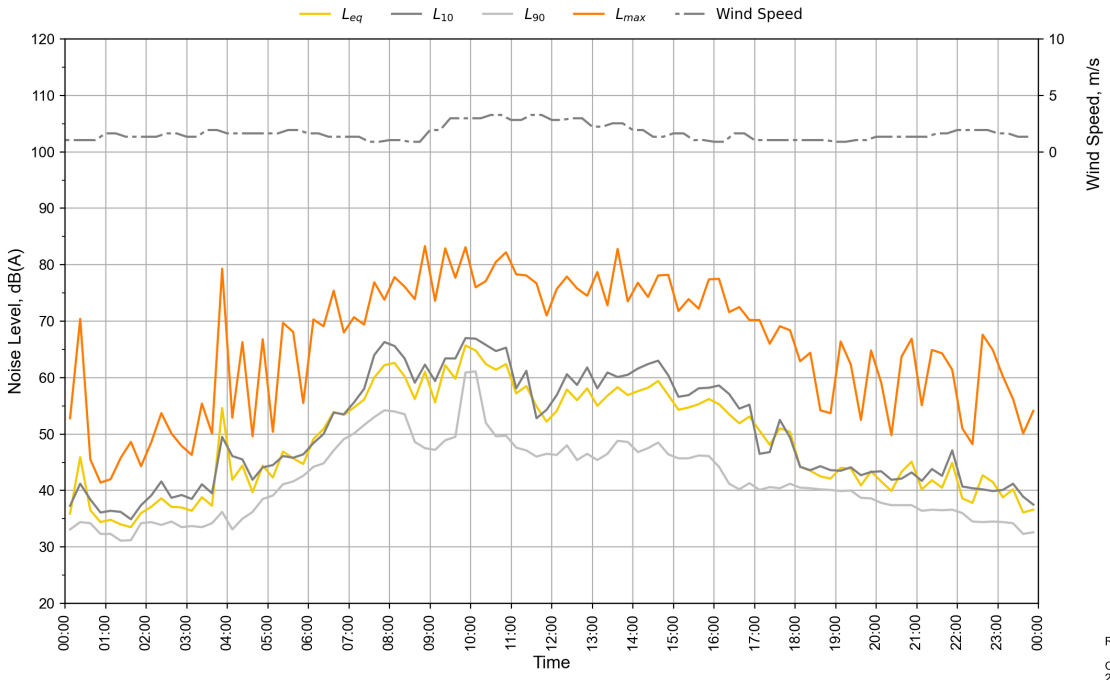
Gables Public School - Wednesday, 31 July 2024



Rion NL-21
888253
Calibration:
2024-02-20

Resonate

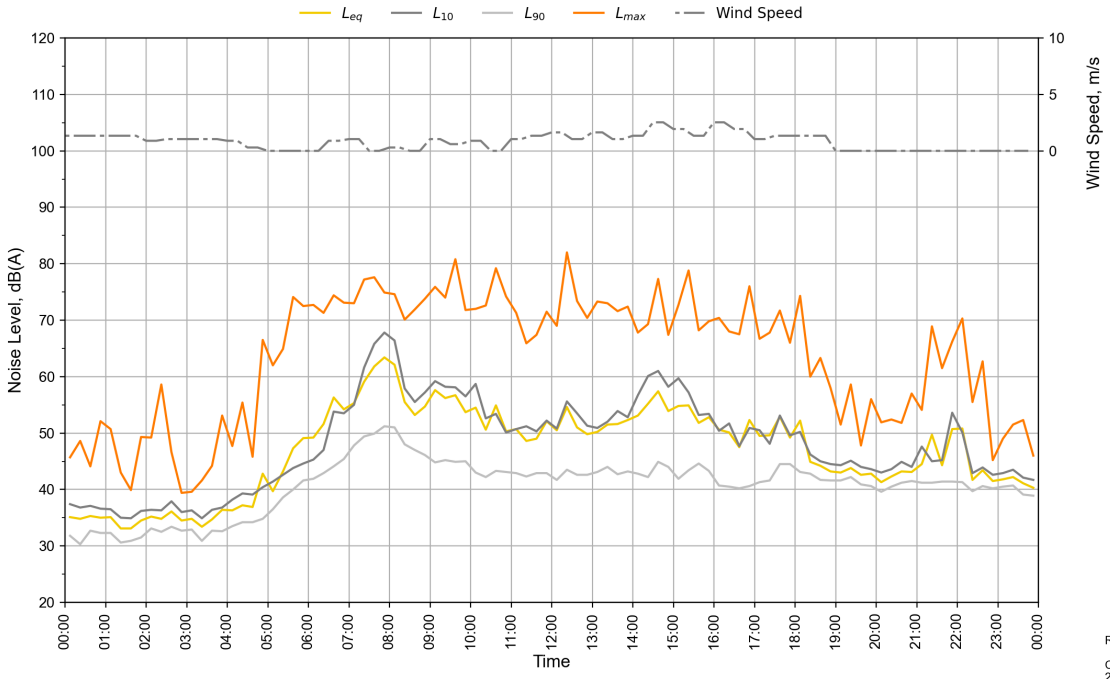
Gables Public School - Thursday, 1 August 2024



Rion NL-21
888253
Calibration:
2024-02-20

Resonate

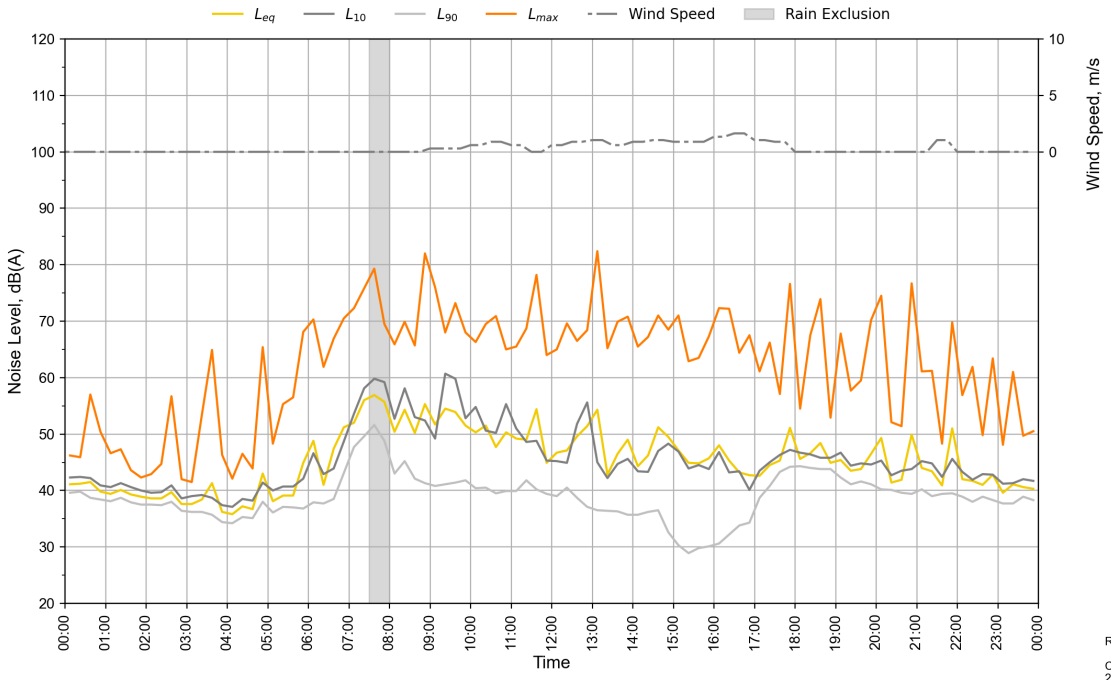
Gables Public School - Friday, 2 August 2024



Rion NL-21
888253
Calibration:
2024-02-20

Resonate

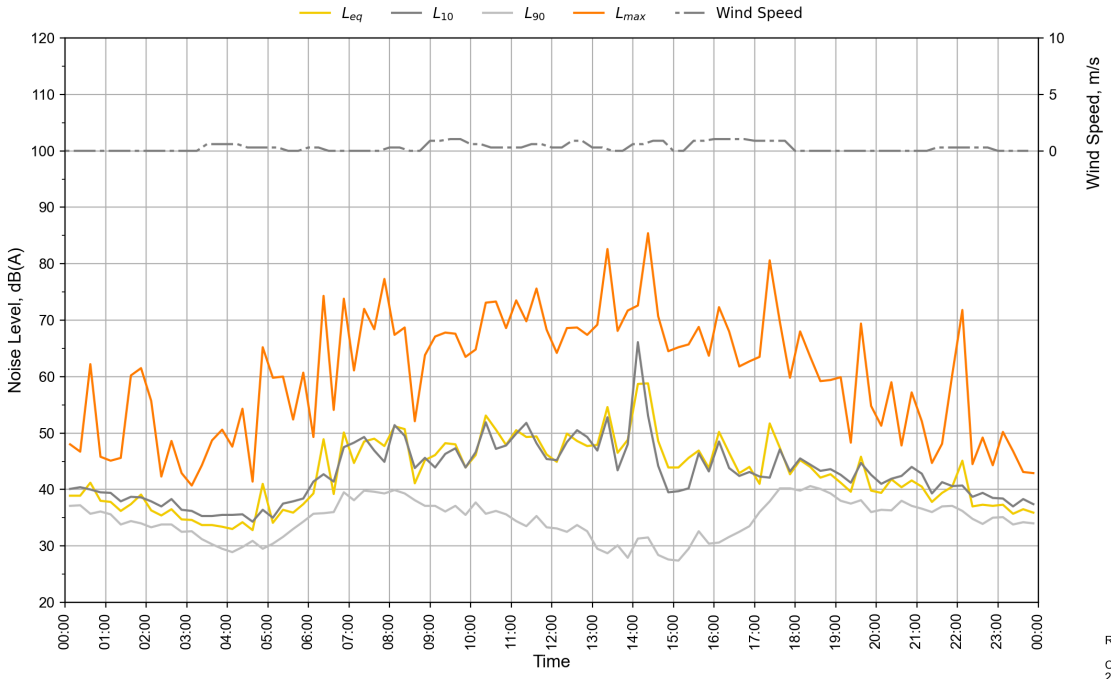
Gables Public School - Saturday, 3 August 2024



Rion NL-21
888253
Calibration:
2024-02-20

Resonate

Gables Public School - Sunday, 4 August 2024

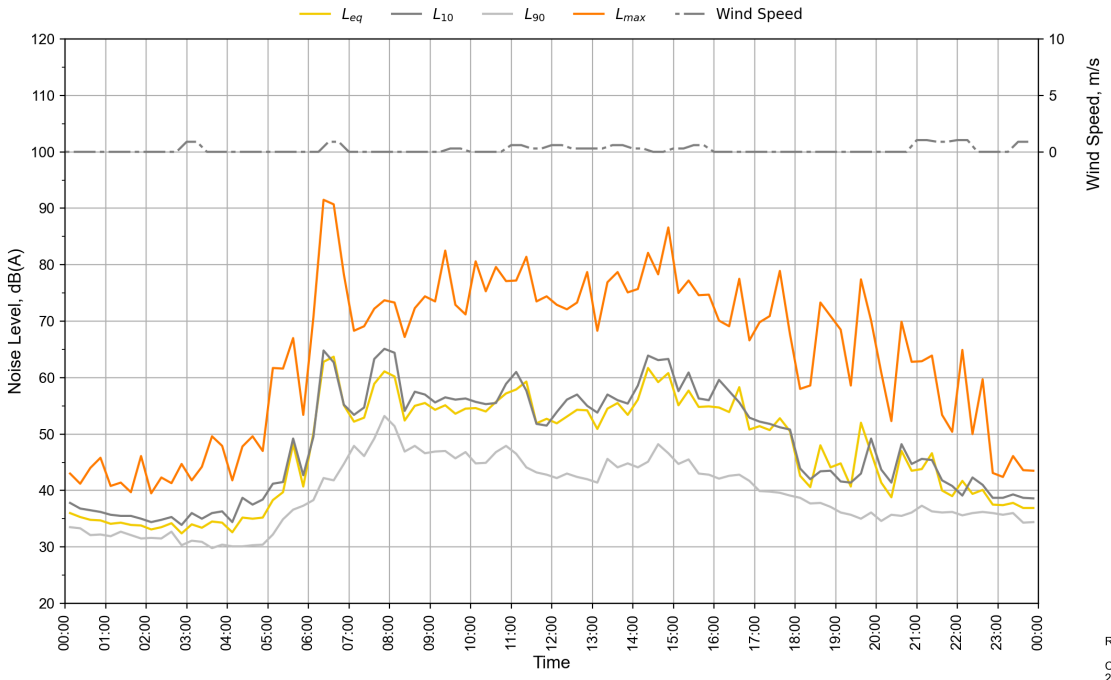


Rion NL-21
888253
Calibration:
2024-02-20

Resonate

Resonate

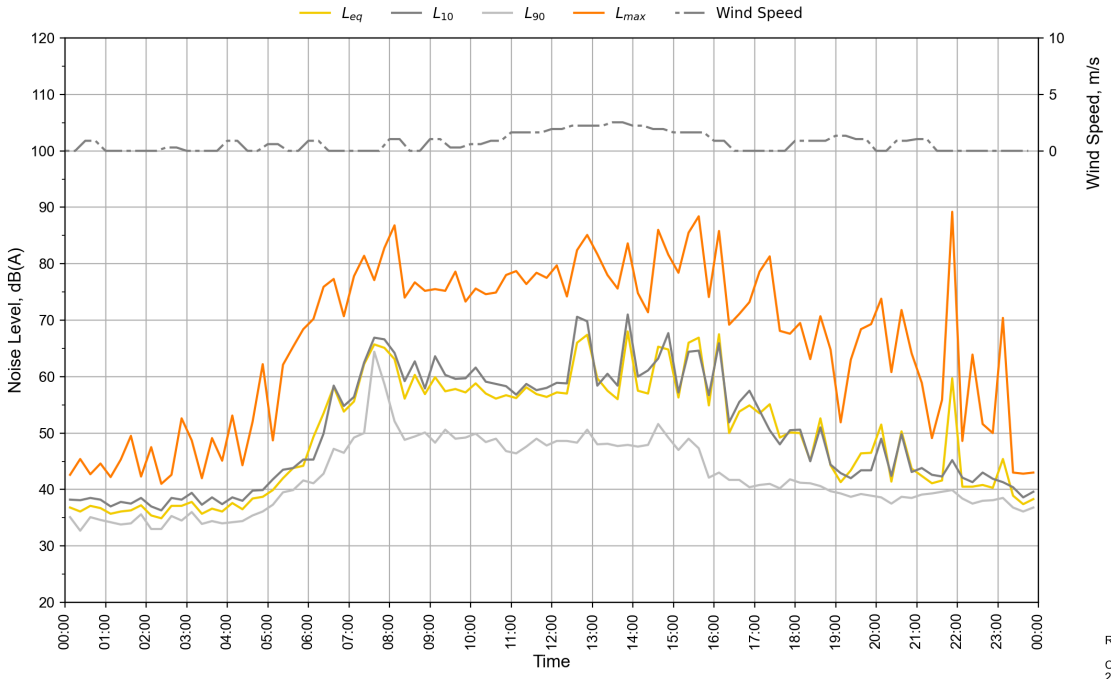
Gables Public School - Monday, 5 August 2024



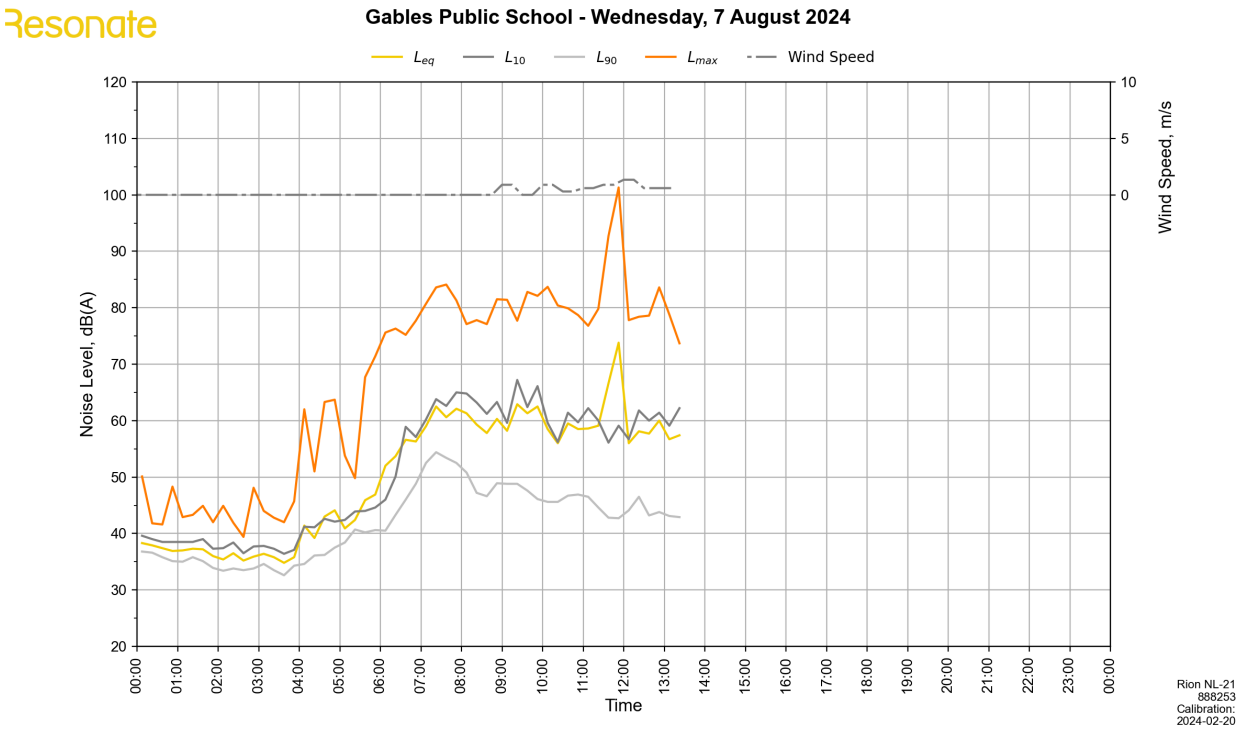
Rion NL-21
888253
Calibration:
2024-02-20

Resonate

Gables Public School - Tuesday, 6 August 2024



Rion NL-21
888253
Calibration:
2024-02-20


Gables Public School - Wednesday, 7 August 2024
L_{eq}
L_{10}
L_{90}
L_{max}
Wind Speed
Noise Level, dB(A)
Wind Speed, m/s
Time
120
110
100
90
80
70
60
50
40
30
20
10
5
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
00:00
Rion NL-21
888253
Calibration:
2024-02-20