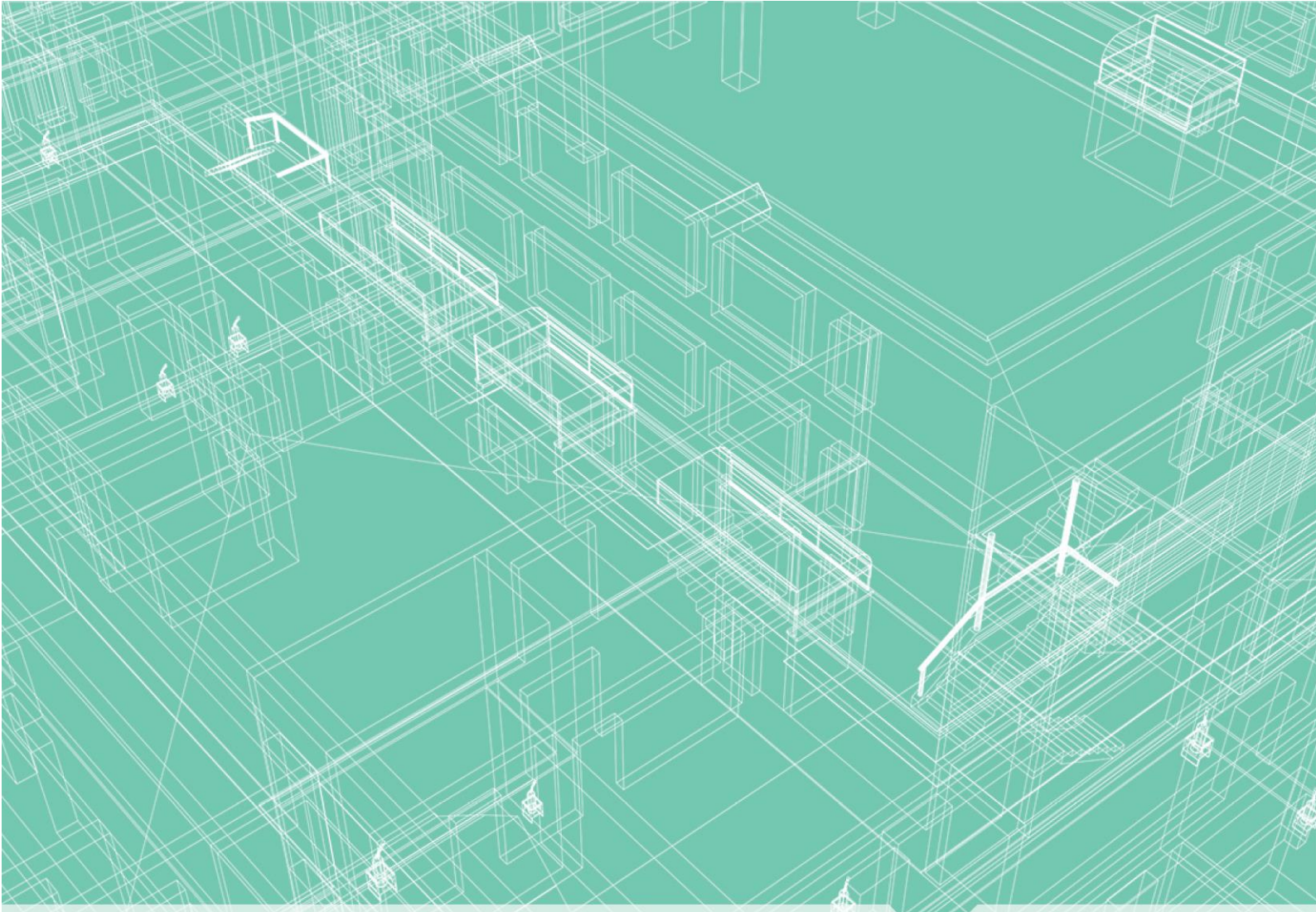

ACOUSTIC SSD DA REPORT (SSD 18_9772)

SANTA SOPHIA CATHOLIC COLLEGE

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1 INTRODUCTION

1.1 OVERVIEW

This acoustic report has been prepared by JHA Consulting Engineers on behalf of the Catholic Education Diocese of Parramatta c/TSA Management Pty Ltd (the Applicant).

It accompanies an Environmental Impact Statement (EIS) in support of State Significant Development Application (SSD 18_9772) for the new Santa Sophia Catholic College on the corner of Fontana Drive and the future road 'B', between Red Gables Road and Fontana Drive, in Box Hill North (the site).

The new school will cater for approximately 1,920 primary and secondary school students, inclusive of a 60 student Catholic Early Learning Centre (CELC). The school will have 130 full-time equivalent staff.

The proposal seeks consent for approximately 15,000sqm of floor space across a part five and part six storey building. The building will present as three main hubs connected by terraced courtyards and garden spaces.

The school will include:

- Catholic Early Learning Centre for 60 students;
- General Learning Spaces for years Kindergarten to 12;
- Community Hub – knowledge centre and cafe;
- Creative Hub – art and applied science;
- Performance Hub – multipurpose hall and music, dance and drama spaces;
- Professional Hub – administrative space;
- Research Hub – science and fitness;
- Associated site landscaping and open space including a fence and sporting facilities;
- Bus drop off from Fontana Drive;
- Pick-up and drop-off zone from future road 'B';
- Pedestrian access points from Red Gables Road north, Fontana Drive and future road 'B';
- Staff parking for 110 vehicles provided off site in an adjacent location;
- Short term parking for pick up and drop off for Catholic Early Learning Centre from Red Gables Road; and
- Digital and non-digital signage to the school.

The purpose of this acoustic report is to demonstrate compliance with the SEARs. This report shall be read in conjunction with the Architectural design drawings and other consultant design reports submitted as part of the application. The objectives of this acoustic assessment are:

- Identify noise sensitive receivers that will potentially be affected by the operation and construction of the proposed development.
- Carry out noise surveys to determine existing ambient and background noise levels on site.
- Establish the appropriate noise level and vibration criteria in accordance with the relevant standards, guidelines and legislation for the following noise emissions:
  - Mechanical plant from the development to the surrounding receivers.
  - Public address and school bell systems.
  - Out-of-school-hours activities within the school hall and other school facilities.
  - Outdoor playgrounds.
  - Child care centre.

- Determine whether the relevant criteria can be achieved based on the proposed operations and construction methods. Where applicable, provide recommendations for any necessary acoustic control measures that will need to be incorporated into the development or use in order to ensure with the assessment criteria.
- Provide recommendations for Construction Noise and Vibration Planning.

The following documentation has been used for the preparation of this report:

- Site drawings of the proposed development.
- Noise data collected on site through the use of noise loggers and a hand held spectrum analyser.
- Operations Plan prepared by TSA Management dated 11/04/2019
- Construction Management Plan prepared by Buildcorp dated 12/04/2019

This document and related work has been prepared following JHA Consulting Engineers Quality and Environmental Management Systems, which are based on AS/NZS ISO 9001 and ISO 14001.

1.2 RESPONSE TO SEARS

The acoustic report is required by the Secretary's Environmental Assessment Requirements (SEARs) for SSD 18_9772. This table identifies the relevant SEARs requirement/s and corresponding reference/s within this report.

SEARs Item	*Report Reference*
6. Environmental Amenity *• Assess amenity impacts on the surrounding locality, including solar access, visual privacy, overshadowing and acoustic impacts.*	Section 5
• Identify any proposed use of the school outside of school hours (including weekends) and assess any resultant amenity impacts on the intermediate locality and proposed mitigation measures.	Sections 5.3 & 5.4
• Detail amenity impacts including solar access, acoustic impacts, visual privacy, view loss, overshadowing and wind impacts. A high level of environmental amenity for any surrounding residential land uses must be demonstrated.	Section 5
11. Noise and Vibration *• Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*	Section 6
• Identify and assess operational noise, including consideration of any public address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.	Section 5
Relevant Policies and Guidelines: • *NSW EPA Noise Policy for Industry (2017)* • *Interim Construction Noise Guideline (DECC)* • *Assessing Vibration: A Technical Guideline 2006* • *Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008)*	Section 4

Table 1: SEARs and Relevant Reference.

2 DESCRIPTION OF THE PROPOSAL

Box Hill North is a suburb of Sydney in the local government area of The Hills, being approximately 48 km north-west of Sydney CBD. The Santa Sophia site is located within the future town centre, on the corner of Red Gables Road and the extension of Fontana Parade. The Gables is a master planned community privately developed by Celestino. The Gables master plan indicates that future uses adjacent to the Santa Sophia site will be sporting fields, residential and mixed uses within the town centre.

The existing site is a greenfield site surrounded by rural land and residences. The surrounding land uses are as follows:

- *North*: Immediately north of the site is currently rural and/or agricultural land. This land will also form part of the Gables master planned community and will be developed for open space and recreational purposes including a lake that will developed on the site of an existing farm dam. Further north is rural residential and grazing land.
- *East*: Land to the east is currently occupied by rural and agricultural uses. It is identified as public open space as part of the Gables.
- *South*: Land to the south is currently occupied by rural and agricultural uses. It is identified as sporting fields as part of the Gables development. Further south is the Box Hill urban release area.
- *West*: Land to the west of the site is rural. This land is identified as part of the future town centre.

Figure 1 shows the proposed The Gables' Masterplan highlighting the location of the Santa Sophia (red shadow).

Figure 1: Proposed The Gables' Masterplan and Santa Sophia location (red shadow).

Santa Sophia will include approximately 15,000m^2 of floor space across six levels (including lower ground). The planning and design of the school will focus on a series of purpose designed hubs:

- Community Hub – knowledge centre and café (Building East).
- Creative Hub – art and applied science (Building Central).
- Performance Hub – multipurpose hall and music, dance and drama spaces (Building North).
- Professional Hub – administrative space (Building North).
- Research Hub – science and fitness (Building North).

Santa Sophia is proposed to accommodate approximately 1980 students in a 4/6 stream college. It will be a Kindergarten to Year 12 co-educational school. The development also proposes:

- The CELC for 60 students (Building South).
- Out of hours and/or vacation care facilities (OOSH).
- Sharing of school facilities with public after school hours.
- Shared use of the neighbouring community sports field.
- Potential use of local commercial space for additional school facilities.

Figure 2 shows the proposed development layout within its boundary as per latest architectural drawings.

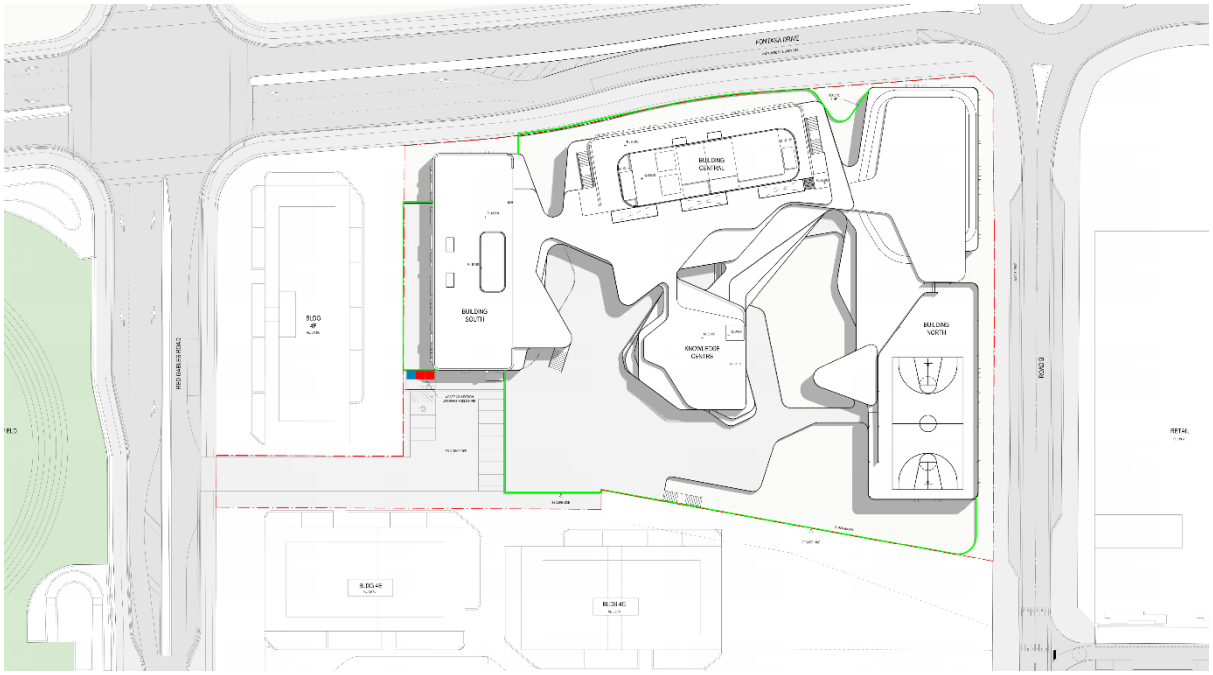


Figure 2: Site layout of the proposed development and its boundary.

At this stage, it is understood that Santa Sophia will operate within typical school hours. The following operating hours have been used for the noise assessment purposes:

- School hours: 8am to 4pm.
- Recess time: 10:30am to 11am.
- Lunch bell time: 12:30pm to 1pm.
- Out of hours: 6am to 9am & 4pm to 10pm.
- CELC: 6am to 6:30pm.

3 SITE MEASUREMENTS

3.1 GENERAL

Attended and unattended noise surveys were conducted in the location shown in Figure 3 in order to establish the ambient and background noise levels of the site and surrounds. This location has been found to be representative as it is located nearby the location of the site.

Noise surveys have been carried out in accordance with the method described in the AS/NZS 1055:1997 *'Acoustics – Description and measurement of environmental noise, parts 1 and 2'*.

Figure 3: Noise Surveys Location and boundary of the site.

3.2 SHORT-TERM NOISE MONITORING

Short-term noise monitoring was carried out to obtain representative octave band noise levels of the site and noise levels from the site.

On Friday 22nd March 2019, a short-term noise measurement was carried out during the day-time period. Short-term noise measurement was carried out with a NTI XL-2 hand-held Sound Level Meter (SLM) (Serial Number A2A-13742-E0). The SLM used a NTI M2230 Class 1 Measurement Microphone (Serial Number 7204 / A15226). The calibration of the SLM was checked before and after each use with a Larson Davis Cal 200 Class 1 Calibrator (Serial Number 15054) and no deviations were recorded.

The SLM microphone was mounted 1.5 metres above the ground and a windshield was used to protect the microphone. Measurement was undertaken in the free-field – i.e. more than 3.5 metres away from any building façade or vertical reflective surface. Weather conditions were calm and dry during the attended noise monitoring.

From observations during the site visit, it is noted that at location 1, the ambient and background noise levels are dominated by low levels of activity and nature. A summary of the results of the short-term noise monitoring are shown in Table 2.

Location	Date and Time	Parameter	Sound Pressure Level, dB re 20µPa								
			Overall dB(A)	Octave Band Centre Frequency, Hz							
				63	125	250	500	1k	2k	4k	8k
1	22/03/2019 12.00 – 12.15	$L_{90,15min}$	**35**	46	39	23	19	19	17	30	21
		$L_{eq,15min}$	**41**	51	44	33	29	28	29	39	31
		$L_{10,15min}$	**44**	53	46	34	28	28	28	42	31

Table 2: Results of the short-term noise monitoring.

3.3 LONG-TERM NOISE MONITORING

Long-term noise monitoring was carried out from Friday 22nd March to Friday 29th March 2019 with a Rion NL-52 noise logger (Serial Number 1254316). The noise logger recorded L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise parameters at 15-minute intervals during the measurement period. The calibration of the noise logger was checked before and after use and no deviations were recorded.

This location was secure and considered to be representative of the typical ambient and background noise levels. The microphone was mounted 1.5 meters above the ground and a windshield was used to protect the microphone.

The detailed results of the long-term noise monitoring are presented graphically in Appendix A. Weather conditions were monitored for the duration of the noise survey and were typically calm and dry with some rain and wind events having been noted to occur during the measurement period. As stated in the NSW NPI, any data likely to be affected by rain, wind or other extraneous noise has been excluded from the calculations (shadowed in the Appendix A graphs).

Background noise levels (L_{A90}) are shown in Table 3, together with the ambient noise levels (L_{Aeq}) measured for each period.

Location	L_{A90} Background Noise Levels, dB(A)			L_{Aeq} Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
1	32	45	33	49	55	49

Table 3: Results of the long-term noise monitoring.

4 RELEVANT NOISE STANDARDS AND GUIDELINES

4.1 STANDARDS AND GUIDELINES

The following standards and guidelines are considered relevant to the project and have been referenced in developing the project noise level criteria.

- Noise Emissions and Intrusive Noise
  - Environmental Planning and Assessment (EP&A) Act 1979.
  - Protection of the Environmental Operations (POEO) Act 1997.
  - Protection of the Environmental Operations. Noise Regulation Controls (NRC) 2008.
  - NSW Environment Protection Authority (EPA) Noise Guide for Local Government (NGLG) 2013.
  - The Hills Council Legislation.
  - NSW Environment Protection Authority (EPA) Noise Policy for Industry (NPI) 2017.
  - Association of Australasian Acoustical Consultants (AAAC) '*Guideline for Child Care Centre Acoustic Assessment*' 2010.
- Traffic Noise
  - NSW Department of Planning (DoP) '*Development Near Rail Corridors or Busy Roads – Interim Guideline*' 2008.
- Construction Noise and Vibration
  - NSW DECCW Interim Construction Noise Guideline (ICNG) 2009.
  - NSW DECC Assessing Vibration: A Technical Guideline 2006.
  - NSW Road Maritime Service (RMS) Construction Noise and Vibration Guideline 2016.
  - Australian Standard AS 2436:2010 '*Acoustics – Guide to Noise Control on Construction, Maintenance & Demolition Sites*'.

4.2 REGULATORY FRAMEWORK

The Environmental Planning and Assessment Act 1979 (EP&A Act) provides the regulatory framework for the protection of the environment in NSW. The EP&A Act is relevantly about planning matters and ensuring that "environmental impact" associated with the proposed development is properly considered and reasonable before granting development consent to develop.

The assessment of "environmental impact" relies upon the identification of acceptable noise criteria which may be defined in a Development Control Plan, or derived from principles using guidelines like NSW EPA Noise Policy for Industry (NPI 2017) or Noise Guide for Local Government (NGLG 2013).

The Protection of the Environment Operations (POEO) Act 1997 has the objective of protecting, restoring and enhancing the quality of NSW environment. Abatement of noise pollution is underpinned by the definition of "offensive noise" as follows:

"...

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.

…"

NGLG 2013 provides a checklist to determine an "offensive noise".

4.3 NSW NOISE GUIDE FOR LOCAL GOVERNMENT

NGLG 2013 is a guideline that is at aimed at councils and planners to provide guidance in the management of local noise problems and in the interpretation of existing policy and legislation.

Table 1.3 of NGLG 2013 contains the management for common neighbourhood noise issues and describes Council as the Appropriate Regulatory Authority (ARA) for private educational facilities. The offensive noise test aids in making a systematic judgment about the offensive nature of noise emissions. The NGLG 2013 offensive noise test considers that noise may be offensive in three ways, according to:

- Audibility.
- Duration.
- Inherently offensive characteristics.

4.4 THE HILLS COUNCIL LEGISLATION

Relevant Planning Documents of The Hills Council Legislation have been reviewed for any noise requirement or criteria.

The Hills Council Local Environmental Plan (TH-LEP 2012) is the environmental planning instrument that applies to the site. The Santa Sophia site is zoned as Local Centre (B2) and the surrounding is zoned as General Residential (R1), Public Recreation (RE1) and High Density Residential (R4). Figure 4 shows the land zoning as per information extracted from TH-LEP 2012 map 7420_COM_LZN_005_020_20161004.

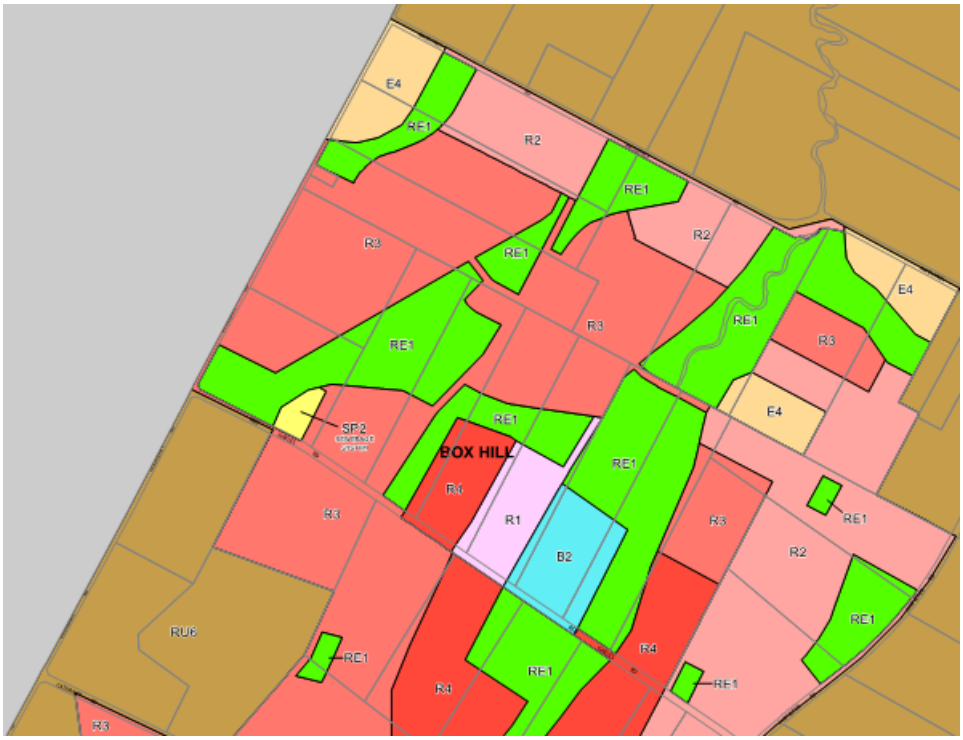


Figure 4: Land Zoning of the site and surroundings.

No relevant noise information has been found in The Hills Development Control Plan (TH-DCP 2012) Part D Section 17, which applies to Box Hill North.

4.5 NOISE EMISSIONS AND INTRUSIVE NOISE

4.5.1 NSW EPA NOISE POLICY FOR INDUSTRY

The NSW EPA Noise Policy for Industry 2017 assesses noise from industrial noise sources - scheduled under the POEO. Mechanical noise from the development shall be addressed following the recommendations in the NSW NPI.

The assessment is carried out based on the existing ambient and background noise levels addressing the following:

- Intrusiveness Criteria, to control intrusive noise into nearby sensitive receivers.
- Amenity Criteria, to maintain the noise level amenity for particular land uses.

These criteria are established for each assessment period (day, evening and night) and the more stringent of the two criteria sets the Project Noise Trigger Level (PNTL).

However, given land use in the area is undergoing a significant land zoning change – from rural to residential – Section 2.4.3 of the NSW NPI states the following: "*When land uses in an area are undergoing significant change, for example, residential subdivisions with associated development of local and regional roads, the background noise levels would be expected to change. The impact of noise from an existing industry on a proposed new residential area should be made using the recommended amenity noise level for the residential land use, not the project intrusiveness noise level.*"

Based on the above, the long-term noise monitoring results have not been used to establish the noise level criteria, as we understand the ambient and background noise levels are not representative of the future noise levels. Therefore, these are not applicable to the project.

The NSW NPI states the following to define the amenity criteria:

"To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance."

Based on the amenity criteria definition and the land zoning, Table 4 shows the amenity criteria and the PNTL for the noise sensitive receivers.

Indicative Noise Amenity Area	*Period*	*Recommended Amenity Noise Level (L_{Aeq}), dB(A)*	*Amenity Criterion, dB(A)*
Residential (R1, R4)	Day	60	58 $L_{Aeq,15min}$ (60-5+3)
	Evening	50	48 $L_{Aeq,15min}$ (50-5+3)
	Night	45	43 $L_{Aeq,15min}$ (45-5+3)
Commercial	When in use	65	63 $L_{Aeq,15min}$ (65-5+3)
Active Recreation (RE1)	When in use	55	53 $L_{Aeq,15min}$ (55-5+3)

Table 4: Amenity criterion and PNTL for noise sensitive receivers.

4.5.2 OPERATIONAL NOISE EMISSION CRITERIA

Council legislation does not establish any noise level criteria for noise emissions from the use of the premises. Given that the activities within the school will only operate during day-time and evening-time, a noise criterion of "background noise level + 5dB" has been adopted for this assessment. This noise level limit is assessed at the boundary of the neighbouring residential properties.

This noise criteria is based on the premise that if intrusive noise is greater than the existing background noise level, there is a potential risk of disturbance and annoyance. However, the noise impact is considered marginal if the difference between the existing background noise level and the intrusive noise is 5 dB(A) or less. This concept has resulted in the commonly used criterion of "background noise level + 5dB" – applicable between 7am and midnight.

This criterion is more stringent during midnight and 7am, being the commonly used criterion of "background noise level + 0dB".

Australian Standard AS 1055.3:1997 provides a guide of estimated average background noise levels for different areas containing residences. These background noise levels will be used in order to establish the operational noise emission criteria. Table 5 shows the background noise levels.

Noise Area Category	*Description of the neighbourhood*	*Average Background A-weighted noise level ($L_{A90,T}$)*		
		07.00-18.00	*18.00-22.00*	*22.00-07.00*
R3	Areas with medium density transportation or some commerce or industry	50	45	40

Table 5: Average background noise levels as per AS 1055:2018.

The worst-case scenario for operational noise emissions from the school premises will be during early morning – 6am – from the ECLC premises. Therefore, the noise level criteria between 6am and 7am will be L_{Aeq} 40 dB(A). For evening time period the noise level criteria is set to L_{Aeq} 50 dB(A).

4.5.3 AAAC GUIDELINE FOR CHILD CARE CENTRE

There are no prescribed regulations or legislation that apply to noise from child care centres or outdoor playgrounds. Therefore, there is no prescribed noise criteria that can be used. Furthermore, we understand that common approach of "offensive noise" criteria is not appropriate for a planning situation such as this proposal.

Our noise assessment approach is based on:

- NSW tribunal decisions when assessing noise from the use of child care centres.
- 'Guideline for Childcare Centre Acoustic Assessment' prepared by the Association of Australasian Acoustical Consultants (AAAC).

The AAAC guideline is addressed for assessment of childcare centres and its noise level criterion for outdoor spaces have been considered as adequate by NSW tribunal decisions. As children do not play outdoors continuously for long periods of time, and as the duration of time for children playing outside is reduced, the overall noise annoyance reduces. Therefore, it is reasonable to allow a higher level of noise impact for a shorter duration.

Whilst the AAAC guideline does not apply for schools, there are similarities in noise emissions from uses of outdoor playground areas for schools and child care centres. Therefore, we recommend that the following noise criteria shall be applied to noise impacts arising from the school's outdoor playgrounds.

Table 6 shows the noise level criteria proposed by the AAAC guideline for assessing noise from outdoor spaces. These are the noise levels at which it is considered that complaints are unlikely.

Use of outdoor area	*Noise Level Criteria*	*Criteria*
Up to 2 hours (total) per day	$L_{Aeq,15min}$ noise level from outdoor area not to exceed the existing background noise level ($L_{A90,15min}$) plus 10 dB $L_{Aeq,15min} < L_{A90,15min} + 10$ dB(A)	$L_{Aeq,15min} \leq 65$ dB(A)
More than 2 hours (total) per day	$L_{Aeq,15min}$ noise level from outdoor area not to exceed the existing background noise level ($L_{A90,15min}$) plus 5 dB $L_{Aeq,15min} < L_{A90,15min} + 5$ dB(A)	$L_{Aeq,15min} \leq 60$ dB(A)

Table 6: Noise level criteria for the playground areas as per AAAC guideline.

4.6 TRAFFIC NOISE

4.6.1 DEVELOPMENT NEAR RAIL CORRIDORS OR BUSY ROADS – INTERIM GUIDELINE

The guideline details the application of clauses 85, 86, 87, 102 and 103 of the Infrastructure State Environmental Planning Policy (SEPP) which is required to be used when a development is adjacent to a rail corridor, a freeway, a toll-way, a transit-way or a road with an annual average daily traffic volume (AADT) of more than 40,000 vehicles.

At this stage, there are no rail corridors or busy roads (as per advice from Ason Group Traffic Engineer) adjacent to the proposed development site or planned to be developed. Therefore, this guideline does not apply to the proposal.

4.7 CONSTRUCTION NOISE AND VIBRATION

4.7.1 NOISE CRITERIA

The ICNG suggest construction noise management levels that may minimise the likelihood of annoyance being caused to noise sensitive residential receivers depending on the duration of works. The management levels for long-term duration works are as follows:

- Within recommended standard hours.

  The Management Level ($L_{Aeq,15min}$) measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background noise level (RBL) by more than 10 dB(A). This noise level represents the point above which there may be some community reaction to noise.

  However, in the case of a highly noise affected area, the Management Level ($L_{Aeq,15min}$) at the most exposed boundary of any affected residential receiver when the construction site is in operation should not exceed 75 dB(A). This level represents the point above which there may be strong community reaction to noise.

- Outside recommended standard hours.

  The Management Level ($L_{Aeq,15min}$) measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background noise level (RBL) by more than 5 dB(A). It is noted that a strong justification is required for works outside the recommended standard hours.

ICNG suggests construction noise management levels for other sensitive land uses surrounding construction sites. Table 7 below summarises the airborne construction noise criteria for most affected noise sensitive receivers surrounding the development site.

Sensitive Receiver		*Airborne Construction Noise Criteria, L_{Aeq} dB(A)*	
		Within Standard Hours	*Outside Standard Hours*
Residential	Noise affected / External	60	55
	Highly noise affected / External	75	N/A
Commercial	External	65	65
Active Recreation	External	65	65

Table 7: ICNG construction airborne noise criteria for sensitive receivers surrounding the site.

The ICNG recommends internal ground-borne noise maximum levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise for some sensitive receivers. The ground-borne noise levels presented below from the ICNG are for residential receivers during evening and night-time periods only, as the objective is to protect the amenity and sleep of people when they are at home.

- Evening: $L_{Aeq,15min}$ 40 dB(A) - internal
- Night: $L_{Aeq,15min}$ 35 dB(A) - internal

The internal noise levels are assessed at the centre of the most affected habitable room.

4.7.2 VIBRATION CRITERIA

4.7.2.1 Human Comfort

The Department of Environment and Climate Change (DECC) developed the document '*Assessing Vibration: A Technical Guideline*' in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. It is based on the guidelines contained in BS 6472.1:2008 '*Guide to evaluation of human exposure to vibration in buildings – Vibration sources other than blasting*'.

The guideline does not address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous (with magnitudes varying or remaining constant with time), impulsive (such as shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Vibration criteria for continuous and impulsive vibration are presented in Table 8 below, in terms of vibration velocity levels.

Place	*Time*	*r.m.s. velocity, mm/s [dB ref 10^{-9}mm/s]*			
		Continuous Vibration		*Impulsive Vibration*	
		Preferred	*Maximum*	*Preferred*	*Maximum*
Residences	Day-time	0.20 [106 dB]	0.40 [112 dB]	6.00 [136 dB]	12.00 [142 dB]
	Night-time	0.14 [103 dB]	0.28 [109 dB]	2.00 [126 dB]	4.00 [132 dB]
Offices, schools, educational and worship	When in use	0.40 [112 dB]	0.80 [118 dB]	13.00 [142 dB]	26.00 [148 dB]

Table 8: Continuous and impulsive vibration criteria applicable to the site

When assessing intermittent vibration comprising a number of events, the Vibration Dose Value (VDV) it is recommended to be used. Table 9 shows the acceptable VDV values for intermittent vibration.

Place	*Time*	*Vibration Dose Values, m/s$^{1.75}$*	
		Preferred	*Maximum*
Residences	Day-time	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational and worship	When in use	0.40	0.80

Table 9: Intermittent vibration criteria applicable to the site.

4.7.2.2 Structural Building Damage

Ground vibration from construction activities can damage surrounding buildings or structures. For occupied buildings, the vibration criteria given in previous section for Human Comfort shall generally form the limiting vibration criteria for the Project.

For unoccupied buildings, or during periods where the buildings are unoccupied, the vibration criteria for building damage suggested by German Standard DIN 4150.3:1993 '*Structural Vibration – Effects of Vibration on Structures*' and British Standard BS 7385.2:1993 '*Evaluation and Measurement for Vibration in Buildings*' are to be adopted. Guideline values from DIN 4150.3:1993 and BS 7385.2:1993 are presented in Table 10 and Table 11 respectively.

Structural type	*r.m.s. velocity, mm/s*			
	Foundation			*Plane of floor uppermost full storey*
	Less than 10Hz	*10 to 50Hz*	*50 to 100Hz*	*Frequency mixture*
Dwellings or similar	5	5 to 15	15 to 20	15
Particularly sensitive	3	3 to 8	8 to 10	8

Table 10: DIN 4150.3:1993 Guideline values of vibration velocity for evaluating the effects of short-term vibration.

Structural type	*Peak particle velocity, mm/s*	
	4 to 15Hz	*15Hz and above*
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s @ 4Hz increasing to 20mm/s @ 15Hz	20mm/s @ 15Hz increasing to 50mm/s @ 40Hz and above

Table 11: BS 7385.2:1993 Guideline values of vibration velocity for evaluating cosmetic damage.

5 OPERATIONAL NOISE EMISSIONS ASSESSMENT

Noise break-out from the proposed development has the potential to impact on existing noise sensitive receivers. For the purpose of this noise impact assessment, the noise sources are assumed as follows:

- Noise emissions from mechanical plant.
- Noise emissions from recess and lunch bells, public address systems.
- Noise emissions from indoor activities – i.e. use of halls for music – from out-of-school-hours events.
- Noise emissions from the rooftop basketball court.
- Noise emissions from outdoor playgrounds.
- Noise emissions from child care centre (CELC).

Each of these noise sources has been considered in the noise impact assessment. The noise impact assessments have also considered the following:

- Noise levels have been considered as continuous over assessment time period to provide the worst-case scenario.
- Distance attenuation, building reflections and directivity.
- Worst-case time period assessment.

5.1 EXTERNAL MECHANICAL PLANT

Noise from proposed development mechanical plant rooms should be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of the noise sensitive receivers.

At this stage, mechanical plant selections have not been made; therefore, it is not possible to undertake a detailed assessment of the mechanical plant noise emissions.

Noise controls will need to be incorporated with the design of the mechanical plant rooms to ensure that the cumulative noise levels from plant to the nearest noise sensitive receivers meets the NSW NPI noise level criteria – refer to Table 4.

Usual design noise controls that may need to be implemented will typically include, but are not limited to:

- Strategic location and selection of mechanical plant to ensure the cumulative noise levels at the receiver boundaries is met.
- Selection of appropriate quiet plant.
- Acoustic noise control measures to be put in place to minimise noise impacts such as:
  - In-duct attenuation
  - Noise enclosures as required
  - Sound absorptive panels
  - Acoustic louvres as required
  - Noise barriers as required

Acoustic assessment of all mechanical plant shall continue during the detailed design phase of the project in order to confirm any noise control measures to achieve the relevant noise criteria at the nearest noise sensitive receivers.

5.2 PUBLIC ADDRESS AND SCHOOL BELL SYSTEMS

Noise from proposed development public address and school bell systems should be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of noise sensitive receivers.

At this stage, public address and school bell systems selections have been not made; therefore, it is not possible to undertake a detailed assessment of the public address and school bell noise emissions.

The EPA notes numerous reports of community concern arising from inadequate design and installation as well as inappropriate use of school public address and bell systems. EPA considers that appropriate design, installation and use of those systems can both:

- Meet the proponent's objectives of proper administration of the school and ensuring safety of students, staff and visitors, and
- Avoid interfering unreasonably with the comfort and repose of occupants of nearby residences.

The Public Address and School Bell Systems shall be designed, installed and operated such that the systems does not interfere unreasonably with the comfort and repose of occupants of nearby residences. It is anticipated that the noise impact to the nearest sensitive receivers will be negligible if following measures are implemented:

- Low-powered horn-type speakers shall be located and orientated to provide a good coverage of the school areas whilst being directly away from residences and near sensitive receivers. System coverage shall be reviewed during the detailed design phase.
- Speakers shall be mounted with a downward angle and as close to the floor as possible.
- The noise level of the systems shall be adjusted on site so they will be clearly audible on the school site without being excessive. The systems shall initially be set sot that the noise at nearby residences and sensitive receivers do not exceed noise level criteria.
- Once the appropriate noise level has been determined on site, the systems shall be limited to these noise levels so that staff cannot increase the noise levels.
- The systems shall be set so that it only occurs on school days.

5.3 MULTI-PURPOSE HALL

The multi-purpose hall is anticipated to host events that include amplified music. The expected noise impacts from the multi-purpose hall have been assessed at the nearest sensitive receivers, using the methodology and assumptions given below.

The noise assessment was made considering the proposed layout as shown on the architectural drawings. The following assumptions have been made for the assessment:

- Events occurring during evening time hours as per the School Operations Plan
- Doors and windows shut during events
- Typical sound power levels for concerts and events

The noise levels inside the multi-purpose hall during a concert, and form the basis of the expected worst-case noise emission from the proposed use, is expected to be 100 dB(A).

The façade, other external building elements and ventilation openings of the multi-purpose hall will need to provide the following minimum sound insulation performance in order to meet the noise level criteria in the nearest commercial and residential receivers.

Calculation	*Nearest Commercial Receiver*	*Nearest Residential Receiver*
$L_{Aeq,15min}$ of Live Band at 1 m	100	100
Increase in reverberant field, dB	3	3
Distance attenuation, dB	-28	-32
Correction for sound insulation rating and façade surface, dB	24	23
Noise Level Criteria evening-time, $L_{Aeq,15min}$	65	50
Minimum sound insulation rating R_w, dB	**34**	**44**

Table 12: Approximate minimum sound insulation for the multi-purpose hall façade system.

5.4 BASKETBALL COURT

The rooftop basketball court of the northern building has the potential to impact on the nearest residential sensitive receivers to the east. The use of the rooftop basketball court will occur during school hours and out of hours by the community. Therefore, the noise assessment considers the worst-case scenario as evening-time period.

Predicted noise levels at the nearest noise residential receiver associated with the rooftop basketball court use are shown in the following table for the worst-case scenarios.

Calculation	*Noise Level dB(A)*
$L_{Aeq,15min}$ basketball game at 1m in free-field	76
Distance (40 m) attenuation, dB	-32
Resulting level at residential receiver	44
Noise Level Criterion evening-time / Complies?	**50 / Yes**

Table 13: Noise assessment at nearest residential receiver from the rooftop basketball court.

For the worst-case scenario, the predicted $L_{Aeq,15min}$ noise level from the use of the rooftop basketball court at the nearest noise sensitive receiver meets the noise level criteria.

5.5 OUTDOOR PLAYGROUNDS

Noise break-out from the outdoor playgrounds has the potential to impact on the nearest noise sensitive receivers. The outdoor playgrounds are spread along the school levels and therefore, students will not gather in the same area.

The key source it will be students in the outdoor playgrounds during recesses or before and after school. However, the outdoor playgrounds are only likely to be at full capacity during recess and lunch times. It is assumed that the vocal effort of the students communicating will be generally 'normal' speech. The noise assessment has assumed the following:

- Students talking 'normal' speech to provide worst-case scenario (70dB(A) Sound Power Level per student)
- For every two students only one will be speaking at any given time with a 'normal' voice.
- A maximum number of 1980 students will be at the same time during recess and lunch times.

- The students will evenly distributed along the different outdoor playgrounds.
- Recess and lunch time duration are approximately 30 minutes.

The predicted noise levels at the nearest noise sensitive receivers are shown in Table 14.

Calculation	*Noise Level dB(A)*
L_{wA} of 990 students with 'normal' vocal effort	110
Surface correction, dB	-27
Assumed average distance (25 m) attenuation, dB	-28
Resulting level at residential receiver	55
Noise Level Criterion day-time (up to 2 hours) / Complies?	65 / Yes

Table 14: Noise assessment at nearest residential sensitive receiver for the outdoor playgrounds.

5.6 CHILD CARE CENTRE

Noise break-out from the CELC in the building south has the potential to impact on the nearest noise sensitive receivers. The key noise source it will be children playing in the outdoor area.

The CELC centre will operate from 6am to 6:30pm. Therefore, the noise assessment shall be carried out for night-time and for the day-time periods. As per the architectural drawings the CELC will have two activity areas, being the south-west facing noise sensitive receivers.

The noise impact assessment has considered the following:

- Noise level emissions as per Table 15, being the highest value of the noise level ranges from the AAAC guideline.
- South-west outdoor playground area with 60 children.
- Number of children and their age is unknown. Therefore, the noise impact assessment has been carried out assuming the worst-case scenario – all children are aged 3 to 6 years.
- Background noise levels at the nearest noise sensitive receiver have been used to provide worst-case scenario.

The L_{WAeq} Sound Power Levels of 1 child with different ages are shown below in Table 15.

Calculation	*Sound Power Level dB(A), re 1pW*
L_{wAeq} of 1 child aged 2 to 3 years	77
L_{wAeq} of 1 child aged 3 to 6 years	80

Table 15: Sound Power Level likely to be generated by a child as per AAAC Guideline.

The nearest residential receiver to be considered is approximately at 15 metres. Predicted noise levels at the nearest noise residential receiver associated with the south-west outdoor playground are shown in the following table.

Calculation	*Outdoor Playground, dB(A)*
$L_{Aeq,15min}$ of 60 children aged 3 to 6 years at 1m	90
Distance (15 m) attenuation, dB	-24
Resulting level at residential receiver	66
Noise Level Criterion day-time (less than 2 hours) / Complies?	65 / (Yes)
Noise Level Criterion night-time (less than 2 hours) / Complies?	45 / No

Table 16: Noise assessment at nearest noise sensitive receiver to the south-west from the outdoor playground – children aged 3 to 6 years.

Based on the noise assessment, outdoor playground shall be restricted to the day-time period (7am to 6pm). For the day-time period scenario, the predicted $L_{Aeq,15min}$ noise level from the use of the outdoor playground area at the nearest residential receiver have a marginal exceedance (by 1 dB(A)). This is not considered to be a significant exceedance for the purpose of this noise assessment.

Use of indoor play areas shall not exceed noise level criteria at the nearest noise sensitive receiver. Predicted noise levels with south-west open and closed windows are shown in Table 17.

Calculation	*Indoor Areas, dB(A)*	
	Open Windows	*Closed Windows*
$L_{Aeq,15min}$ of 60 children aged 3 to 6 years at 1m	90	90
Increase in reverberant field, dB	3	3
Distance (23 m) attenuation, dB	-27	-27
Reduction windows, dB	-10	-27
Resulting level at residential receiver	56	39
Noise Level Criterion day-time / Complies?	55 / (Yes)	55 / Yes
Noise Level Criterion night-time / Complies?	40 / No	40 / Yes

Table 17: Noise assessment at nearest noise sensitive receiver to the south-west – children aged 3 to 6 years.

Based on the noise assessment, open south-west windows shall be restricted to the day-time period (7am to 6pm). For the open windows day-time period scenario, the predicted $L_{Aeq,15min}$ noise level from the use of the indoor playground areas at the nearest residential receiver have a marginal exceedance (by 1 dB(A)). This is considered as a negligible exceedance for the purpose of this noise assessment.

5.7 OFFENSIVE NOISE

Based on the noise emissions assessments presented in the sections above, following comments regarding "offensive noise" shall be considered:

- The operational key noise sources from the proposed school will be mechanical plant, public address and school bell system, out-of-school-hours events at the multi-purpose hall, rooftop basketball court plus outdoor playgrounds use of the school and child care centre.
- Mechanical plant will be selected and noise control measures implemented to ensure that the noise levels at the nearest noise sensitive receiver do not exceed the NSW NPI noise criteria established in Section 4.3.2.
- Recommendations for the implementation and use of the public address and school bell systems has been provided in Section 5.2 in order to meet the noise level criteria at the nearest noise sensitive receivers.
- Noise from out-of-school-hours events held within the multi-purpose hall will meet the noise level criteria at the nearest noise sensitive receivers assuming that building envelope construction designed achieves the sound insulation rating provided in Section 5.3 and provided that doors remain closed during use.
- Noise associated with the rooftop basketball court during out of school hours is anticipated to meet the noise level criteria.
- By controlling noise emissions (associated with the operation of the proposed development) in accordance with the relevant criteria, amenity of noise sensitive receivers will be maintained and noise emissions should not be intrusive, therefore it is not expected that people and noise sensitive receivers will be adversely affected by the development.

Based on the comments above, the development is able to satisfy the requirements of the POEO for "offensive noise" provided the relevant criteria outlined in Section 4.3 are achieved.

6 CONSTRUCTION NOISE AND VIBRATION PLANNING

Currently the project is at an early design stage and a detailed construction program is not yet full defined. This section of the Construction Noise and Vibration Planning provides general recommendations only and provides applicable criteria together with best noise and vibration control practices to be observed during the construction of the proposed development.

This preliminary advice in relation to construction noise and vibration management shall form the basis for the Contractor's Construction Noise and Vibration Management Plan.

Any noise from demolition and construction activities to be carried out on site must not result in *'offensive noise'* to any noise sensitive receiver. To this end, the Contractor employed to undertake the demolition and/or construction works is responsible for ensuring that any site noise and, in particular, any complaints shall be monitored, investigated, managed and controlled.

6.1 RELEVANT STANDARDS FOR CONSTRUCTION NOISE AND VIBRATION CRITERIA

Section 4.7 of this report contains the relevant legislation, codes and standards plus construction noise and vibration criteria for this project.

6.2 WORKING HOURS

The following construction hours are proposed as follows:

- Monday to Friday: 7am to 6pm.
- Saturday: 7am to 5pm.
- Sundays and Public Holidays: No excavation or construction works

6.3 PRELIMINARY CONSTRUCTION NOISE ASSESSMENT

A preliminary construction noise assessment has been carried out based on typical plant and machinery expected throughout the construction stages. The preliminary noise assessment has been considered at the nearest existing residential receivers.

These levels are based on the database published by the UK Department for Environmental, Food and Rural Affairs (DEFRA) & Australian Standard AS2436:2010 *'Guide to Noise Control on Construction, Maintenance & Demolition Sites'* for a 15-minute period.

The expected construction noise sources and the predicted noise levels at the nearest residential receiver are shown below in Table 18.

Item	*Typical Power Noise Level L_{A10} (dB ref 10pW)*	*Typical Noise Level $L_{A10,15m}$ at 7m (dB ref 20µPa)*	*Predicted Noise Level $L_{Aeq,15m}$ at nearest residential receiver*
Angle grinders	104	76	< 20
Truck	108	80	20
Circular saw	115	87	27
Piling rig	120	92	32
10-40tn Excavator	117	89	29
Truck	114	86	26
40-50tn Mobile crane	111	83	23
Concrete pump	114	86	26
Concrete truck	110	82	22
Drill	94	66	< 20

Table 18: Anticipated airborne noise levels for equipment / plant used during construction works.

Based on the results of the preliminary assessment as shown above, the noise associated with the normal construction works is expected to meet the noise limits for standard hours & out-of-hours works in accordance with the ICNG Guideline.

6.4 CONTROL ELEMENTS

In order to meet the noise and vibration requirements of the site, the Contractor will be required to engage a qualified acoustic consultant to assist in the compilation of a Construction Noise and Vibration Management Plan, and undertake noise and vibration monitoring for the duration of the project.

6.4.1 GENERAL CONTROL ELEMENTS

As a general rule, minimising noise and vibration should be applied as universal work practice at any time of day, but especially for any construction works to be undertaken at critical times outside normal daytime/weekday periods. Therefore, it is recommended that noisy construction works will not be undertaken between 6am and 7am in order to minimise any sleep disturbance to the nearest residential receivers.

It is noted that the reduction of noise and vibration at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise minimisation. Providing treatments at the affected receivers should only be considered as a last resort. Construction noise and vibration shall be managed by implementing the strategies listed below:

- *Plant and equipment*. In terms of both cost and results, controlling noise and vibration at the sources is one of the most effective methods of minimising the impacts from any work site activities. Work practices that will reduce noise and vibration at the source include:
  - Employing quieter techniques for all high noise activities such as rock breaking, concrete sawing, and using power and pneumatic tools.
  - Use quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
  - Selecting plant and equipment with low vibration generation characteristics.

  - Operate plant in a quietest and most effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Regularly inspecting and maintain plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.
- *On site noise management.* Practices that will reduce noise from the site include:
  - Maximising the distance between noise activities and noise sensitive receivers. Strategically locate equipment and plant.
  - Undertaking noisy fabrication work off-site where possible.
  - Avoid the use of reversing beeping alarms or provide for alternative systems, such as broadband reversing alarms, particularly during night or out-of-hours works.
  - Maintaining any pre-existing barriers or walls on a demolition or excavation site as long as possible to provide optimum sound propagation control.
  - Constructing barriers that are part of the project design early in the project to afford mitigation against site noise.
  - Using temporary site building and material stockpiles as noise barriers. These can often be created using site earthworks and may be included as a part of final landscape design.
  - Installing purpose built noise barriers, acoustic sheds and enclosures.
- *Work scheduling.* Scheduling work during periods when people are least affected is an important way of reducing adverse impacts. The following scheduling aspects may reduce impacts:
  - Provide respite periods, including restricting very noisy activities to daytime, restricting the number of nights that after-hours work is conducted near residences, or by determining any specific requirements, particularly those needed for noise sensitive receivers.
  - Scheduling activities to minimise impacts by undertaking all possible work during hours that will least adversely affect sensitive receivers and by avoiding conflicts with other scheduled events.
  - Scheduling work to coincide with non-sensitive periods.
  - Scheduling noisy activities to coincide with high levels of neighbourhood noise so that noise from the activities is partially masked and not as intrusive.
  - Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from sensitive receivers.
  - Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
  - Designating, designing and maintaining access routes to the site to minimise impacts.
  - Including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.
- *Consultation, notification and complaints handling.*
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and Project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint. Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding receivers are minimised when noise goals cannot be met due to safety or space constraints.

6.4.2 ADDITIONAL NOISE AND VIBRATION CONTROL MEASURES

If, during construction, an item of equipment exceeds ether the noise criteria at any location or the equipment noise level limits, the following noise control measures, together with construction best practices, shall be considered to minimise the noise impacts on the neighbourhood.

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix C of AS 2436:2010.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc) not specifically identified in this plan incorporates silencing/shielding equipment as required to meet the noise criteria.

Implementation of all reasonable and feasible mitigation measures for all internal and underground works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

The NSW RMS '*Construction Noise and Vibration Guideline*' provides safe working distances for vibration intensive plant and are quoted for both 'cosmetic' damage (in accordance with BS 7385.2:1993) and human comfort (in accordance with DECC's '*Assessing Vibration: A Technical Guideline*'). The recommended safe working distances for typical construction plant are provided in Table 19.

Plant Item	*Description*	*Cosmetic Damage*	*Human Response*
Small Hydraulic Hammer	5-12 tonne	2m	7m
Medium Hydraulic Hammer	12-18 tonne	7m	23m
Large Hydraulic Hammer	18-34 tonne	22m	73m
Vibratory Pile Driver	Sheet piles	2-20m	20m
Pile Boring	<800mm	2m	N/A
Jackhammer	Hand held	1m	Avoid Contact with Structure

Table 19: Recommended minimum working distances for vibration intensive plant from sensitive receivers.

If Contractor has concerns for the disruptions at nearest sensitive receivers due to vibration intensive plant use, it is recommended that prior to the commencement of the works, to undertake a preliminary vibration survey on each key vibration generating activity / equipment.

The preliminary vibration survey and assessment will determine whether the vibration levels might exceed the relevant criteria then vibration mitigation and management measures will need to be put in place to ensure vibration impacts are minimised as far as practicable.

7 CONCLUSION

A noise & vibration impact assessment has been carried out for the proposed development of Santa Sophia Catholic College at Box Hill North. This report forms part of the documentation package to be submitted to the Department of Planning as part of the State Significant Development Application.

This report establishes relevant noise level criteria, details the acoustic assessment and provides comments and recommendations for the proposed development.

Ambient and background noise surveys have been undertaken at the existing site to establish the appropriate noise criteria in accordance with the relevant guidelines. However, due to re-zoning the land use in the area, the noise level criteria adopted are based on amenity criteria (NSW NPI) and estimated likely background noise levels (AS 1055.3:1997).

The noise assessment has adopted methodology from relevant guidelines, standards and legislation to assess noise impact. The noise impacts have been predicted at the nearest noise sensitive receiver boundaries.

At this stage, mechanical plant selections have not been made. Therefore, recommendations have been provided to minimise the impact of external noise emissions associated with the mechanical plant of the proposed development to the nearest sensitive receivers.

At this stage, public address and school bell systems have not been selected. Therefore, recommendations have been provided to minimise the impact of external noise emissions associated with the public address and school bell systems of the proposed development to the nearest sensitive receivers.

The multi-purpose hall façade is recommended to have a minimum sound insulation performance of R_w44 in order to meet the noise level criteria in the nearest residential receiver.

The expected noise impact from the use of the rooftop basketball court & outdoor playgrounds are expected to meet the established noise level criteria at the nearest residential receiver.

South-west CELC outdoor playground area noise impact has been assessed. Noise impact predictions at the nearest residential receiver show that noise level criteria will be exceeded during night-time period (6am to 7am). Indoor playground areas noise impact has been carried out for open and closed windows configurations. Predictions show that noise level criteria will be exceeded during night-time period (6am to 7am) with open windows. Therefore, it is recommended during night-time period to restrict south-west outdoor playground area use and close south-west windows / doors.

A preliminary construction noise assessment has been carried out. Based on the results of the preliminary assessment as shown above, the noise associated with the normal construction works is expected to meet the noise limits for standard hours & out-of-hours works in accordance with the ICNG Guideline.

Potential construction noise and vibration impacts on the nearest residential receiver have been presented in this report and recommendations based on the relevant guidelines are provided. If, during any construction work, equipment exceeds the established noise and / or vibration level criteria at any sensitive receiver, the additional noise and vibration control measures shall be considered to minimise the noise and vibration impacts.

Based on the information presented in this report, relevant objectives will be satisfied and therefore approval is recommended to be granted.

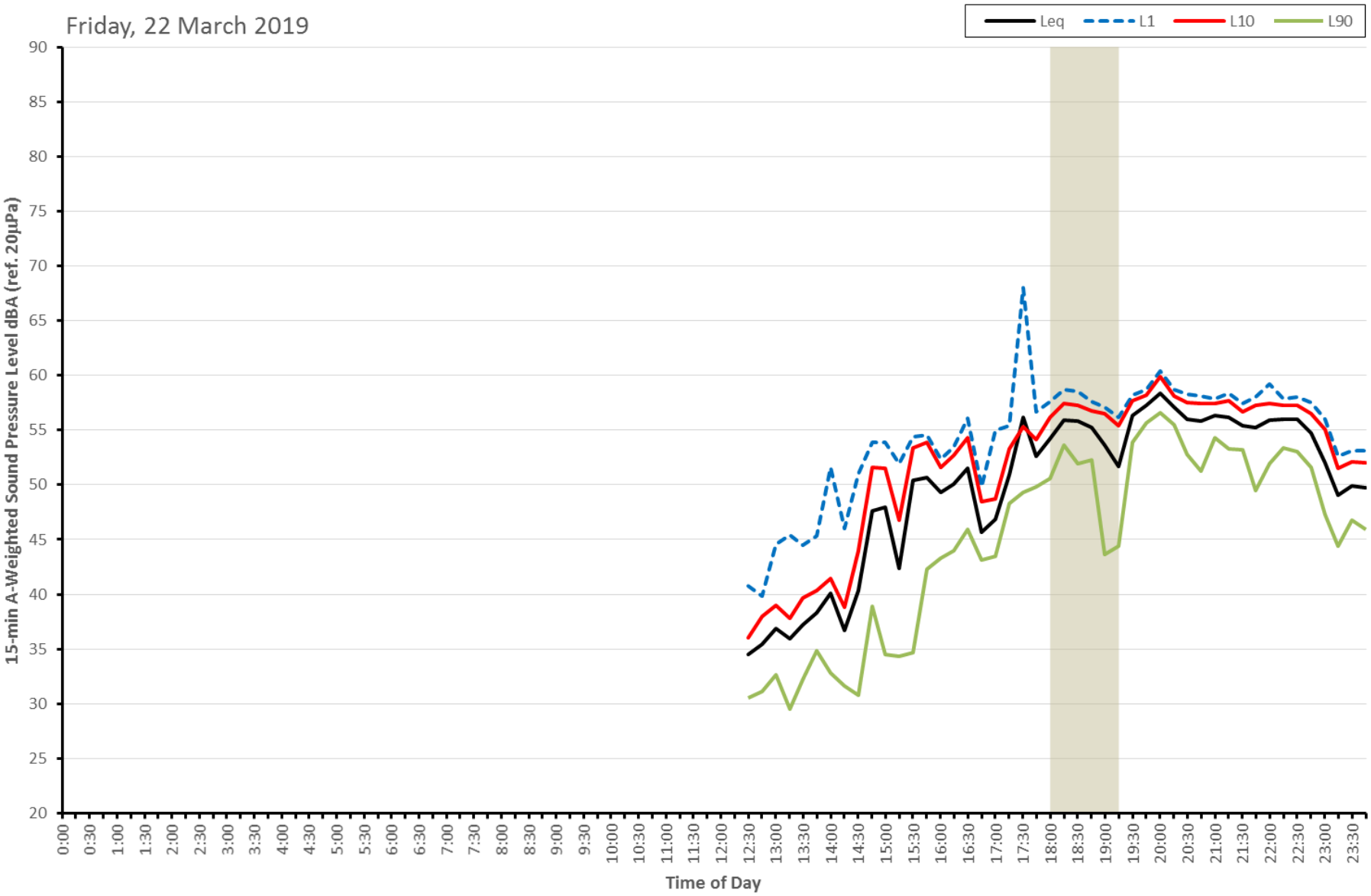
APPENDIX A: LONG-TERM NOISE MONITORING RESULTS

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

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

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.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Leq
L1
L10
L90
15-min A-Weighted Sound Pressure Level dBA (ref. 20µPa)
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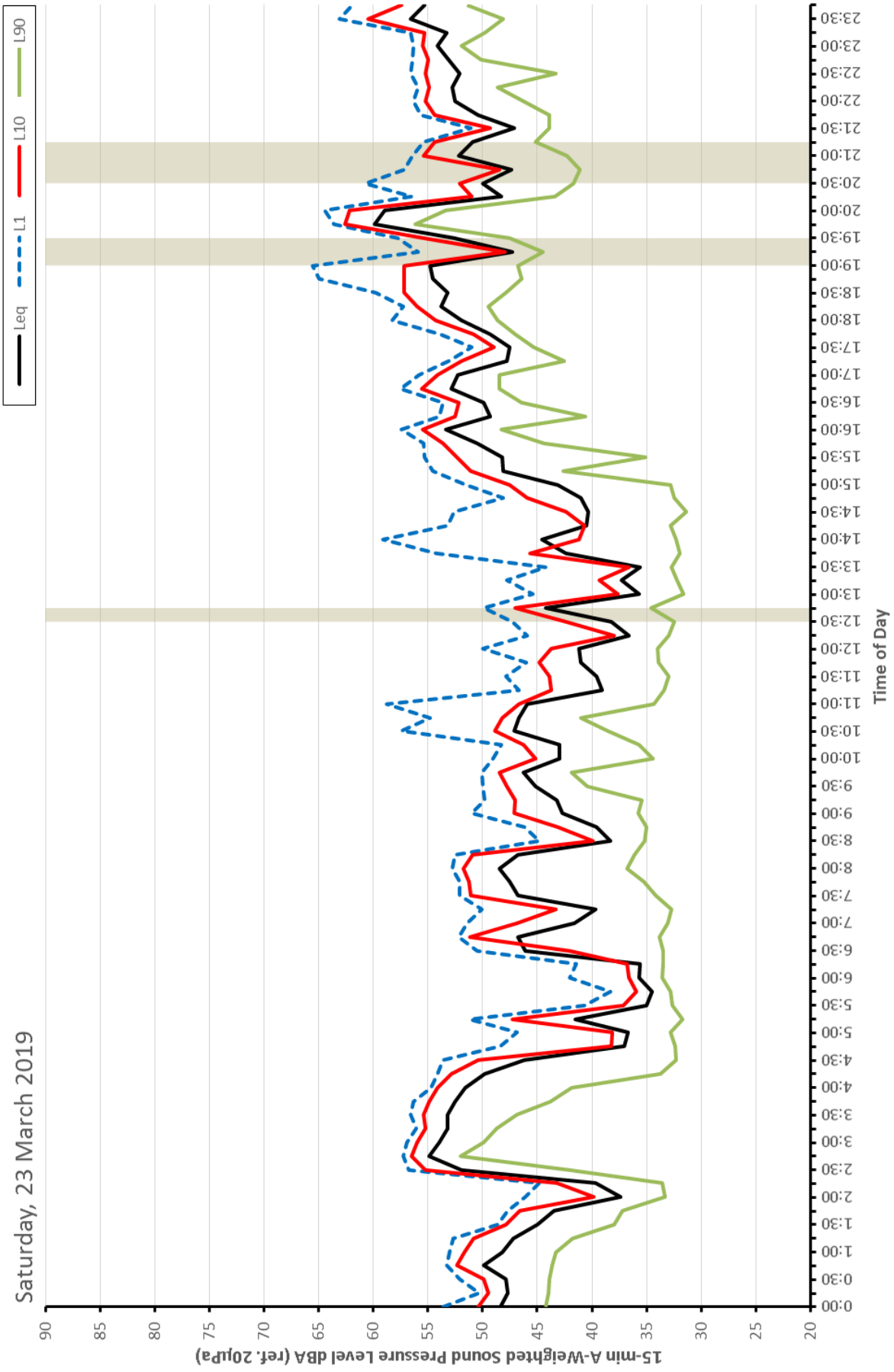
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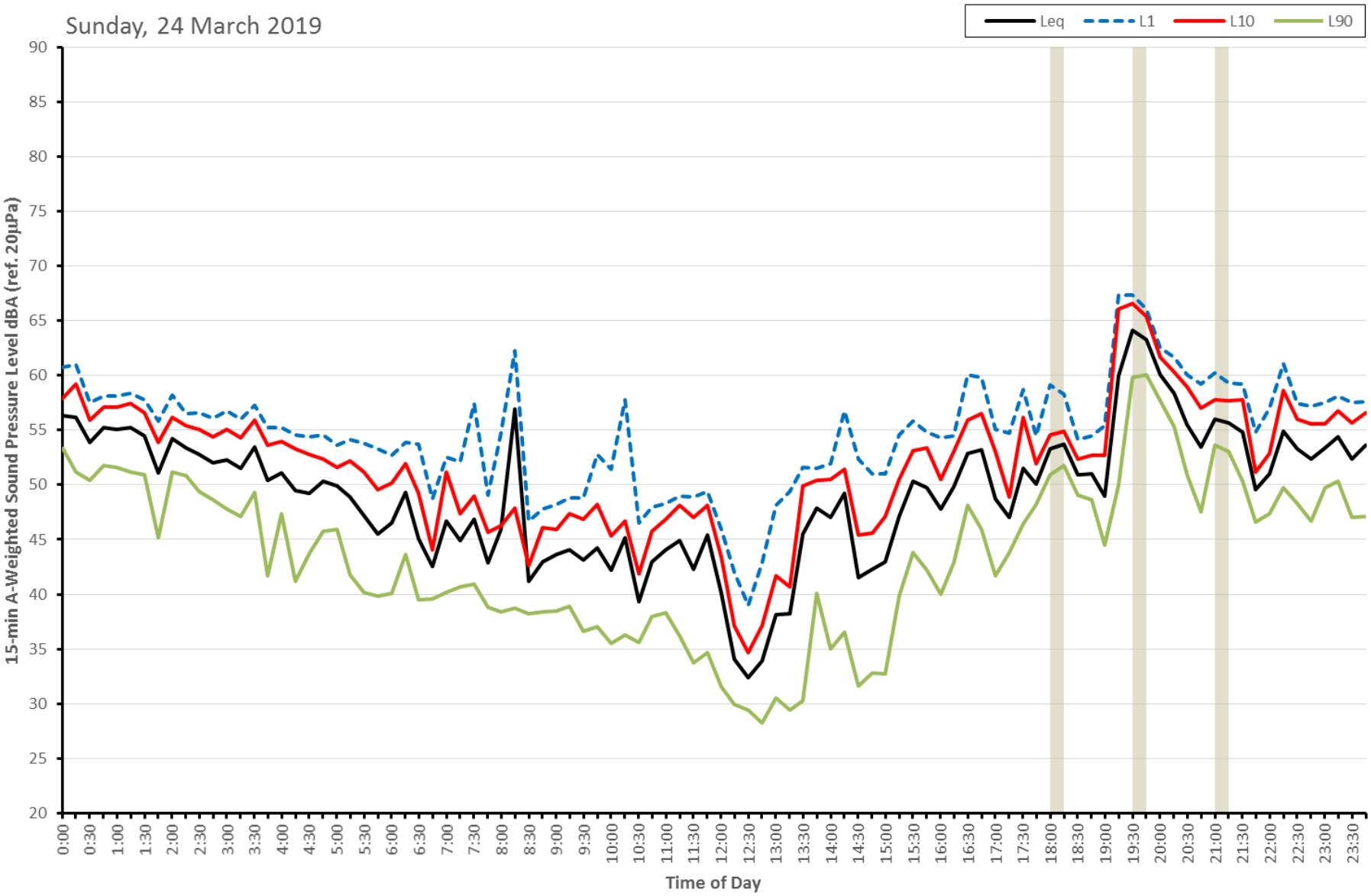
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L10
L90
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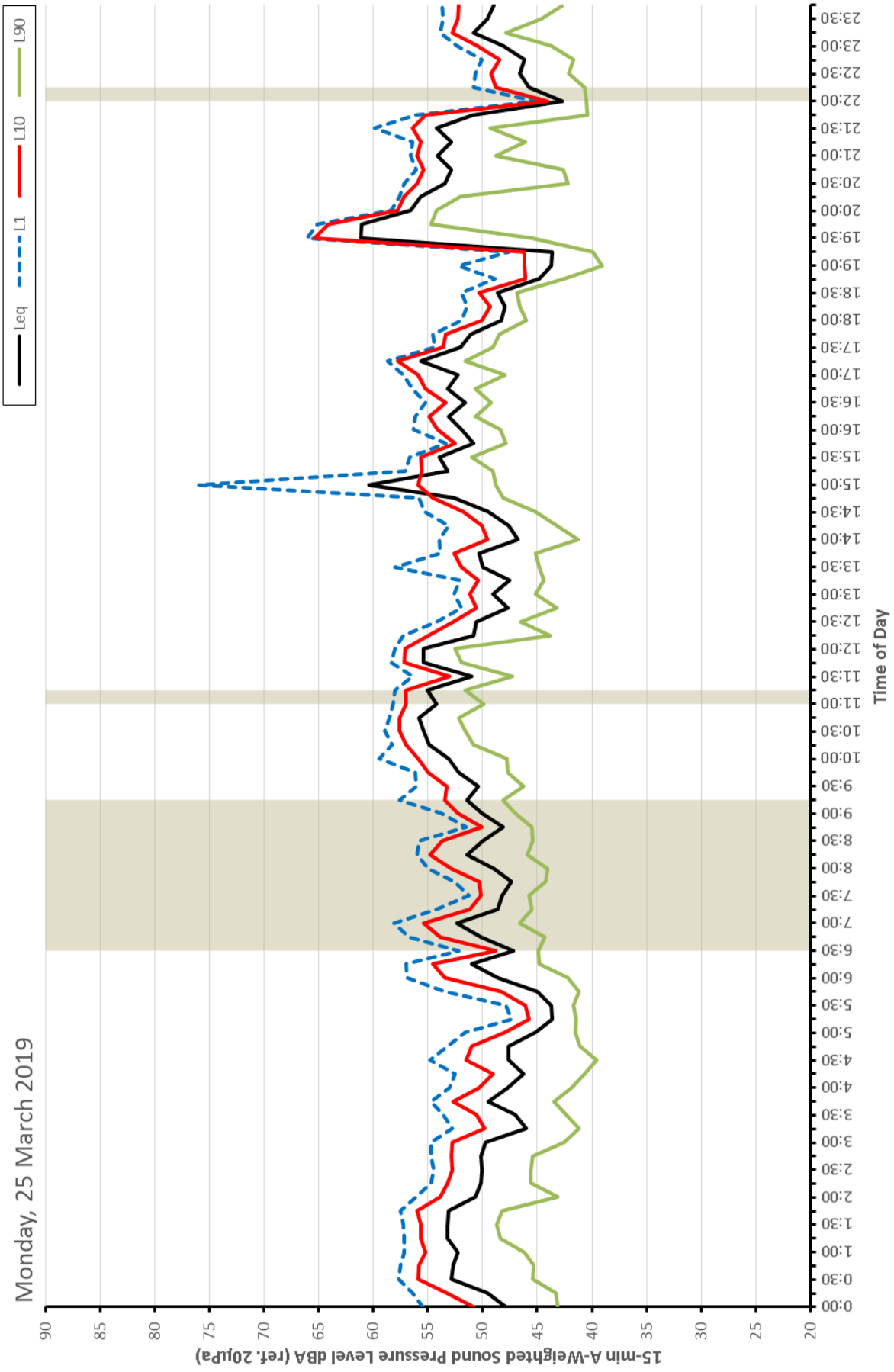
Time of Day


Monday, 25 March 2019
Leq
L1
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L90
15-min A-Weighted Sound Pressure Level dBA (ref. 20µPa)
Time of Day
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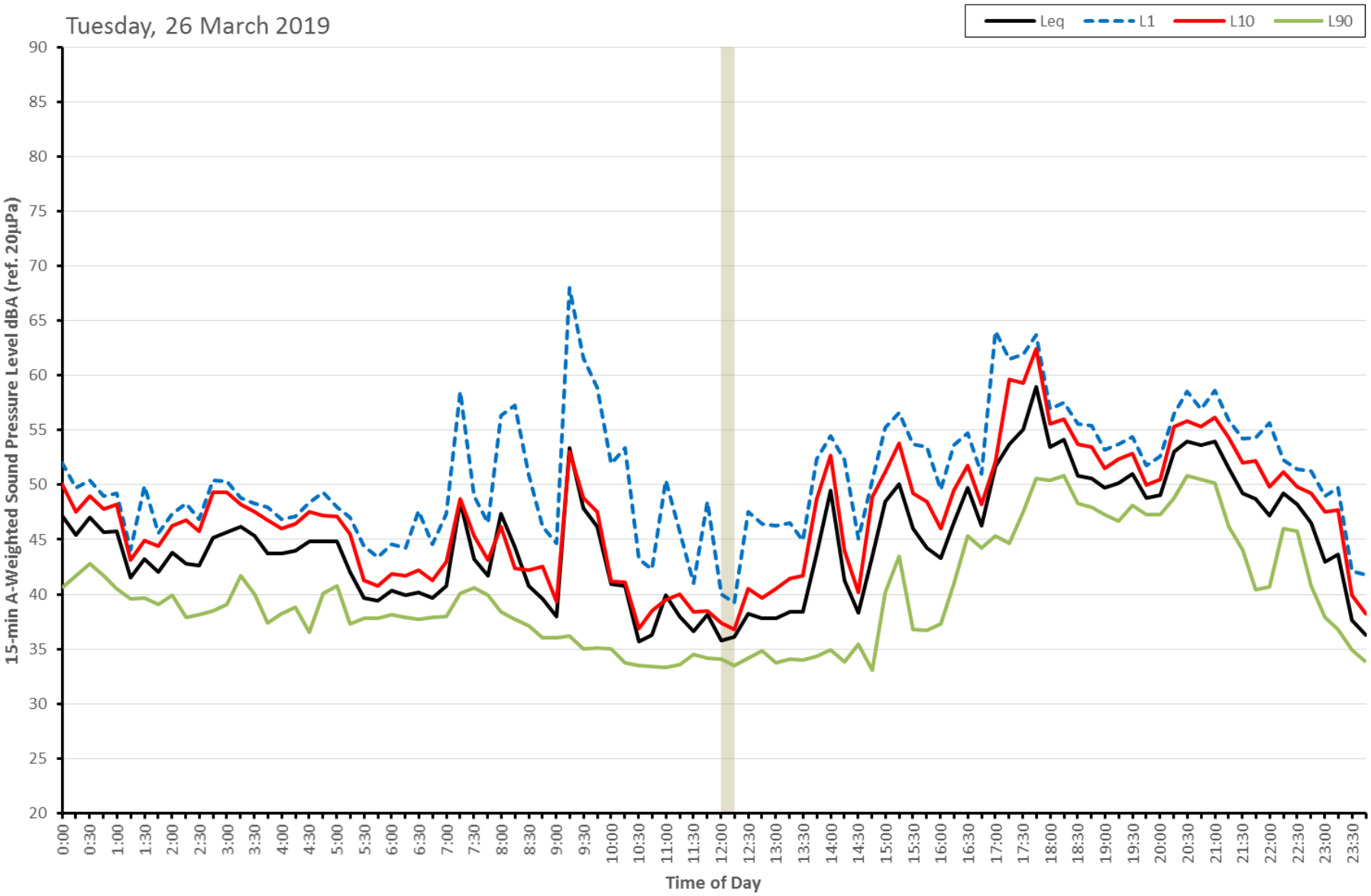
Tuesday, 26 March 2019
Leq
L1
L10
L90
15-min A-Weighted Sound Pressure Level dBA (ref. 20µPa)
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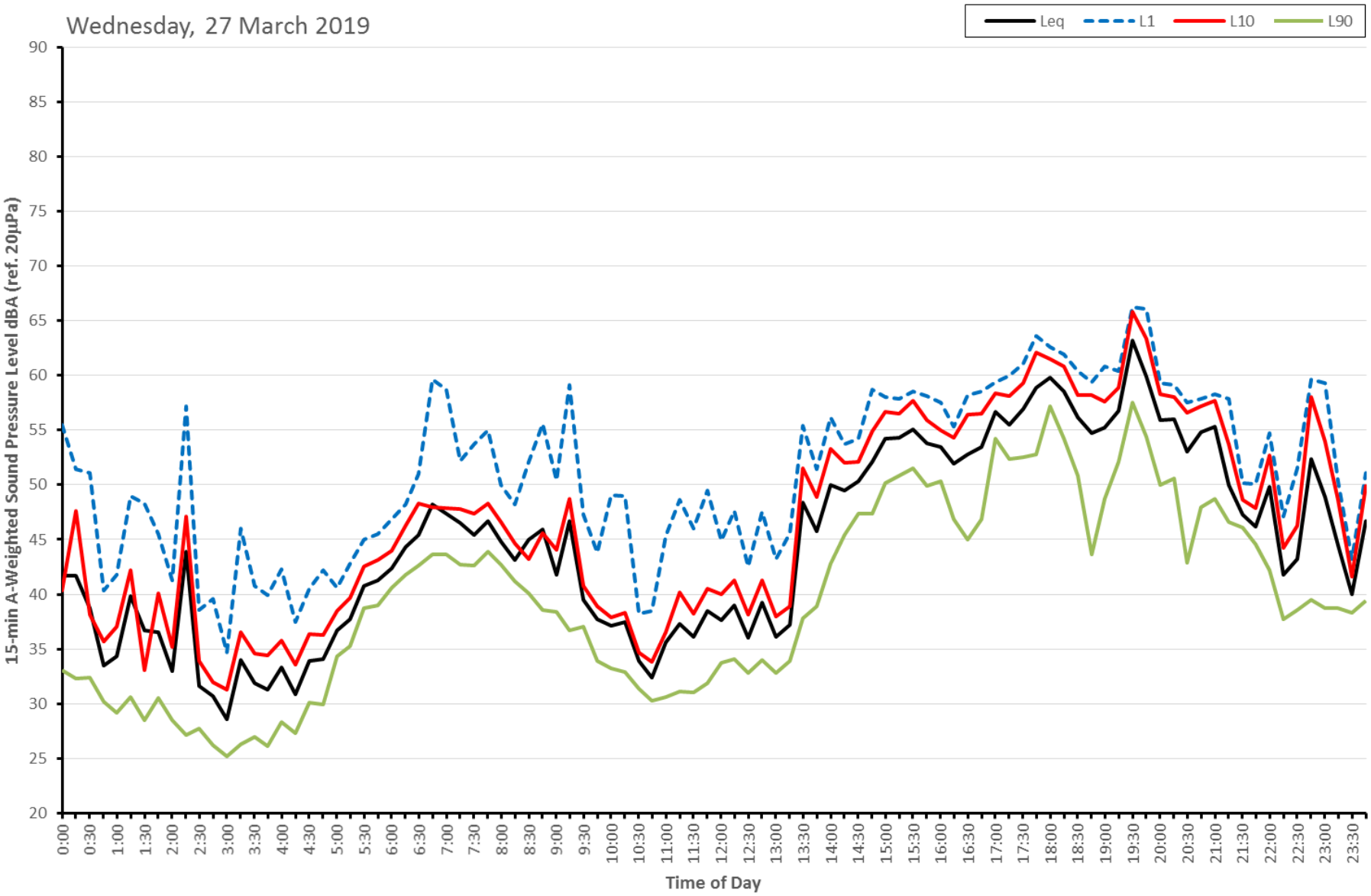
Time of Day


Wednesday, 27 March 2019
Leq
L1
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L90
15-min A-Weighted Sound Pressure Level dBA (ref. 20µPa)
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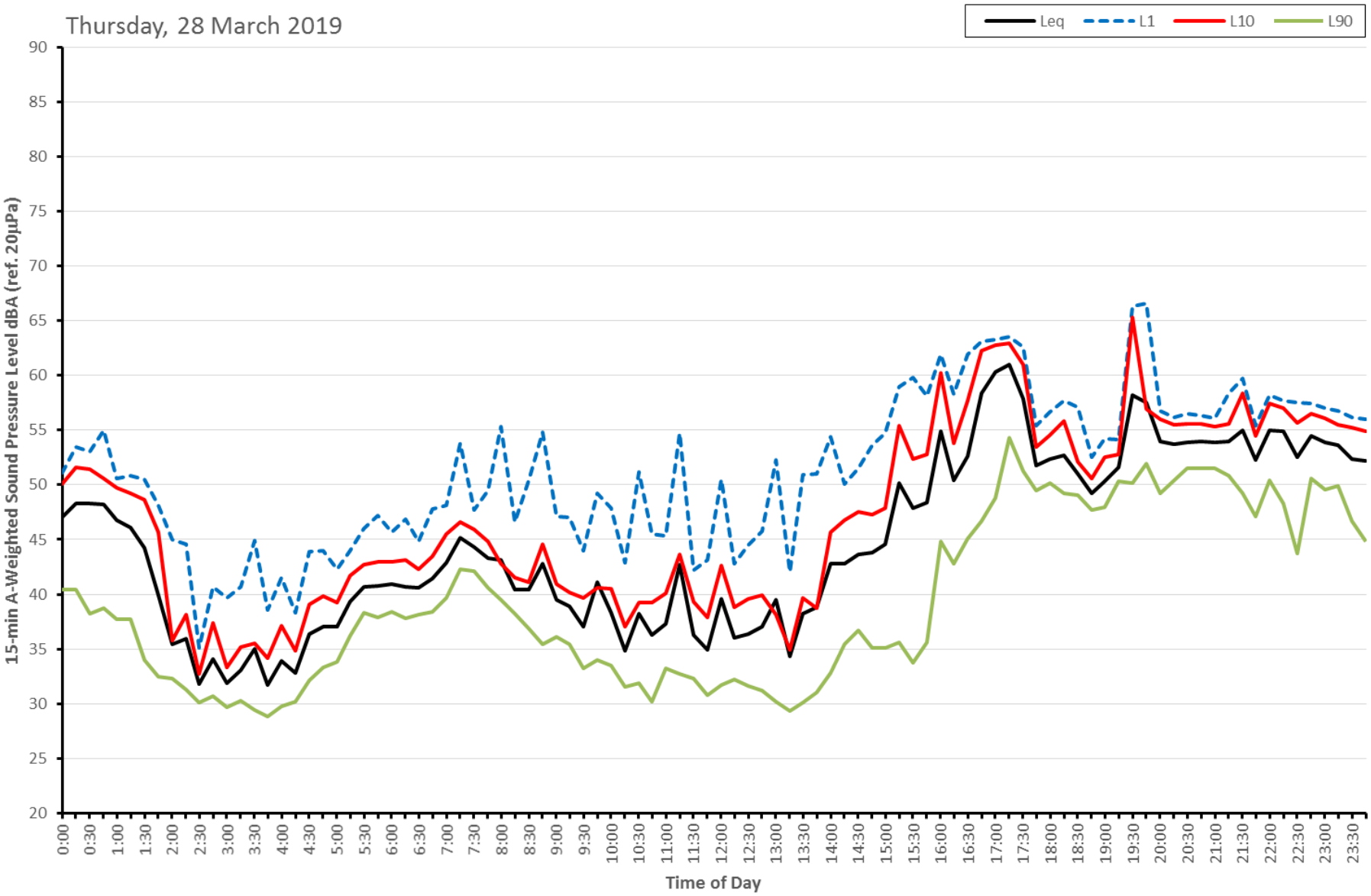
Time of Day


Thursday, 28 March 2019
Leq
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L90
15-min A-Weighted Sound Pressure Level dBA (ref. 20µPa)
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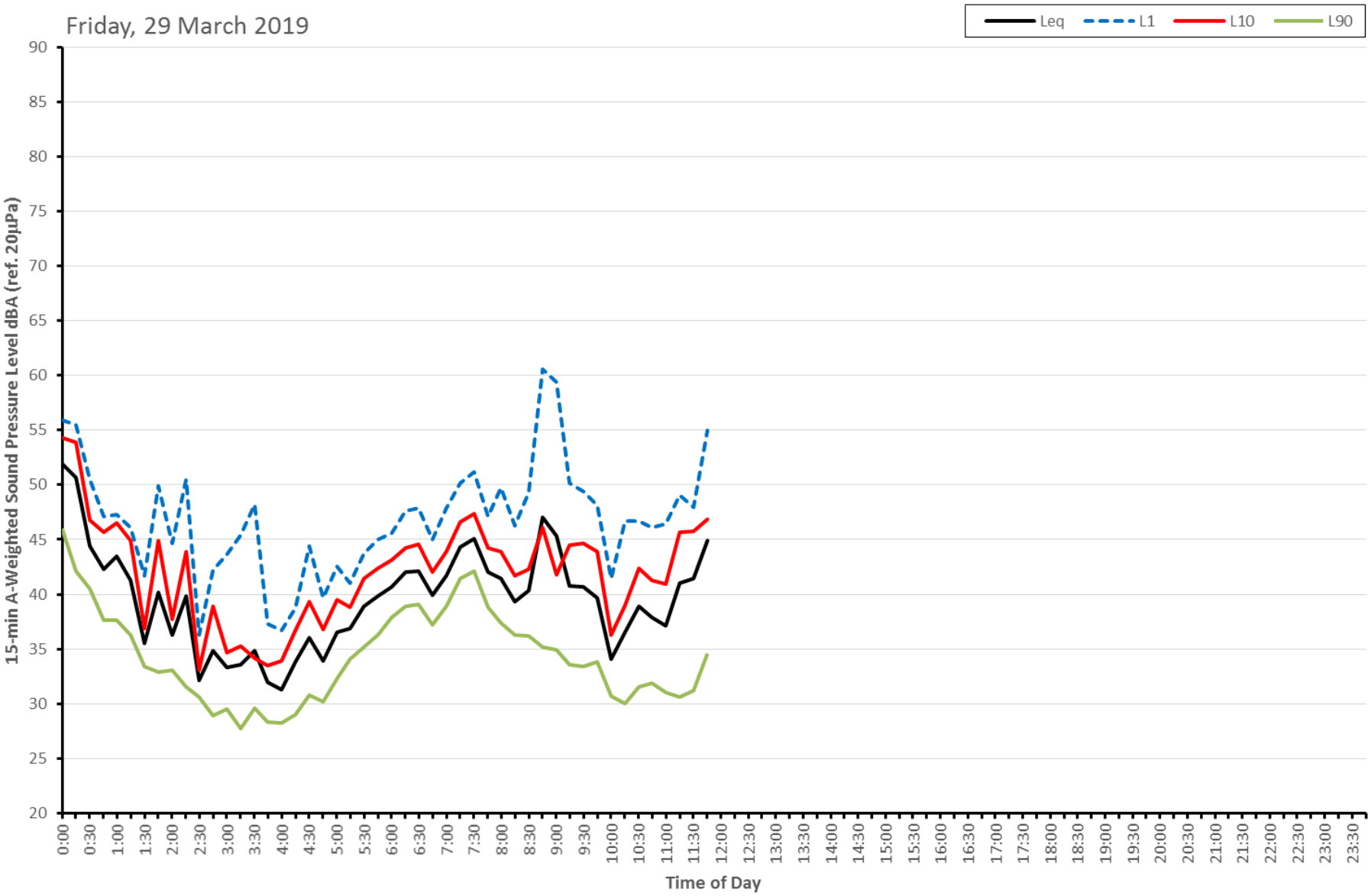
Time of Day


Friday, 29 March 2019
Leq
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15-min A-Weighted Sound Pressure Level dBA (ref. 20µPa)
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Time of Day