JOHN HUNTER HEALTH AND INNOVATION PRECINCT PROJECT

Noise and Vibration Impact Assessment for

State Significant Development Application (SSDA)

Issued

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Glossary

Term	Definition
dB	Decibel is the unit used for expressing sound pressure level (SPL) or power level (SWL).
dB(A)	Decibel expressed as an 'A – weighted' sound pressure level, based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds.
Frequency	The rate of repetition of a sound wave. Frequency is measured Hertz (Hz), or cycles per second. Human hearing ranges approximately from 20 Hz to 20 kHz (2000 Hz).
Ground-borne noise	The transmission of noise energy as vibration of the ground. The energy may then be re-radiated as airborne noise.
$L_{1(period)}$	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
$L_{10(period)}$	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
$L_{90(period)}$	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
$L_{Aeq(period)}$	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
L_{Amax}	The highest sound pressure level recorded over a measurement period.
Octave Band Centre Frequency	The most commonly used frequency bands are octave bands, in which the centre frequency of each band is twice that of the band below it.
Rating Background Level (RBL)	Rating background level is the overall single-figure background level representing each assessment period (day/evening/night) over a measurement period.
Sound Power Level (SWL)	Expressed in dB, it is the total acoustic energy radiated by a plant or equipment to the environment
Sound Pressure Level (SPL)	Expressed in dB, it is the level of noise measured by a standard sound level meter and requires a description of where the noise was measured relative to the source
Vibration	Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure-borne noise or human comfort issues respectively.

Initialisms

ACRONYM	Definition
ASB	Acute Services Building
CNVMP	Construction Noise and Vibration Management Plan
ED	Emergency Department
EIS	Environmental Impact Statement
ESG	Engineering Services Guidelines (NSW HI, 2016, Updated Section 13 Acoustics, 2017)
HI	Health Infrastructure
HNLHD	Hunter New England Local Health District
HMRI	Hunter Medical Research Institute
ICNG	Interim Construction Noise Guideline (NSW EPA, 2009)
JHCH	John Hunter Children's Hospital
JHH	John Hunter Hospital
JHHIP	John Hunter Health Innovation Precinct
NICB	Newcastle Inner City Bypass
NMLs	Noise Management Levels
NPI	Noise Policy for Industry (NSW EPA, 2017)
RBL	Rating Background Level
RNC	Royal Newcastle Centre
SEARs	Secretary's Environmental Assessment Requirements
SSDA	State Significant Development Application

Executive Summary

NSW Health Infrastructure (HI) proposes the construction of an Acute Services Building (ASB) and refurbishment of existing hospital facilities as part of the John Hunter Health and Innovation Precinct (JHHIP) Project ('the Project').

This acoustic report includes a noise and vibration assessment that has been undertaken to establish the potential impacts of the Project, including assessment of construction noise and vibration impacts plus operational noise.

The assessment has been prepared in accordance with accordance with Item 22 of the Secretary's Environmental Assessment Requirements (SEARs) issued on 1 February 2021 for State Significant Development Application (SSDA) No.SSD-9351535. Refer to Section 1 and Section 3 for further details.

The existing noise environment has been established based on long-term and short-term monitoring data. Appropriate criteria for both noise and vibration have been discussed and set according to established guidelines and standards including:

- NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NSW NPI) 2017.
- NSW EPA Interim Construction Noise Guideline 2009.
- NSW EPA Assessing Vibration: A Technical Guideline 2006.

A summary of the outcomes and recommendations of this noise and vibration assessment is as follows:

Construction Noise

- Proposed construction hours (including Outside Recommended Standard Hours) are as follows:
    - Monday to Friday - 6:00am to 6:00pm.
    - Saturday - 7:00am to 5:00pm.
    - Sunday and Public Holidays – No works.

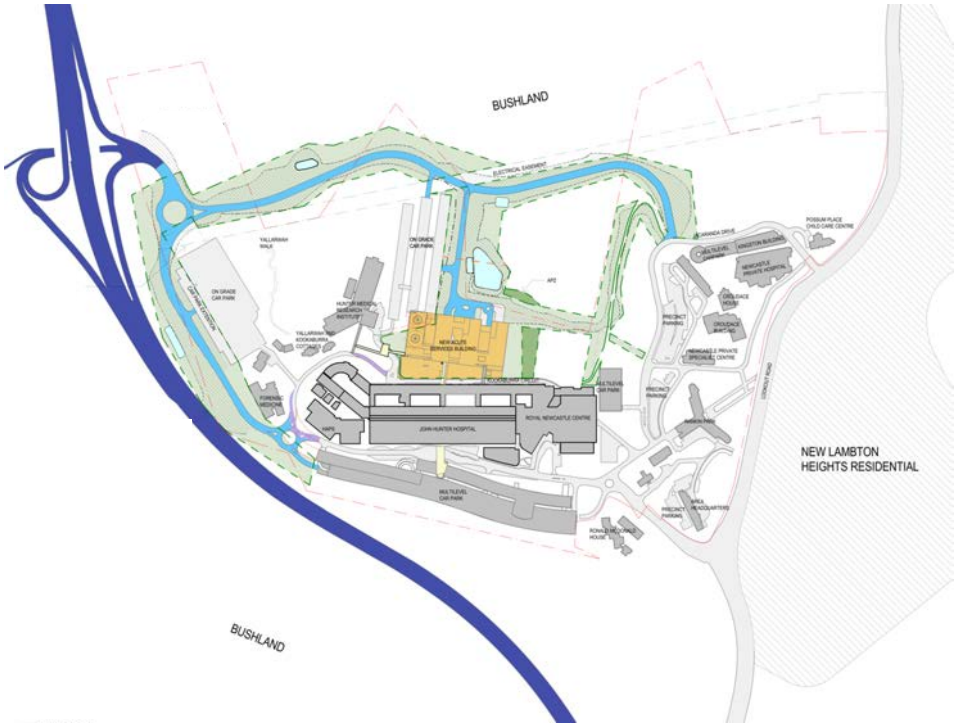


Figure 1: Site Context Plan

- Based on the results from the high-level assessment based on the indicative works, we make the following comments (with reference to Figure 1):
    - Construction noise impacts will be greatest at on Campus receivers including the existing John Hunter Hospital (JHH) and Hunter Medical Research Institute (HMRI) buildings. Noise from various plant and equipment operating individually are generally predicted to be above the Noise Management Levels (NMLs) due to the proximity to the nearest affected receivers. The worst-case noise impacts are for excavators with hammers with noise levels predicted to be above the NMLs by up to 20 dB.
    - Noise levels from operations of various plant and equipment are predicted to be up to 15 dB lower when the location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NMLs depending on the distance to the receiver.
    - Construction noise impacts at residential receivers are the highest beyond bushland to the west and north of the JHH. The worst-case noise impacts are for excavators with hammers which are up to 16 dB above NMLs (construction noise target) during Recommended Standard Hours and 21dB above during Outside Recommended Standard Hours due to the low RBL (background noise level) at these residential receiver locations. These levels (between 50 to 60dB) are not loud in an absolute sense and are consistent with the pre-existing ambient noise levels at these receiver locations. Further attenuation can be expected from absorption across bushland which is not included in predictions. Therefore, noise impact is not expected to be

significant. It is also noted that these noise levels are also well below the 75dB(A) Highly Affected Noise Levels outlined in the Interim Construction Noise Guideline (ICNG).

- Generally, for all other receivers identified (both on and off campus), the noise generated from the construction works from individual equipment operating is below the Highly Noise Affected Level and generally able to meet the NMLs when further away from the perimeter boundary.
- Where NMLs are exceeded, mitigation measures are to be considered and incorporated where reasonable and feasible, and would include:
  - Schedule noisy activities to less sensitive times of the day for each nominated receiver (i.e. daytime hours).
  - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on and 1 hour off.
- The predictions for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and hammers, and the proximity to on campus sensitive receivers (some of which are within 20m).
- Construction traffic along the roads surrounding the site will meet applicable road noise targets on nearby receivers during the day-time period.
- Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when NMLs cannot be met due to safety or space constraints.

Construction Vibration

- Based on the scope of works and typical equipment required, some human perception vibration impacts are expected and there is requirement to review works processes during detailed works planning to ensure that minor cosmetic impacts to structures are avoided – particularly from the use of excavators with hammers near the existing John Hunter Health Campus (JHHC) buildings. In addition, there is potential for vibration impacts on sensitive equipment. The engaged Contractor would be required to prepare a comprehensive Construction Noise and Vibration Management Plan (CNVMP) based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

  In addition to the assessment of structural and human perception vibration, the CNVMP prepared by the Contractor must ensure, at the relevant on campus buildings (including but not limited to the existing JHH, HMRI, Private Hospital)

and other Hospital campus areas where sensitive equipment is operated, that the equipment-specific vibration criteria are set and managed accordingly.

The Contractor shall carry out a vibration assessment at the commencement of each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. Site law tests will help determine allowable working distances from structures to manage vibration.

If the detailed site law assessment indicates that vibration levels might exceed the relevant criteria then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures.

A method of monitoring vibration levels must then be put in place. Additionally, vibration monitors must also be put in place to manage sensitive areas for human comfort and vibration-sensitive equipment. Vibration mitigation measures and vibration criteria will then need to be reviewed.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

Operational Noise

Once the Project is completed, the premises are to operate 24 hours a day, seven days per week.

- Mechanical Plant

Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 5 of this report.

Criteria have been established in Section 7.3.1 of this report.

At this stage, final plant selections have not been made. A preliminary assessment has been carried out which outlines noise controls that will be incorporated as required and identifies noise controls for key equipment including Cooling Towers and Emergency Generators.

During the Detailed Design, the Project's Acoustic Consultant will provide detailed design advice to the architect and services engineers to ensure that noise emissions from plant and equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

- Traffic Noise Generation

  Off Campus - General traffic increase along Lookout Road, Kookaburra Circuit and Jacaranda Drive, as a result of the new ASB, is unlikely to have adverse noise impacts on receivers surrounding the site.

  On Campus – A quantitative assessment has been carried out to assess traffic noise generation on campus from proposed ambulance bays, Emergency Department drop off, ASB carpark and new campus roads. The assessment has determined that on campus traffic noise generation will be below the relevant operational noise emission criteria.

- Emergency Helicopter Operations

  Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an EIS for Designated Development, which would include a detailed assessment of noise impacts in the surrounding community. A high-level assessment has been carried out, regardless, in order to understand likely changes in noise levels expected from the proposed Helicopter Landing (HLS) on the ASB rooftop. Further details are provided in Section 7.5.

1 Introduction

Acoustic Studio has been engaged by NSW HI to assess the potential noise and vibration impacts of the proposed ASB and refurbishment of existing hospital facilities as part of the JHHIP. The Project Site is located on Lookout Road, Lambton Heights.

The assessment has been prepared in accordance with accordance with Item 22 of the SEARs issued on 1 February 2021 for SSDA No.SSD-9351535. The following outline the SEARs requirements for Noise and Vibration, and the relevant sections where each requirement is addressed within this report.

Item	SEARS Requirement	Relevant Section in Report
22	Noise and Vibration	
	Provide a noise and vibration impact assessment that:	
	• includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction	Section 6
	• details the proposed construction hours and provide details of, and justification for, instances where it is expected that works would be carried out outside standard construction hours	Section 6.1
	• includes a quantitative assessment of the main sources of operational noise, including consideration of any mechanical services (e.g. air conditioning plant) and aviation operations	Section 7.4
	• outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers	Section 7.1
	• considers sources of external noise intrusion and vibration in proximity to the site (including road and aviation operations) and identifies building performance requirements for the proposed development to achieve appropriate internal amenity standards	Section 8
	• demonstrates that the assessment has been prepared in accordance with polices and guidelines relevant to the context of the site and the nature of the proposed development.	Section 5.1

Table 1: SEARS Requirements

The assessment has been carried out by:

- Establishing the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- Quantifying the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- A quantitative assessment of main noise and vibration generating sources associated with construction.
- Carrying out a quantitative assessment of the main sources of operational noise including building services, traffic generation and consideration of aviation operations.
- Assessing whether the relevant criteria can be achieved and, where applicable, recommending measures to minimise and mitigate potential impacts.

The assessment considers noise and vibration impacts for community and land uses surrounding the site.

1.1 Project Overview

In June 2019, the NSW Government announced a significant expansion of the John Hunter and John Hunter Children's Hospitals with the $780 million JHHIP project.

The JHHIP will transform healthcare services for Newcastle, the greater Hunter region and northern NSW communities. The infrastructure will provide additional inpatient capacity to the John Hunter and John Hunter Children's Hospitals and create further opportunities for partnerships with industry and higher education providers.

The JHHIP will deliver an innovative and integrated precinct with industry-leading facilities working in collaboration with health, education and research partners to meet the current and future needs of the Greater Newcastle, Hunter New England and Northern NSW regions.

The John Hunter Health and Innovation Precinct Project is being planned and designed with ongoing communication and engagement with clinical staff, operational staff, the community and other key stakeholders with a strong focus on the following:

- Patient-centred care
- Contemporary models of care
- Future economic, health and innovation development opportunities
- Environmental sustainability

1.2 Subject Site

The JHHC is located on Lookout Road, Lambton Heights, within the City of Newcastle Local Government Area (LGA), approximately 8km west of the Newcastle CBD. The hospital campus is located approximately 3.5km north of Kotara railway station.

The JHHC comprises the JHH, John Hunter Children's Hospital (JHCH), Royal Newcastle Centre (RNC), the Rankin Park Rehabilitation Unit and the Nexus Unit (Children & Adolescent Mental Health). JHHC is a Level 6 Principal Referral and tertiary Hospital, providing the clinical hub for medical, surgical, child and maternity services within the Hunter New England Local Health District (HNELHD) and across northern NSW through established referral networks. Other services at the campus include the HMRI, Newcastle Private Hospital and the HNELHD Headquarters.

1.3 SSDA Proposal

Approval is being sought for a new ASB and refurbishment of existing hospital facilities at JHH comprising:

- Construction and operation of a new seven-storey ASB (plus 4 semi-basement levels) to provide:
    - an expanded and enhanced Emergency Department;
    - expanded and enhanced medical imaging services;
    - expanded and enhanced intensive care services - Adult, Paediatric and Neonatal;
    - expanded and enhanced Operating Theatres including Interventional Suites;
    - an expanded Clinical Sterilising Department;
    - Women's Services including Birthing Unit, Day Assessment Unit and Inpatient Units;
    - integrated flexible education and teaching spaces;
    - expanded support services;
    - associated retail spaces;
    - new rooftop helipads;
    - new semi-basement car parking;
- Refurbishment of existing buildings to provide:
    - additional Inpatient Units;
    - expanded support services;
- A new Hospital entry canopy and works to the existing drop off;

- Link bridge to the HMRI;
- Campus wayfinding and signage;
- Landscape works;
- Site preparation including bulk earthworks, tree removal, environmental clearing, cut and fill;
- Mines grouting remediation works;
- Construction of internal roads network and construction access roads and works to existing at-grade carparking;
- Connection to the future Newcastle Inner City Bypass; and
- Inground building services works and utility adjustments.

2 Surrounding Land Uses

The project site is situated within suburban mixed-use zone characterised by residential, commercial, and medical facility land uses. The following existing land uses surround the existing the project boundaries:

- Residential receivers to the south-east on the opposite side of Lookout Road from the campus.
- Residential to the distant north and west.
- Bushland to the immediate north and west.
- HMRI to the immediate north west.
- Newcastle Private Hospital plus commercial receivers including cafés.
- Childcare.

Figure 2 presents the project site in context of the surrounding land uses, and displays long-term noise monitoring locations plus off-site, short term monitoring locations.

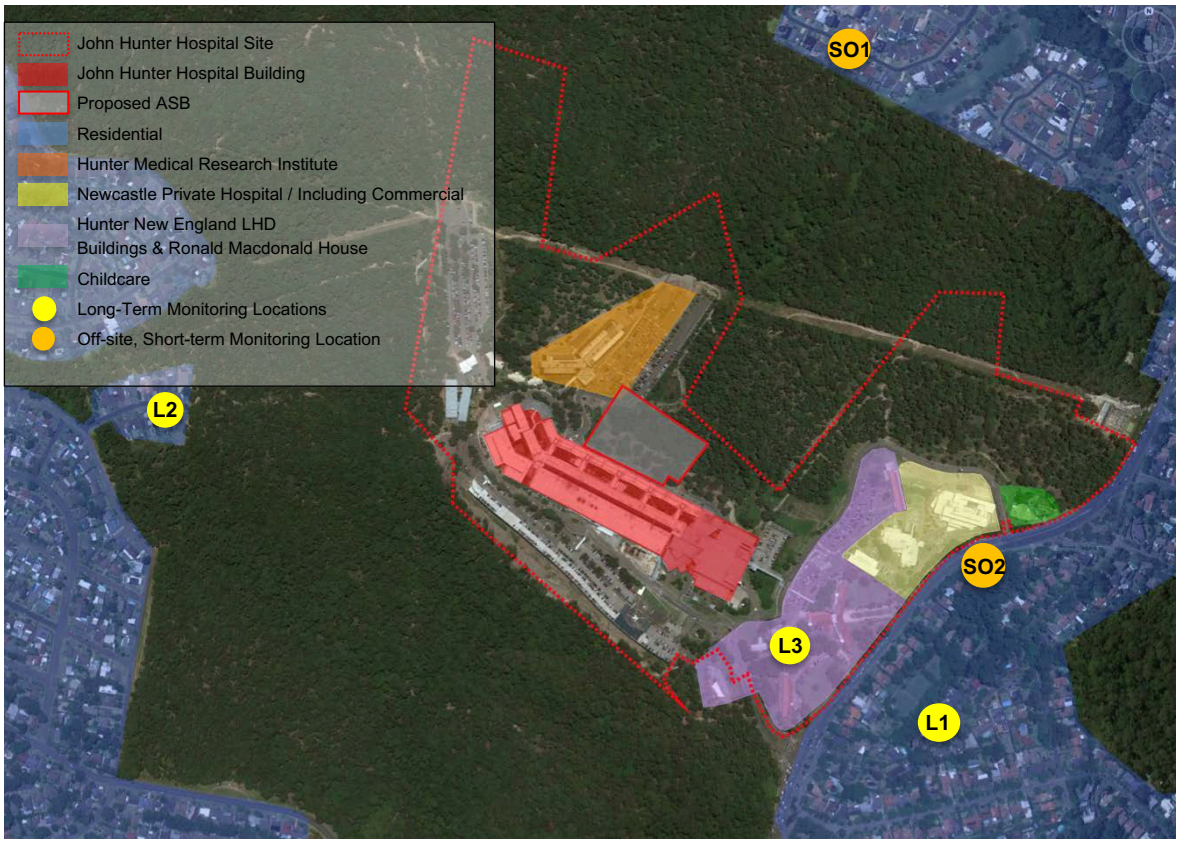


Figure 2: Aerial View showing ASB Site in relation to noise-sensitive receivers

The site is located within a suburban environment in New Lambton Heights, characterised by medium levels of activity throughout the day / evening and low levels of activity in the night.

Figure 3 presents the project site and short-term noise monitoring locations carried out on campus.

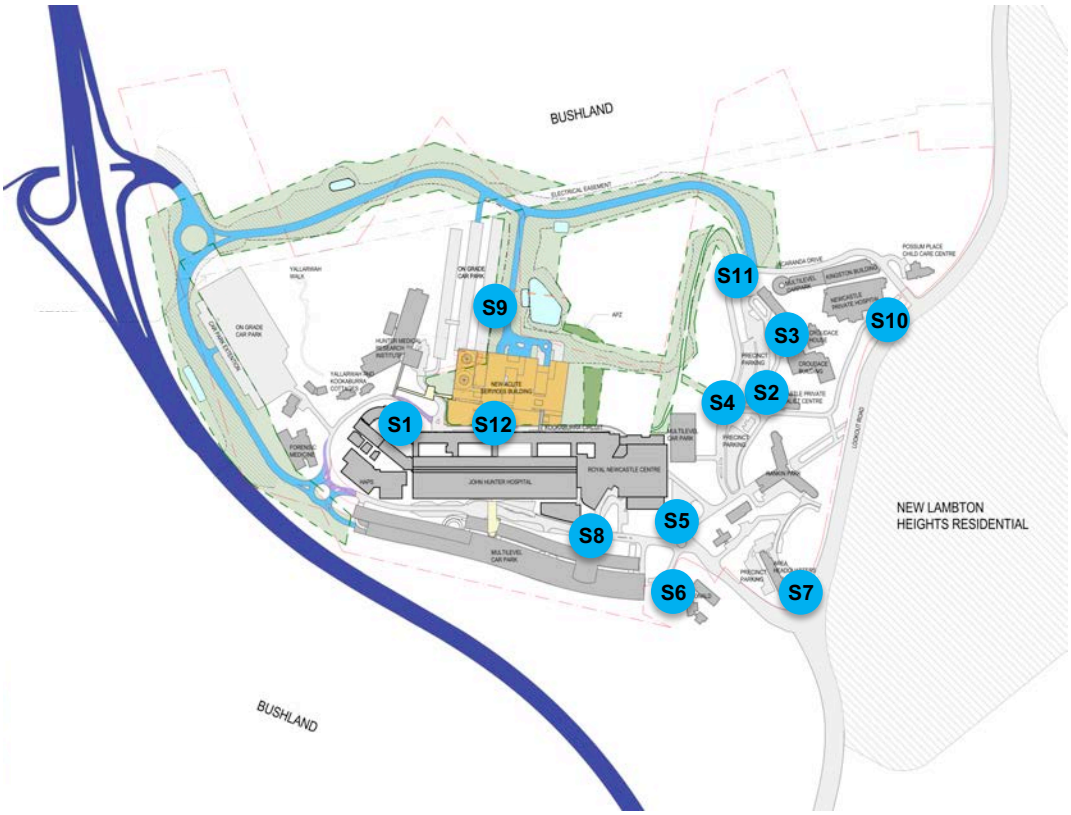


Figure 3: Site Plan, Proposed Works and short-term noise monitoring locations

3 The Key Acoustic Issues

The SEARs requirements for assessment of noise and vibration assessment are outlined Table 1.

The following acoustic issues are to be addressed as part of the assessment:

External Noise Emissions associated with the Operation - Noise emissions from the Project are to be managed to limit environmental noise impacts on sensitive receivers resulting from the operation of the proposed development.

External Noise Intrusion – From external noise sources including plant and equipment, road traffic and helicopter movements.

Noise and Vibration Emissions from demolition, site preparation, bulk excavation and construction - The impact of noise and vibration generated during the construction stages of the Project on surrounding noise and vibration sensitive premises.

The development will contribute to an increase in noise and vibration to the surrounding environment during Construction. Typically, this will result from a combination of intermittent and continuous noise from construction and excavation equipment, construction traffic and plant commonly used on construction sites.

Design noise and vibration targets have been set for the Project and construction noise impacts have been anticipated from standard construction procedures.

The noise and vibration targets and expected impacts are reported in Section 5 and Section 6 of this report. Where the noise and vibration impacts are predicted to be above the NMLs, then all reasonable and feasible noise and vibration mitigation measures must be considered as detailed in Section 6.5.

The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

The comprehensive CNVMP is to provide the following:

- A quantitative construction noise and vibration assessment, which includes:
    - Identifying noise and vibration sensitive receivers potentially affected by the proposed works.
    - Reference the appropriate construction noise and vibration criteria outlined in Section 5.2 of this report.
    - Identifying noise and vibration sources associated with the proposed works.
    - Providing an assessment of noise and vibration generated by the proposed works against the relevant management levels.
    - Determining the likely need for noise and vibration mitigation and management measures.
- A control strategy for construction noise and vibration mitigation to best minimise potential impacts through implementation of reasonable and feasible measures.
- Noise and vibration monitoring as required, using monitors equipped with alert/notification systems to ensure works are carried out in accordance with the applicable Guidelines and Standards.

4 Existing Noise Environment

4.1 General Survey Information

A survey of the existing noise environment at and around the site was conducted through unattended noise monitoring to continuously record the noise levels on the site. Unattended long-term noise monitoring was carried out for the following periods:

- From Friday 9th October to 16th October 2020 at the JHHC and the nearest residential noise sensitive receivers to establish the typical range of **ambient** and **background noise** levels at receiver locations.

Unattended long-term noise monitoring was carried out with the following noise loggers:

- Logger 1: Ngara (Serial Number 87809E)
- Logger 2: Ngara (Serial Number 878007).
- Logger 3: Ngara (Serial Number 8780FB).

The noise loggers recorded L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} noise parameters at 15-minute intervals continuously for the measurement period. The calibration of the loggers was checked before and after use and no variations were noted.

Operator attended, short-term monitoring was also carried out as follows:

- 22nd January 2020
- 9th October 2020
- 16th October 2020

The short term monitoring was conducted in order to supplement the long-term outdoor data across the site and at key surrounding receivers, and to obtain spectral noise data for traffic noise at the proposed site. These short-term measurements included measurements at the property boundaries of the closest residential properties, which were used to confirm that the long-term monitoring at each location (on the opposite side of the street) is representative of the background and ambient noise levels at the nearest noise sensitive receivers.

Attended short-term measurements were made with two Brüel & Kjær Hand-held Analysers Type 2250 (Serial Numbers 2832406 and 3010373). The calibrations of the analysers were checked before and after the surveys and no variation in levels occurred.

Windshields were used to protect the microphones of all the loggers and analysers. Weather conditions were generally calm and dry during the attended noise surveys, and therefore the data captured was not affected by weather.

Isaac Bradbury and David Hanson of Acoustic Studio Pty Ltd carried out the surveys.

4.2 Noise Monitoring Locations

The loggers were located at the proposed site at the following locations:

- Location L1 – Residential – 9 Ardlessa Way, New Lambton Heights NSW 2305
- Location L2 – Residential – 11 Sygna Cl, Rankin Park NSW 2287
- Location L3 – JHH Campus – On green between Rankin Park Centre and car park.

The unattended long-term noise monitoring locations are shown in Figure 2.

The detailed results of the unattended long-term noise monitoring at the three (3) logger locations are shown in Appendix B.

These locations were chosen as they:

- Were secure places to leave the noise loggers unattended, and
- Were judged to provide representative of background and ambient noise levels at the nearest noise sensitive receivers.
- For residential receivers, noise loggers L1 and L2 were installed at locations considered representative of the nearest, reasonably most - or potentially most - affected residences as detailed in the NPI.
    - **Logger Location L1 - Residences to the East -** The nearest residential dwellings from the Proposal to the east are directly opposite the JHHC along Lookout Road. However, Logger Location L1 (9 Ardlessa Way) was selected as it is considered representative of the reasonably most affected residences to the east when based on distance and exposure to the Proposal whilst having lower background noise levels due to setback and relative elevation from traffic noise exposure along Lookout Road.
    - **Logger Location L2 - Residences to the West / North -** The nearest residential dwellings to the West (Sygna Close) and North (Roberts Circuit) are at comparable distances from the Proposal (with the northern residences slightly closer when considering the key industrial noise sources located at the proposed ASB). A single Logger Location L2 (11 Sygna Close, to the West) was selected to represent the more conservative monitoring position for both West and North residential receivers (i.e. the lower ambient and background noise environment). This was confirmed with comparison against attended measurements at Roberts Close to the North (S01) where higher background noise levels were observed to be influenced by distant traffic noise from Lookout Road. Further to this, the background noise level and calculated RBL at monitoring Location L2 was below the minimum Day and Night RBL outlined in the NPI and therefore corrected up to the minimum RBL (noted in Appendix C.2). This resulted in determination of

the most stringent PNTL for both north and west residential receivers in accordance with the NPI. Review of the attended measurements at residential receivers to the North (S01) also confirmed that whilst background levels are higher than the minimum RBL stated in the NPI, they were only slightly higher, such that applying the conservative PNTL established with Logger L2 for residential receivers to the north is not considered onerous or overly stringent for the project.

4.3 Unattended Long-term Monitoring Results

4.3.1 Background and Ambient Noise

The logged data shows the background and ambient noise levels representative of the area. The recorded background noise levels have been used to establish noise targets for noise emitted from the construction and operation of the new building.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L_{90}. The Rating Background Noise Level (RBL) provides a single figure that represents the background noise level over the entire monitoring period for assessment purposes. The ambient noise level impacting on the buildings is referred to as the equivalent continuous sound level (L_{eq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

The background sound levels have been established in general accordance with the methodology described in the NSW Noise Policy for Industry (NPI), i.e. the 10th percentile background sound level for each period for each day of the ambient noise survey. The median of these levels is then presented as the background sound level for each assessment period. These background noise levels are shown in Table 2 below, together with the L_{Aeq} ambient noise levels measured for each period.

Location	Background Noise Levels (RBL), dB(A)			Leq Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger Location 1	41	41	35	56	48	47
Logger Location 2	32	35	29	57	50	42
Logger Location 3	47	47	47	58	57	55

Table 2: Long-term background and ambient noise levels

Based on our observations during the site inspections, both ambient and background noise levels around the Project Site are generally dominated by traffic noise and general suburban hum around the site at all three locations.

4.4 Short-term Monitoring Results

Fourteen (14) short-term noise monitoring locations were chosen as representative of the site and surrounds as follows:

- **Location S1 –** JHH, overlooking HMRI
- **Location S2 –** Private Specialist Centre
- **Location S3** – The Lodge
- **Location S4** – Corner Jacaranda Dr and Tea House Rd
- **Location S5** – JHH Entrance Roundabout
- **Location S6** – Ronald McDonald House
- **Location S7** – Lookout Road; JHH entrance road (Traffic Measurement)
- **Location S8** – Kookaburra Cct. Opposite Helipad
- **Location S9** – HMRI Carpark
- **Location S10** – Lookout Road; adjacent to Newcastle Private Hospital (Traffic measurement)
- **Location S11** – Jacaranda Dr. north bend (Traffic Measurement)
- **Location S12** – JHH Service Road, overlooking HMRI Carpark
- **Location SO1 (Off-site, short term Monitoring location)** – 28 Roberts Circuit.
- **Location SO2 Off-site, short term Monitoring location** – 7 Lookout Road (Traffic measurement)

A summary of the measured values of the short-term background and ambient noise monitoring around the existing site is provided in Table 3.

Location	Time	Descriptor	Measured sound level, dB re 20 **µ**Pa									
			Overall dB(A)	Octave band centre frequency[1], Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
S1	Between 2-3pm, 9th Oct. 2020	L_{eq}	49	61	58	49	48	44	44	41	38	33
		L_{90}	45	57	52	46	46	42	39	35	32	24
S2	Between 2-3pm, 9th Oct. 2020	L_{eq}	56	65	63	63	56	51	50	49	44	35
		L_{90}	49	58	58	55	52	44	43	39	34	24

S3	Between 2-3pm, 9th Oct. 2020	L_{eq}	54	63	74	64	48	48	46	43	37	30
		L_{90}	48	57	56	51	45	45	44	40	33	22
	Between 12-1pm, 16th Oct. 2020	L_{eq}	51	64	61	53	48	46	46	44	42	35
		L_{90}	47	60	56	49	44	43	43	39	36	29
S4	Between 3-4pm, 9th Oct. 2020	L_{eq}	66	69	76	66	65	63	61	58	54	49
		L_{90}	54	62	60	56	54	50	50	47	41	31
	Between 12-1pm, 16th Oct. 2020	L_{eq}	60	71	67	62	59	58	56	51	47	40
		L_{90}	55	64	61	56	55	53	51	45	50	33
S5	Between 3-4pm, 9th Oct. 2020	L_{eq}	64	74	77	69	63	60	58	55	50	47
		L_{90}	55	63	61	57	54	51	51	48	41	32
S6	Between 3-4pm, 9th Oct. 2020	L_{eq}	57	64	64	58	57	51	50	49	50	43
		L_{90}	47	59	57	51	45	43	42	39	34	26
	Between 12-1pm, 16th Oct. 2020	L_{eq}	53	67	65	55	50	47	47	45	44	39
		L_{90}	47	60	56	49	44	43	42	39	37	31
S7	Between 3-4pm, 9th Oct. 2020	L_{eq}	72	70	75	73	71	67	68	65	58	51
		L_{90}	58	62	62	58	56	54	54	51	42	32
	Between 12-1pm, 16th Oct. 2020	L_{eq}	71	71	74	73	67	68	67	62	56	50
		L_{90}	58	63	64	59	55	54	53	51	45	38
S8	Between 4-5pm, 9th Oct. 2020	L_{eq}	62	67	72	63	60	58	58	53	47	40
		L_{90}	49	59	57	52	49	45	45	39	32	24
	Between 1-2pm, 16th Oct. 2020	L_{eq}	60	70	71	61	58	54	55	52	47	40
		L_{90}	51	62	59	53	48	47	48	43	36	28
S9	Between 4-5pm, 9th Oct. 2020	L_{eq}	53	67	59	50	47	44	44	48	46	37
		L_{90}	45	57	52	45	44	41	40	38	35	25
S10	Between 4-5pm, 9th Oct. 2020	L_{eq}	71	72	74	72	66	66	68	64	57	48
		L_{90}	59	65	65	59	53	55	56	52	45	36

S11	Between 5-6pm, 9th Oct. 2020	L_{eq}	58	60	58	53	54	53	55	49	42	36
		L_{90}	45	53	51	47	44	41	41	36	32	27
S12	Between 1-2pm, 16th Oct. 2020	L_{eq}	57	63	64	56	54	52	52	50	44	37
		L_{90}	46	56	59	48	46	43	41	37	33	24
SO1	Between 2-3pm, 9th Oct. 2020	L_{eq}	47	65	55	48	41	39	38	38	43	37
		L_{90}	38	43	45	41	36	35	34	28	23	19
	Between 1-2pm, 16th Oct. 2020	L_{eq}	45	61	53	47	43	40	39	37	38	33
		L_{90}	40	47	46	42	36	36	36	31	30	24

Table 3: Summary of short-term traffic, background and ambient noise levels

4.5 Traffic Noise

From the attended measurements in Table 3, the noisiest (Day) and quietest (Night) 1 hour traffic periods are summarised in Table 4 below. Traffic noise levels have also been calculated based on attended measurements and traffic data along lookout road from Roads and Maritime Services Traffic Volume Viewer[1].

Location	Traffic Noise Levels at 7m , dB(A)			
	1 Hour Period		Period	
	Day $L_{eq, (1\ hr\ –\ 3pm\ to\ 4pm)}$	Night $L_{eq, (1\ hr\ –\ 1am\ to\ 2am)}$	Day $L_{eq, (15\ hr)}$	Night $L_{eq, (9\ hr)}$
Lookout Road	72	58[2]	70	63

Table 4: Summary of measured traffic noise levels

[1] https://www.rms.nsw.gov.au/about/corporate-publications/statistics/traffic-volumes/aadt-map/index.html#/?z=6

5 Project Noise and Vibration Targets

5.1 Relevant Standards and Guidelines

The following acoustic standards and guidelines have been considered in establishing noise and vibration criteria and assessment for this project.

- Newcastle Local Environmental Plan (LEP) 2000 and 2014.
- Newcastle Development Control Plan (DCP) 2012.
- NSW EPA Noise Policy for Industry (NSW NPI) 2017.
- NSW EPA Road Noise Policy (RNP) 2011.
- NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline" (ICNG) 2009.
- NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline" (AVTG) 2006.
- NSW Department of Planning "Development Near Rail Corridors and Busy Roads – Interim Guideline" 2008.
- NSW Protection of the Environmental Operations (POEO) Act 1997.
- Australian Standard AS 2107:2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors".
- Australian Standard AS 2021:2000 "Acoustics – Aircraft noise intrusion - building siting and construction".
- Australian Standard "AS 2436 : Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites" 2010.
- Australian Standard "AS 1055 : Acoustics – Description and Measurement of Environment Noise" 1997.
- Australian Standard "AS 2670.2 : Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)" 1990.
- British Standards Institution "BS 6472 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)" 1992.
- German Standard DIN 4150-3:1999 "Structural vibration Part 3: Effects of vibration on structures".
- British Standard BS7385: Part 2: 1993 "Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration".

- NSW Health Infrastructure "Engineering Services Guidelines (ESG)", August 2016. We note that Section 13 (Acoustics) of these guidelines has been updated. The updated guideline performance requirements for acoustics are provided in "Design Guidance Note No.33", (RevA 19 July 2017).
- *"Australasian Health Facility Guidelines"* December 2012 Revision v.4.0.

5.2 Construction Noise and Vibration

5.2.1 Noise Management Levels

The relevant guideline applied for the assessment of construction noise is the ICNG. This guideline provides construction NMLs for Residential, Commercial and Industrial noise receivers as follows.

Residential Receivers

Section 4 of the ICNG provides recommendations for standard hours of work and suggests construction NMLs that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 5 outlines the methodology for determining construction NMLs at nearby residential receivers surrounding the development site based on existing background noise levels.

Time of Day	Management level $L_{Aeq\ (15\ min)}$	How to Apply
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 RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the 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 RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 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.

Table 5: Residential construction Noise Management Levels for airborne noise as outlined in the ICNG

The project-specific construction Noise Management Levels are shown in Table 6 based on the measured background noise levels at the site (in Section 4 – also refer to Appendix C).

Location	Period		Rating Background Level RBL, dB(A)	Noise Management Level $L_{eq\ (15\ min)}$ dB(A)	
Residential – East (Location 1)	Recommended Standard Hours	Monday to Friday 7am to 6pm	41	RBL + 10	51
		Saturday 8am to 1pm	41		51
	Outside Recommended Standard Hours	Monday to Friday 6am to 7am	41	RBL + 5	46
		Saturday 7am to 8am	41		46
		Saturday 1pm to 5pm	41		46
Residential - West / North (Location 2)	Recommended Standard Hours	Monday to Friday 7am to 6pm	35	RBL + 10	45
		Saturday 8am to 1pm	35		45
	Outside Recommended Standard Hours	Monday to Friday 6am to 7am	35	RBL + 5	40
		Saturday 7am to 8am	35		40
		Saturday 1pm to 5pm	35		40

Table 6: Project Specific residential construction Noise Management Levels for airborne noise

The ICNG also recommends *ground-borne* NMLs 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.

The ground-borne noise levels presented below are for evening and night-time periods only, as the objective is to protect the amenity and sleep of occupants during the more sensitive time periods.

Time of Day	Noise Management level $L_{eq\ (15\ min)}$ dB(A)
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

Table 7: Residential construction Noise Management Levels for ground-borne noise

Non-Residential Receivers: Commercial, Hospital and Educational Receivers

The ICNG also provides recommended construction NMLs for commercial, hospital and educational facilities surrounding a construction site, which are as follows:

Occupancy	Management level $L_{eq\ (15\ min)}$ dB(A)
Offices, retail outlets	70 dB(A) - External
Hospital wards and operating theatres	45 dB(A) - Internal / 65 dB(A) - External[3]
Classrooms at schools and other educational institutions	45 dB(A) - Internal / 65 dB(A) - External[4]

Table 8: Industrial, commercial, educational and hospital construction Noise Management Levels for airborne noise

Construction Noise Impacts on the Existing JHHC

On Campus receivers have been included in the assessment to assist with managing construction noise impacts on Campus.

The ICNG does not provide specific guidance for hospitals other than recommending a NML of 45 dB(A) for wards or operating theatres, above which the proponent is to consult with the health authority to determine ways to manage noise impacts.

For assessment of JHHC buildings, reference is made to the Non-Residential Receiver NMLs in Table 8 above. In addition:

- For temporary accommodation located on the JHHC nearby to the proposed works site (including Kookaburra / Yallarwah cottages), these are considered equivalent to "Hospital Wards" for the purposes of the construction noise assessment.
- For Childcare Centres reference is made to the Association of Australian Acoustical Consultants (AAAC) Technical Guideline on Child Care Centre Noise Assessments (in the absence of specific guidance in ICNG or AS2107). Based on this guideline an $LA_{eq\ (1\ hour)}$ noise level of 40 dB(A) is recommended for indoor play and sleeping areas (or 60 dB(A) externally[3])

[3] Minimum 20 dB loss from a closed façade typical of commercial, hospital ward or childcare.

[4] Where internal noise levels are specified, the NSW NPI assessment methodology states that in cases where the gaining of internal access for monitoring is difficult, then external noise levels 10 dB above internal noise levels apply assuming a window opened sufficiently to provide ventilation.

5.2.2 Construction Traffic Noise on Public Roads

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criterion applies to additional traffic generated on public roads from construction vehicles / traffic.

Table 9 below provides the RNP criteria for additional traffic generated on local roads from land use development in relation to the applicable receiver types surrounding the site.

Receiver	Assessment Criteria (external[4])	
	Day (7am to 10pm) $L_{eq\ (period)}$ dB(A)	Night (10pm to 7am) $L_{eq\ (period)}$ dB(A)
Residential	60 (15 hour)	55 (9 hour)
Hospital Wards	55 (1 hour)	55 (1 hour)
School classrooms (Educational)	60 (1 hour)	-
Childcare Centres	55 (1 hours) – Sleeping Rooms	-
	60 (1 hours) – Indoor Play	-
	55 (1 hour) Outdoor Play	-

Table 9: RNP assessment criteria for additional traffic on local roads generated by land use development including construction vehicles / traffic

Results from the traffic noise level measurements along Lookout Road are presented in Table 4 show that the existing traffic noise levels are currently exceeding the criteria for receiver types along Lookout Road. In such cases, the increase in the traffic noise levels arising from the additional traffic generated from land use development is assessed in relation to the existing noise levels.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"… (in relation to existing noise levels)… "represents a minor impact that is considered barely perceptible to the average person".*

5.2.3 Vibration Criteria

Construction vibration is to be assessed in terms of:

- Human comfort
- Disruption to sensitive equipment
- Structural damage

Relevant management levels for each of these are detailed in the sections that follow.

Human Comfort

The DEC AVTG provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990. This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration plus targets for critical areas in hospital and educational buildings, and provides recommendations for measurement and evaluation techniques.

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent:

- **Continuous vibration** continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted rms acceleration values.
- **Impulsive vibration** is a rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
- **Intermittent vibration** can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

Examples of these vibration types are provided in Table 10 below.

Continuous	Impulsive	Intermittent
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

Table 10: Examples of vibration types

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 11. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
	Night time	0.14	0.10	0.28	0.2
Offices, schools, educational institutions and places of worship	Day or night time	0.40	0.28	0.80	0.56
Workshops	Day or night time	0.80	0.58	1.6	1.16
Impulsive vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
	Night time	2.0	1.4	4.0	2.8
Offices, schools, educational institutions and places of worship	Day or night time	13.0	9.2	26.0	18.4
Workshops	Day or night time	13.0	9.2	26.0	18.4

Table 11: Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. Table 12 sets out the acceptable VDV values for intermittent vibration.

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 12: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Sensitive Equipment

Areas with sensitive equipment are likely to require a higher degree of vibration isolation than the values in Table 11 & Table 12.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 13 details the VC curves applicable to a range of highly sensitive equipment that is to be referred to and considered in conjunction with manufacturer guidelines specific to each type of equipment.

Curve	Max Value 8-80Hz	Detail Size	Equipment Types / Requirements
	Microns / sec, rms	Microns	
VC-A	50	8	Bench Microscopes < 400 x Magnification, optical and other precision balances, coordinate measuring machines and optical comparators
VC-B	25	3	Bench Microscopes > 400 x Magnification, microsurgery and neurosurgery
VC-C	12.5	1	Electron Microscopes < 30,000 x magnification, magnetic resonance imagers and microelectronics manufacturing equipment
VC-D	6	0.3	Electron Microscopes > 30,000 x magnification, mass spectrometers and cell impact equipment
VC-E	3	0.1	Un Isolated laser and optical research systems

Table 13: VC Curves for Highly Sensitive Equipment

Figure 4 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 11.

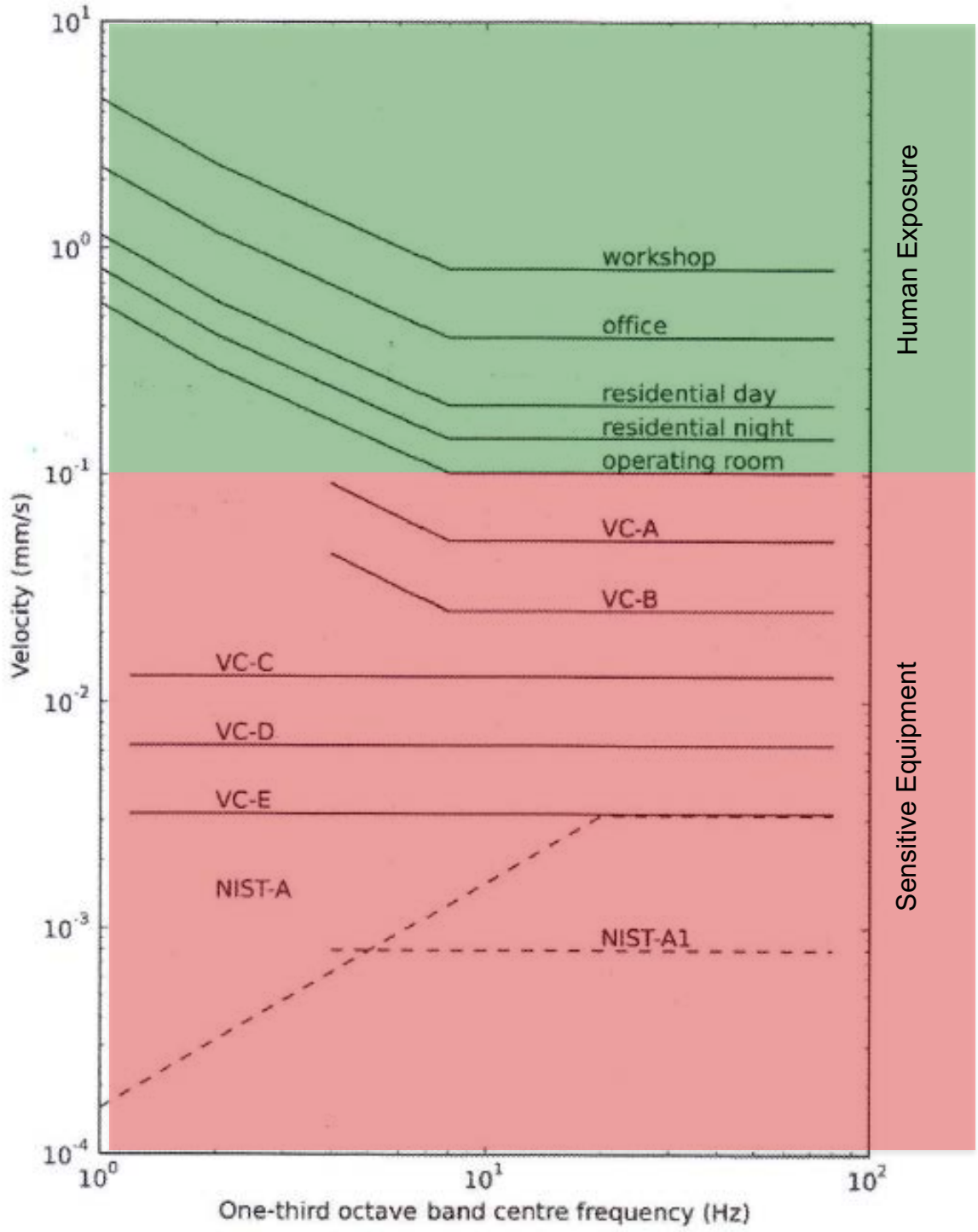


Figure 4: VC Curves - Source: ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration, Association of Noise Consultants (2012)

Structural Damage

Vibration-induced damage of buildings and structures is a common concern, but it is actually rare in practice. This explains why there is limited reliable data on the threshold of vibration-induced damage in buildings and there is no directly relevant Australian Standard. There are guidelines available in a number of international standards, although these vary significantly.

German Standard

The relevant German standard is *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures" (Feb 1999)*. This standard gives guidelines for short-term and steady state structural vibration. The short-term vibration limits as follows:

Structural type	Vibration Velocity, v_i, in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

Table 14: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Short-term Vibration

The guidelines note that: "*provided the values given in* Table 14 *are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of* Table 14 *are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.*"

British Standard

The relevant standard is BS7385: Part 2: 1993[5]. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the buildings:

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	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 15: Transient Vibration Guide Values for Cosmetic Damage

The standard states in Annex A, that ... *"the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance". It is recommended that buildings of importance be considered on a case-by-case* basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that would be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report would be prepared both pre and post exposure, both internally and externally.

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993, which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting (it is noted that blasting is not proposed for the Enabling Works). The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration would be examined on an individual basis. It is suggested that

in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

Summary

Table 16 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above[1]	Limit is for peak particle velocity y in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s[1]	For buildings particularly susceptible to vibration. Limit is for peak *resultant* particle velocity, measured on the ground adjacent to the structure

Table 16: Summary of vibration limits

Recommendations

It is clear from the above that relevant standards provide a wide range of suggested vibration limit values for structural damage, but the actual risk of vibration-induced damage is relatively low.

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project, whereby conservative vibration criteria are adopted in the first instance. It would be possible to relax these criteria if required, subject to review of specific buildings by a structural engineer and a regime of vibration monitoring.

The recommended precautionary vibration management levels are:

- 3 mm/s (130 dB re 10^{-6} mm/s) for buildings surrounding the Project identified as "sensitive". At this stage no structures at or surrounding the site have been identified as particularly sensitive to vibration-induced damage.
- 5 mm/s (134 dB re 10^{-6} mm/s) for residential dwellings.

- 20 mm/s (146 dB re 10^{-6} mm/s) for classrooms, non-precision laboratories and commercial premises.

These vibration management levels apply across the full frequency range of relevance (i.e. typically 1 Hz – 100Hz encountered in building construction).

Additional Vibration Management Levels

We understand that the following areas have sensitivity to vibration due to the occupancy / use or due to vibration-sensitive equipment. This list is not exhaustive and there may be other vibration-sensitive areas which would be identified during the preparation of a detailed CNVMP.

- JHH Building
    - Level 2
        - Audiology
        - Sleep Lab
        - Allied Health – Speech Pathology
        - Emergency Department – Medical Imaging
        - Medical Imaging (JHH and RNC buildings)
    - Level 3
        - Theatres
- HMRI

Detailed review of all potentially vibration sensitive receivers on campus will be carried out and objective requirements will be established including further consultation with the relevant stakeholders prior to works commencing on site and incorporated within the CNVMP prepared by the contractor.

5.3 Operational Noise Emissions

5.3.1 General Noise

NSW Noise Policy for Industry

The NSW NPI provides guidance on methodology for determining project-specific noise trigger levels or targets for external noise emissions from plant associated with a development.

The criteria have two components:

- Intrusiveness Noise Level – controlling intrusive noise impacts in the short term for residences.
- Amenity Noise Level (ANL) – maintaining noise level amenity for particular land uses for residences and other land uses.

Applying the more stringent of the two criteria provides the Project Noise Trigger Level (PNTL).

The NSW NPI considers the following when establishing the criteria:

- The existing Ambient (L_{eq}) and Background noise levels (L_{90}) that surround the site.
- The time of day that the noise generating development will be in operation, defined by the following:
    - Day (7am to 6pm).
    - Evening (6pm to 10pm).
    - Night (10pm to 7am).
- The type of receivers.
- The type of area that the development site and its nearest receivers are located. The NSW NPI provides recommended noise levels for specific receiver types and the type of area they are located within.
- The type of noise source and its characteristics. The NSW NPI provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

Further guidance on establishing the criteria can be found in the NSW NPI.

Noise Impacts on the Surrounding Community

Based on the measured noise levels detailed in Section 4 and in accordance with the methodology outlined in the NSW NPI (further described in Appendix C), Table 17 details the corresponding targets of allowable noise emission from external plant and equipment at the nearest receiver boundaries from the Hospital.

Receiver (External)	Period	Project Noise Trigger Level (PNTL) $L_{eq(15min)}$ dB(A)
Residential (East)	Day	46
	Evening	38
	Night	33
Residential (West / North)	Day	40
	Evening	38
	Night	33
Hospital Ward	When in use	43
Commercial Premises	When in use	58

Table 17: NSW NPI Project Noise Trigger Levels for external noise emissions from proposed development

Noise Impacts on the Existing JHHC

Redevelopment of any site must consider all neighbouring receivers. When the redevelopment site is an extension of an existing campus, neighbouring receivers will include existing "on-campus" buildings. However, compliance with the NPI PTNL in Table 17 is discretionary.

A target noise level of 55 dB(A) is recommended at external occupied and trafficable areas surrounding existing JHHC buildings. This is based on observations of pre-existing conditions made by Acoustic Studio during site inspections and noise surveys at the JHHC. This target also applies to external areas for the proposed ASB. We note that this is lower than existing plant noise levels measured within some areas of the existing JHHC (for example, close to plant areas such as existing cooling towers).

Applying these noise targets at the nearest JHH and HMRI buildings will generally achieve the PTNLs at other JHHC receivers.

5.3.2 Sleep Disturbance (Residential Receivers)

Noise sources with the potential for sleep disturbance are likely to occur during night-time (10pm to 7am) operational and construction works activities.

The NSW NPI provides guidance on the assessment of sleep disturbance based on the predicted event $L_{Aeq,15min}$ and/or L_{AFmax} noise levels at the receiver that are considered applicable to the SSDA. It suggests Sleep Disturbance Screening Criteria of:

- Event $L_{Aeq,15min}$ 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater, and/or
- Event L_{AFmax} 52 dB(A) or Night Time RBL + 15 dB, whichever is the greater.

If the $L_{Aeq,15min}$ noise level above background is less than 5 dB and/or maximum noise emergence above background is less than 15 dB, then the noise is considered unlikely to cause sleep disturbance. If the screening test level is exceeded, then further assessment of sleep disturbance effects is warranted.

The Sleep Disturbance Screening Criteria are presented in Table 18.

Residential Receiver Location	Period	Sleep Disturbance Screening Criteria	
		$L_{Aeq,15min}$ dBA	$L_{AFmax,}$ dBA
All	Night (10pm to 7am)	40	52

Table 18: Sleep Disturbance Screening Criteria

The Sleep Disturbance Screening Criteria $L_{Aeq,15min}$ and L_{AFmax} not exceeding the $L_{A90,\ (15\ minute)}$ by more than 5 dB(A) and 15 dB(A) respectively are screening criteria for the purpose of assessing potential impacts from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance Screening Criteria is exceeded, the detailed analysis is to cover the extent to which the noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the RNP.

Other factors that may be important in assessing the extent of impacts on sleep include:

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

A further consideration for sleep awakening is whether the environmental noise has changed. Section 5.3 "Response to a Change in Noise Level" of the RNP states:

"While people may express a certain tolerance for their existing noise environment, they may feel strongly about increases in noise. […] The difference in reported awakenings from sleep was equivalent to a difference of 7 dB(A) in maximum noise levels."

Section 5.4 of the RNP, "Sleep Disturbance", states that:

"From the research on sleep disturbance to date it can be concluded that:

- *Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep;*
- *One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly."*

The internal noise levels provided in the RNP are related to potential sleep awakening.

Typically noise impact assessments consider the worst-case scenario, including when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB(A) attenuation from outside to inside through the open window. This situation is considered likely during warmer seasons. When windows are closed, the likely sound attenuation through standard windows with poor seals (common in older houses) is approximately 20 dB(A).

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests (extract from RNP Section 5.4 above) that short term external noises of 60 to 65 dB(A) are unlikely to cause awakening reactions. In addition, external levels of 75 to 80 dB(A) are unlikely to affect health and wellbeing significantly, provided that these events occur no more than twice in one night.

Residential Receiver Location	Period	Sleep Awakening Level L_{AFmax}, dB(A)
All	Night (10pm to 7am)	60 to 65

Table 19: Sleep Awakening Level

5.3.3 Traffic Noise

NSW Road Noise Policy

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The relevant criteria is as per construction traffic noise criteria outlined in Section 5.2.2.

5.3.4 Emergency Helicopter Operation

Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an Environmental Impact Statement (EIS) for Designated Development, which would include a detailed assessment of noise impacts on the surrounding community.

This assessment provides a review of helicopter noise on the community surrounding the site and is detailed in Section 7.5.

5.4 External Noise Intrusion

5.4.1 Helicopter Noise

The NSW HI Engineering Services Guidelines (ESG) aim to provide a performance based guide for the development of design and specification documentation for health care facilities. The ESGs recommend internal noise level design criteria within hospitals for helicopter noise intrusion. Table 20 provides recommended maximum internal design sound levels corresponding to the key spaces within hospital buildings.

Room Type	Recommended Internal Helicopter Noise Levels L_{Amax} (slow) dB
Clinical	
Operating Theatre	65
Birthing Room or Delivery Suite	75
Intensive Care	65
Patient Room / Single Bed Ward	68
Multi Bed Ward	68
Toilet / En-suite	75
Patient Corridor	80
Counselling / Bereavement / Interview Room	65
Consultation Room	65
Speech and Language Therapy	65
Treatment / Medication / Examination Room	65

Room Type	Recommended Internal Helicopter Noise Levels L_{Amax} (slow) dB
Public Areas	
Corridors and Lobby Spaces	80
Cafeterias / Dining	80
Toilets	70
Waiting Rooms, Reception Areas	80
Multi Faith / Chapel	65
Staff / Back of House Areas	
Meeting Room	70
Board / Conference Room (Large)	70
Open Plan Offices	75
Private Offices	70
Multi Person Offices	75
Locker Room	-
Rest Room	75
Classrooms, Training Rooms	75
Lecture theatre	75
Library	80
Workshops	-
Plant Rooms	-
Laboratories	75

Table 20: Engineering Services Guideline (2017) – Recommended Internal Helicopter Noise Levels

6 Construction Noise and Vibration Assessment

6.1 Proposed Hours

Proposed construction hours for the Project are as follows and includes request for extended construction hours outside the ICNG Standard Construction Hours:

Proposed Construction Hours

- Monday to Friday –
    - 6:00am to 7:00am (Outside Recommended Standard Hours)
    - 7:00am to 6:00pm (Recommended Standard Hours)
- Saturday –
    - 7:00am to 8:00am (Outside Recommended Standard Hours)
    - 8:00am to 1:00pm (Recommended Standard Hours)
    - 1:00pm to 5:00pm (Outside Recommended Standard Hours)
- Sunday and Public Holidays – No works.

In order to minimise disruption to the community, the above extended hours are proposed for normal construction activities.

The works are critical public infrastructure being delivered to provide essential health services to the local Newcastle, Hunter New England Local Health District and Northern NSW communities. Extended construction hours are needed in order to:

- Reduce the length of the project in order to meet the critical project delivery timeframes driven by:
    - The need to provide clinical services to meet the significant forecast population growth, ageing population and Socio-economic status of residents within the JHHIP's tertiary catchment;
    - The need to replace current infrastructure to provide contemporary patient centred models of care in the delivery of Level 6 tertiary services;
    - Significant increased demand for acute, sub-acute and ambulatory health services.
- Allow construction vehicles to avoid peak road network times and shift changeover times to reduce the impact on the surrounding road network;
- Minimise the impact on hospital operations during core business hours such as planned surgery and outpatient clinics

The impacts of the extended hours has been considered as follows:

- Given the remote location of the development and absence of residential sensitive receivers nearby, there is minimal additional acoustic impact for the conservative additional construction hours, the nearest residential receivers are located more than 300m away. Predicted worst case construction noise levels at residential receivers are not loud in an absolute sense when compared to the pre-existing ambient levels at these locations, which are of a similar noise level.
- The pre-existing background noise levels measured during the proposed extended construction hours are consistent with background noise levels during standard construction hours and therefore the relative impact of construction noise during the extended construction hours is expected to be minimal.
- All feasible and reasonable mitigation measures will be implemented to minimise noise impact during extended construction hours. This includes ensuring that noise intensive works such as excavation and hammering are not carried out during these periods.

These drivers strongly support the requirement for extended construction hours.

For work outside the proposed extended construction hours an out of hours work procedure will be implemented as part of the construction noise and vibration management plan.

The Contractor will agree the process with HI, LHD, TfNSW, RMS and City of Newcastle to address the approvals and additional measures required prior to scheduling any out of hour's works. Therefore, these working hours have been excluded from this assessment.

6.2 Description of Proposed Works

An indicative construction works program has been developed that outlines the key activities in each particular location. Based on this, it is anticipated that the key activities to occur for each area / stage are as follows:

Enabling Works

- Construction access roads
- In-ground services diversion / reticulation (Water, Fire, Electrical, Stormwater, Mechanical etc)
- Civil infrastructure works, including but not limited to
    - Site Clearing (entire site)
    - Bulk Earthworks
    - Detention and Sedimentation Basins & Controls
- Mines Grouting
- Shoring

Stage of Work (Period)	Main Tasks	Typical Plant
Enabling Works (12 Months)	Construction of access roads	Vibratory Roller / Compactor / Grader / Excavators / Bobcats / Skip Trucks Concrete Trucks / Concrete Pumps
	Services Diversion / Reticulation	Jackhammer / Excavator / Grinder / Saws / Drills
	Site Clearing	Chain saw / Wood Chipper / Bobcats / Skip Trucks
	Bulk Earthworks	Excavators / Backhoe / Bobcats / Skip Trucks / Rock Breaker
	Excavation	Excavators / Backhoe / Bobcats / Skip Trucks / Rock Breaker
	Detention and Sedimentation Basins Controls	Excavators / Backhoe / Bobcats
	Mines Grouting	Drilling Rigs / Concrete Trucks / Concrete Pumps / Concrete Batching Plant
	Shoring	Mobile Crane / Hand Tools / Excavator

Table 21: Enabling Works

Main Works

- Construction of New Acute Services Building
- New linkway between existing JHH and ASB
- Refurbishment of existing JHH areas
- Civil infrastructure works, including but not limited to:
    - Internal road network
    - Works to existing at-grade car parking
- Landscape works
- New Hospital Entry Canopy
- Link bridge to HMRI

Stage of Works (Period)	Main Tasks		Typical Plant
Main Works (>12 Months)	Internal Roads		Vibratory Roller / Compactor / Grader / Excavators / Bobcats / Skip Trucks Concrete Trucks / Concrete Pumps
	Piling works		Piling Rigs
	Foundation		Forklift / demo saw / mobile crane / concrete mixer truck/ concrete vibrator
	Structure	Formwork	Tower crane / mobile crane / hand tools / drill
		Concrete cores	Concrete mixer trucks / concrete pump / concrete vibrator
	Façade & Roof	Installation of façade and glazing	Drill / hand tools / mobile crane / tower crane
		Roofing	Hand tools / drills / tower crane / angle grinders / circular saw
	Fitout	Essential services	Hand tools / hammer drill / concrete mixer / demo saw / circular saw / angle grinder
		Fitout and finishes	Cement mixer / masonry saw / Hand tools / circular saw / angle grinders
	Major External	Linkway	mobile crane / hand tools / drill
		Canopy	
	Landscaping		Excavators / bobcats / skip trucks
	External works		Demo saw / excavators / hand tools / drills / angle grinders / hammer drill / mobile crane / tower crane

Note: Items shaded in grey are works to be carried out internally within the building

Table 22: Main Works

6.3 Construction Noise

The following sections outline the preliminary assessment carried out for construction noise emissions.

6.3.1 Noise Sources

The key noise sources for the activities occurring during construction works and the associated equipment sound power levels are listed in Table 23. These values are based on Acoustic Studio's database and the relevant Australian and International Standards including AS2436:2010 and BS5228-1:2009.

Equipment Type	Item	Typical Noise Level $L_{eq,15min}$ dB(A) SWL
Heavy Vehicles	Concrete Mixer trucks	109
	Hiab Truck	111
	Dump Truck (20 Tonne 35-50 Tonne)	107
	Dump Truck (Tipping Material)	117
	Delivery trucks (semi-trailers, rigid trucks)	105
	Tipper / Skip Truck	111
Site Machinery	Mobile Crane	111
	Tower Crane	108
	Bulldozer (D7, D9, D10)	113
	Bobcat	110
	Excavator (w/bucket) / Backhoe / Front Loader	113
	Excavator (with rock breaker / rock saw – up to 40 tonne)	119
	Wood Chipper	117
	Compactor	110
	Grader (Cat 825)	107
	Vibratory Roller	107
	Forklift	104
	Piling / Drill Rig	113
	Concrete pump	110
	Concrete Vibrator	101
	Concrete Batching Plant	110

Equipment Type	Item	Typical Noise Level $L_{eq,15min}$ dB(A) SWL
Hand Held Tools	Angle Grinder	101
	Drill	91
	Hammer Drill	104
	Jackhammer	110
	Hand Tools (Electric)	99
	Circular saw	112
	Chain Saw	114

Table 23: Anticipated airborne noise levels for equipment / plant during construction works

Potential sources of vibration and ground-borne noise during the Project works include:

- Rock breaking and excavation.
- Vibratory Rollers
- Drilling for Mines grouting
- Piling Works

Vibration and ground-borne noise impacts are likely to be highest during the excavation stages of the Project, when equipment such as rock breakers and jackhammers are used. Rock breaking and hammering are potential methods for bulk earthworks and excavation. Where practical, the contractor should aim to implement alternative low noise and vibration methods.

6.3.2 Sensitive receivers

Nearest sensitive receivers to the Project Site that will be potentially affected by noise and vibration are surrounding residential, commercial and educational premises as presented in Section 2.

Table 24 outlines the most critical receivers surrounding the site for each type of impact.

Receiver		Impact	Location	Typical Worst Case Distance from construction site (m)
Residential		Airborne	East	400
		Airborne	West	300
		Airborne	North	
HMRI	Offices	Airborne + Vibration	West	25 to 130
Existing JHH Buildings	Hospital Wards and Operating Theatres	Airborne + Vibration	South	20 to 110
Private Hospital Campus Buildings		Airborne	East	220
Childcare		Airborne	East	440
Commercial / Offices		Airborne	East	330

Table 24: Noise sensitive receivers and approximate distance to Project construction works site

6.3.3 Construction Noise Assessment Methodology

A preliminary assessment of the likely noise impacts of the proposed works on the most-affected receivers surrounding the site has been carried out.

The assessment has considered the following:

- Typical activities considered in the noise impact assessment are as detailed in Section 6.2.
- Project specific Noise Management Levels at each sensitive receiver location as outlined in Section 5.2.
- Noise level predictions are calculated using the noise data provided in Table 23. Where multiple plant types exist (such as trucks) typical worst-case levels are applied.
- Noise level predictions consider:
    - Distance attenuation
    - Shielding
    - Ground and building reflections
- The noise level predictions are based on assumptions that represent the worst-case scenario.
- L_{Aeq} noise levels are predicted for the operations of the nearest works area on the site to each of the nearest sensitive receiver location.
- Predictions consider the typical worst-case distances in Table 24.
- The predictions consider individual tasks and associated equipment with a range from the nearest construction site boundary (for receivers on campus that are adjacent to the site) and the centre of construction site.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period to provide a worst-case assessment, unless otherwise stated.

6.3.4 Assessment Results

Construction Noise

Table 25 presents the results for the construction noise assessment at surrounding receivers based on typical plant and equipment outlined in Section 6.3.1 operating within the boundary of the construction works site.

Location	Residential		HMRI	Existing JHH Building	Private Hospital	Childcare	Commercial
	East	West / North					
NML	51[6] / 46[7]	45[6] / 40[7]	70	65	65	60	70
Construction	Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)						
Trucks	41	53	61 - 75	62 - 77	56	50	53
Concrete Mixer Truck	39	51	59 - 73	60 - 75	54	48	51
Mobile Crane	41	53	61 - 75	62 - 77	56	50	53
Compactor	40	52	60 - 74	61 - 76	55	49	52
Grader / Roller	37	49	57 - 71	58 - 73	52	46	49
Excavator with Hammer	49	61	69 - 83	70 - 85	64	58	61
Excavator with bucket / Backhoe / Front loader	43	55	63 - 77	64 - 79	58	52	55
Bobcat	40	52	60 - 74	61 - 76	55	49	52
Concrete Pump	40	52	60 - 74	61 - 76	55	49	52
Jackhammer	40	52	60 - 74	61 - 76	55	49	52
Drilling / Piling Rig	43	55	63 - 77	64 - 79	58	52	55
Concrete Vibrator	31	43	51 - 65	42 - 67	46	40	43
Batching Plant	40	52	60 - 74	61 - 76	55	49	52
Grinder	31	43	51 - 65	42 - 67	46	40	43

[6] Project specific "Recommended Standard Hours" NMLs for Monday to Friday and Saturday

[7] Project specific "Outside Recommended Standard Hours" for Monday to Friday and Saturday

Location	Residential		HMRI	Existing JHH Building	Private Hospital	Childcare	Commercial
	East	West / North					
NML	51[6] / 46[7]	45[6] / 40[7]	70	65	65	60	70
Construction	Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)						
Hand Tools / Drills	29	41	49 - 63	40 - 65	44	38	41
Chain / Circular Saw	44	56	64 - 78	65 - 80	59	53	54
Wood Chipper	47	59	67 - 81	68 - 83	62	56	59
Forklift	34	46	54 - 68	55 - 70	49	43	46

Table 25: Predicted equipment/plant noise levels at the nearest surrounding community receiver locations – Levels predicted to exceed the NMLs during "Recommended Standard Hours" are in red and levels predicted to exceed NMLs "Outside Recommended Standard Hours" (only applicable to residential receivers) are in blue.

Construction Traffic Noise

As described in Section 5.2.2 and as per the RNP, an increase in the traffic noise level of up to + 2dB in relation to the existing traffic noise level is considered to be a minor impact and barely perceptible to the average person.

When considering existing traffic volume data for the roads surrounding the, the allowable target of increase in traffic volume to maintain an increase of less than 2 dB are as shown in Table 29 based on information from GTA Consultants (GTA) plus a review of the *"John Hunter Health and Innovation Precinct, State Significant Development Application, Traffic Impact Assessment"* prepared by GTA.

Road	Existing Traffic Volume (2019)			Allowable Target of Increase in Traffic Volume		
	Period					
	Peak Hour		Typical Daily	Peak Hour		Typical Daily
	am	pm		am	pm	
Lookout Road	4031	3928	48000	2357	2297	28000
Kookaburra Circuit	1531	1345	14000	895	786	8150
Jacaranda Drive	272	251	2000	159	147	1150

Table 26: Indicative limit of increase in traffic volume due to addition of construction traffic, in order to maintain an increase in traffic noise level of less than 2 dB(A).

Based on the Traffic Impact Assessment[8] we understand the following with regard to construction workers and parking:

- Given the site's proximity to public transport services, workers will be encouraged to use public transport to access the site where practical.
- A small amount of parking may be available on site, this will be limited to the construction compound.
- Construction workers will not be allowed to park within the JHHC or associated road network.
- Construction worker arrivals and departures will be minimised during peak hours. Health Infrastructure will work with the contractor to explore further initiatives such as park and ride shuttle bus services and encourage car-pooling.

Traffic Noise Generation from Light and Heavy Vehicles

Based on the Traffic Impact Assessment[8], anticipated light and heavy vehicle generation is as follows:

- Light Vehicles
    - Traffic generation will be largely generated by construction worker movements to and from the site.
    - As noted above, construction workers for both stages is currently unknown. Notwithstanding, limited parking will be available on-site, with workers to be encouraged to use public transport to access the site. As such, light vehicle traffic generation associated with construction workers will be minor and expected to be well within the allowable target of increase in Table 26.
- Heavy Vehicles
    - Early Works - 15 to 20 heavy vehicles at one time during enabling works, with peak activity potentially increasing to 30 to 40 vehicles per day.
    - Main works - up to 120 vehicles per day can be expected. These movements would likely be spread across the day.
    - Heavy vehicles would include concrete trucks, articulate haul or delivery trucks.

Based on the above, volumes of construction traffic are expected to be well below the allowable target of increase in traffic volumes outlined in Table 26 that is referenced to the RNP. When factoring in higher noise levels from heavy vehicle on campus, plus the

[8] *"John Hunter Health and Innovation Precinct, State Significant Development Application, Traffic Impact Assessment"* prepared by GTA.

campus speed limits, the increase above existing traffic noise levels is expected to be less than 2 dB.

Further to the above, once the Contractor is engaged on this project, a detailed understanding of construction traffic vehicle generation will be confirmed and included in the CNVMP.

Cumulative Noise Impact

Construction of the Newcastle Inner City Bypass (NICB) is currently underway at various locations surrounding the JHHC. As the construction of the NICB progresses, there may be times that construction of the NICB at locations nearby to the Hospital occurs in line with the Project.

At this stage information on the timing and progression of the NICB works nearby to the Hospital and noise sensitive receivers around the hospital is not confirmed. The Contractor will need to collaborate with NICB proponent and construction works in the vicinity of the hospital to minimise cumulative impacts of noise and vibration and be captured in the CNVMP to include:

- Coordination with timing of NICB works where cumulative impact needs to be considered and managed against NMLs / VMLs.
- Predictions of noise impact from concurrent works.
- Coordination with NICB works respite periods.
- Coordination of traffic routes to minimise impact.
- Coordination of community consultation.

6.3.5 Summary of Noise Assessment Findings and Discussion of Noise Controls During Construction

Based on the results from the high-level assessment based on the indicative works, we make the following comments:

- Construction works noise impacts will be greatest at on Campus noise receivers including the existing JHH and HMRI buildings. Noise from various plant and equipment operating individually are generally predicted to be above the NMLs due to the proximity to the nearest affected receivers. The worst-case noise impacts are for excavators with hammers with noise levels predicted to be above the NMLs by up to 20 dB.
- Noise levels from operations of various plant and equipment are predicted to be up to 15 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NMLs depending on the distance to the receiver.
- Construction noise impacts at residential receivers are the highest beyond bushland to the west and north of the JHH. The worst-case noise impacts are for excavators with hammers which are up to 16 dB above NMLs (construction noise target) during Recommended Standard Hours and 21dB Outside Recommended Standard Hours due to the low RBL (background noise level) at these residential receiver locations. These levels between 50 to 60dB are not loud in an absolute sense and are consistent with the pre-existing ambient noise levels at these receiver locations. Further attenuation can be expected from absorption across bushland which is not included in predictions. Therefore, noise impact is not expected to be significant. It is also noted that these noise levels are also well below the 75dB(A) Highly Affected Noise Levels outlined in the Interim Construction Noise Guideline (ICNG).
- Generally, for all other receivers identified (both on and off campus), the noise generated from the construction works noise from individual equipment operating is below the Highly Noise Affected Level and generally able to meet the NMLs when further away from the perimeter boundary.
- Where NMLs are exceeded, mitigation measures to be considered and incorporated where reasonable and feasible would include:
- Schedule noisy activities to less sensitive times of the day for each nominated receiver (i.e. daytime hours).
- Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on and 1 hour off.
- The predictions for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and hammers, and the proximity to on campus sensitive receivers (some of which are within 20m).

- Construction traffic along the roads surrounding the site will meet applicable road noise targets on nearby receivers during the day-time period.
- Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when NMLs cannot be met due to safety or space constraints.

It is important to recognise that the actual noise levels generated during the construction works are likely to vary considerably depending on many factors including:

- Number of items of plant and equipment operating simultaneously.
- Location of equipment on the site – relative to the noise-sensitive receivers.
- Shielding of noise provided by structures and hoardings on and around the site.
- Reflections provided by existing structures on and around the site.
- Meteorological conditions.

When construction and excavation works are likely to exceed stated criteria at nearest sensitive receivers, particularly when works occur in the areas closer to the nominated receiver, all feasible and reasonable noise control measures are to be considered.

If, during construction works, an item of equipment exceeds either the NML at any location or the maximum recommended equipment noise levels, the following noise control measures, together with construction best practices presented in Section 6.5 shall be considered to minimise the noise impacts on the neighbourhood:

- Consider implementing equipment-specific temporary screening for noisy equipment, or other noise control measures recommended in Appendix E of AS2436. This is most likely to apply to noisier items such as jackhammers.
- For large work areas, solid screening or hoarding as part of the worksite perimeters would be beneficial.
- Locate specific activities such as carpentry areas (use of circular saws etc) to internal spaces or where shielding is provided by existing structures or temporary screening.
- Managing the arrival of trucks and heavy vehicles on site at any given time (through scheduling deliveries at different times).
- Unnecessary idling of vehicles and equipment is to be avoided.
- Traffic routes are to be prepared to minimise the noise impact on the community (such as entry and exit point at different locations on the site and access via separate roads where practical).

- When loading and unloading trucks, adopt best practice noise management strategies to avoid materials being dropped from a height.
- Adopt quieter methodologies. For example, where possible, use concrete sawing and removal of sections as opposed to jackhammering.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc), not specifically identified in this assessment, incorporates silencing/shielding equipment as required to meet the noise criteria.

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

It is recommended that a comprehensive CNVMP is prepared further to this assessment. The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

6.4 Construction Vibration

When considering the vibration impact associated with construction works, the following is to be taken into account.

- The type of vibration generating equipment.
- Geotechnical characteristics of the site.
- The layout of the site, including the location of static sources of vibration.
- Techniques used in construction to minimise generated vibration levels.
- Hours of work with regard to the nature of operations in the affected buildings and the duration of the works.

6.4.1 Summary of Vibration Assessment and Discussion of Vibration Controls During Construction

A detailed vibration assessment has not been carried out at this stage, as actual vibration levels experienced will be dependent upon

- Site and strata characteristics.
- Specific construction equipment used.
- Vibration requirements of sensitive equipment.

Activities that have the potential to generate ground-borne vibration during the construction works include:

- Excavator hammer

- Vibratory roller
- Jackhammer
- Piling

Based on the scope of works and typical equipment required, some human perception vibration impacts are expected and there is requirement to review works processes during detailed works planning to ensure that minor cosmetic impacts to structures are avoided – particularly from the use of excavators with hammers near the existing JHHC buildings. In addition, there is potential for vibration impacts on sensitive equipment. The significance of these impacts will need to be determined as part of the CNVMP prepared by the Contractor.

Final details of the vibration management controls required for the works would be determined when the CNVMP is prepared by the Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment.

In addition to the assessment of structural and human perception vibration, the CNVMP prepared by the Contractor must ensure, at the relevant on campus buildings (including but not limited to the existing JHH, HMRI, Private Hospital) and other Hospital campus areas where sensitive equipment is operated, that the equipment-specific vibration criteria are set and managed accordingly.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. Site law tests will help determine allowable working distances from structures to manage vibration.

If the assessment indicates that vibration levels might exceed the relevant criteria, then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures.

On campus buildings present the most stringent vibration criteria, particularly given their proximity to the Project Site. Controlling vibration at these receivers will also ensure that vibration criteria at all other receivers will also be satisfied.

The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

6.5 Control elements

6.5.1 Noise

As a general rule, prevention is to be applied as universal work practice at any time of day, but especially for the occasional construction works to be undertaken at critical times outside normal daytime/weekday periods.

It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise mitigation/minimisation. Providing treatments at the affected residences or other sensitive land uses is to be only considered as a last resort. Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
  - Use quieter methods.
  - Use quieter equipment.
  - Operate plant in a quiet and effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Maintain equipment regularly.
  - Where appropriate, obtain acoustic test certificates for equipment.
- On-site noise management
  - Strategically locate equipment and plant.
  - Avoid the use of tonal reversing alarms or provide for alternative systems (such as broadband reversing alarms).
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
  - Brief Project staff and workers on the noise sensitivity of the neighbours to the site, particularly the residents nearby. The staff and workers need to be mindful of the noise from their discussions and colour of the language, particularly in sensitive periods, for example, during the pre-start times or "toolbox talk" as they gather to commence for work in the morning.
- 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.
- Work scheduling

- Schedule activities to minimise noise impacts.
- Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
- Keep truck drivers informed of designated routes, parking locations and delivery hours.

6.5.2 Vibration

At this stage, we anticipate that construction works will result in some structural and human perception vibration impacts at surrounding receivers – particularly from the use of excavators with hammers near the existing JHH and HMRI buildings.

Vibration management controls required for the works would be determined when the CNVMP is prepared by the Contractor.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels will then need to be put in place. An additional review of vibration mitigation measures and vibration criteria may then be necessary.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on-site.

The following considerations shall be taken into account:

- Modifications to excavation and construction equipment used.
- Modifications to methods of excavation and construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

6.5.3 Vibration surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks are to be carried out on site at the outset of each key vibration generating activity (if vibration is considered to be an issue).

Shortly before the commencement of each activity, the background vibration level is to be measured and again once the activity has begun. If the survey indicates levels of vibration exceeding those expected, the vibration management strategy for that process is to be re-assessed.

6.5.4 Additional Noise and Vibration Control Measures

All practical means should be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

If, during construction, an item of equipment exceeds either the NML at any location or the maximum recommended equipment noise levels, the following noise control measures, together with construction best practices presented in Section 6.5.1, shall be considered to minimise the noise impacts on the neighbourhood.

- Modifications to construction equipment used:
    - Avoid the use of large excavators – use the smallest size practicable;
    - Avoid the use of vibratory rollers – switch off vibration mode, or use the smallest size practicable if vibration must be employed;
    - Avoid the use of tracked vehicles on site, where practicable, particularly large tracked excavators and cranes – use vehicles with tyres.
- Modifications to methods of construction:
    - Saw cutting can be considered for rock removal rather than conventional rock hammering techniques to limit vibration when close to vibration sensitive locations.
- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, residential receivers are likely to be more sensitive to noise before 9 am than the other receivers.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix E of AS2436.
- 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 assessment incorporates silencing/shielding equipment as required to meet the noise criteria.
- Minimise noise from workers as discussed in Section 6.5.1.

Implementation of all reasonable and feasible mitigation measures for all construction 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.

6.6 Noise and vibration monitoring

6.6.1 Noise monitoring

The Contractor is to consider implementing environmental noise monitoring at the locations described below.

- West or North Boundary Residential Receivers
- On campus John Hunter Health Campus Receivers.

An allowance of 1.5 days per week, at least, is to be dedicated to monitoring of noise and vibration for the first four weeks of construction works. Further monitoring is to be reviewed after this time or sooner should it be deemed necessary by the acoustic consultant and the Project Manager. This is to take place mainly at the above locations although other locations and plant and equipment monitoring are to take place as and when necessary. If results indicate vibration levels exceeding allowable VMLs appropriate action is to be taken.

6.6.2 Vibration monitoring

A vibration monitoring system is to be implemented if required. This system would monitor vibration levels when there is potential for them to change. This could happen in various situations, such as, changes in equipment and activities or changes to work procedures that might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding VMLs appropriate action is to be taken.

6.6.3 Reporting

The Contractor is to prepare a noise monitoring report each month for review by the Project Manager. The reports are to summarise and interpret the results of the noise and vibration monitoring carried out during the past month.

6.6.4 Communication and complaints

The Contractor is to establish a communication register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition, the following procedures are an example of the procedures that are to be specifically adopted for complaints relating to noise.

Upon receipt of a complaint the Contractor is to:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the predicted noise level, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

If the activity is occurring outside normal working hours, the activity is to be immediately stopped. Where stopping the activity would create a safety issue the activity may be permitted to continue only as long as is necessary to make the area safe. The activity is to then cease.

Any activity that is directed to cease due to excessive noise is not to recommence until the Project Manager is satisfied that the noise and vibration target requirements can be met and has given permission to recommence the activity.

The Site Supervisor is to ensure that a report of any incident is provided to the Project Manager.

The Project Manager is to provide a report on the incident to the relevant stakeholders.

The Contractor is to provide a 24-hour telephone contact number and this number is to be prominently displayed on the site.

6.7 Non-compliances

Non-compliance reports can be used as appropriate to deal with failures to meet the construction noise and vibration management and control requirements.

7 Operational Noise and Vibration Assessment

7.1 General

The following outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers

The layout and design to minimise noise impact include:

- A Helicopter Landing Site (HLS) will be located on the ASB roof on the west most wing to provide for arrival and departure path requirements. This provides the maximum practical elevation from residences and other noise sensitive receivers.
- A new western and northern road is proposed for the campus. The road is located whilst maintaining a separating buffer with bushland to the northern residential receivers. This long-term strategy has been developed to integrate with the new inner-city bypass. This will allow for access from the west (currently restricted to the east) which will provide a distribution of traffic movements and untangling of current user flows. In addition, noise from the proposed roads will be negligible when compared to the noise from the new inner-city bypass.
- Ambulance and public Emergency Department drop off are located between the new ASB and existing JHH. The building provides shielding and separation from surrounding noise sensitive receivers.
- Semi-basement carparking limits the impact of carpark noise emissions to surrounding receivers.
- The proposed ASB leverages existing functionality from the existing hospital to maintain the consolidated loading dock in its existing location, removing the need to provide an additional loading dock.
- Strategies for control of noise emission from plant and equipment include:
    - Selecting plant and equipment without any annoying characteristics such as low frequency or tonality (which can often be associated with pumps and chillers).
    - Locating of plant strategically (basement, interstitial and on roof) to ensure that the cumulative noise contribution at the receiver boundary is achieved. Where practical, plant will be located facing away from the nearest noise sensitive receivers or controls will be provided as required to reduce noise impact.
    - Noise mitigation / control measures that are allowed for in the design (generally for plant and equipment) may include:

- Noise enclosures or barriers / screening as required.
- Acoustic louvres as required.
- In-duct attenuation.
- Sound absorptive panels.

7.2 Operating Hours

Once the construction of the Hospital is completed, the premises are to operate 24 hours a day, seven days per week.

7.3 Building Services

It is recommended that allowances are made for the following external noise controls for buildings services proposed for the Hospital.

7.3.1 Mechanical Plant and Equipment

Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 5 of this report.

Major plant is currently proposed to be located in the following areas:

- Level B4 – Plant Rooms (Chillers / Generators / Substation / Fire Services)
- Level 2 – Plant Rooms (Air Handling Units)
- Level 7 - Plant Rooms / Rooftop Plant (Air Handling Units /Medical Plant/ Cooling Towers / fans)

At this stage, final plant selections have not been made, therefore, a detailed assessment has not been carried out. Any plant selections will be reviewed in Detailed Design to ensure that noise emissions meet the applicable environmental noise criteria.

Acoustic Studio has carried out a preliminary review and makes the following comments:

General

- The current Proposal includes plant rooms on multiple levels including rooftop plant.
- The nearest potentially affected receivers are on campus receivers including HMRI, existing JHH and Private Hospital Buildings. Achieving compliance at these receivers will also ensure compliance is achieved at all other noise sensitive receiver locations;
- The plant will potentially operate 24 hours a day, 7 days a week.

- The most restrictive night time criterion for 24hrs plant operations is 43 dB(A) at hospital wards. Considering the distance to receivers in other catchments, achieving this criterion for each building will ensure compliance with the relevant criteria at all other receivers;
- Plant rooms and external plant should be designed to achieve 70 dB(A) at 1m from a plant room opening with a direct line of site to the nearest residential receiver will generally ensure that the most stringent criteria can be achieved. This level is indicative and will depend on actual location and orientation. Plant may exceed 70 dB(A) at 1m depending on specific location, shielding and noise controls that may be applied. Treatment to be considered may include
    - Plant Rooms - sound absorptive lining internally and / or acoustic louvres.
    - External Plant – enclosures / screens

During the Detailed Design phase, acoustic detailed design advice will provide to the architect and services engineers to ensure that noise emissions from plant and equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

General design considerations and controls that may need to be implemented typically include, but are not limited to:

- Strategic selection and location of plant to ensure the cumulative noise contribution at the receiver boundary is achieved, and/or
- Noise control measures to be put in place to minimise noise impacts such as:
    - Noise enclosures or barriers/screening as required.
    - Acoustic louvres as required.
    - In-duct attenuation.
    - Sound absorptive panels.

The following outlines allowances that have been included based on the current proposals. Actual treatments may change (and still achieve the relevant noise emissions targets) depending on final locations, orientation and equipment selections.

Cooling Towers (Level 7)

The current cooling tower selection is based on a low sound fan selection with a sound pressure level of 67 dB(A) at 15m. Based on the selection and proposed screening around rooftop plant, no further treatment is required to achieve the relevant criteria at the nearest receiver boundaries.

Emergency Generators (Basement Level 4)

The current design option includes a generator plant room to house generators on Basement Level 4.

Noise controls allowed for include:

- Masonry walls (minimum 140 mm concrete block or equivalent).
- Attenuators to intake and exhaust to achieve a maximum 75 dB(A) at 1m
- Manufacturer provided silencers to mufflers to achieve a maximum 75 dB(A) at 1 m.

7.4 Operational Noise – The Use

Operational noise emissions will include:

- Activities associated with the use – there will be potential noise impacts from hospital operations on nearby residential receivers. In particular, these noise impacts are expected from:
    - Traffic volumes arising from:
        - Increased public and staff
        - New Campus Roads
        - Emergency vehicles (Ambulances)
    - Emergency helicopters and new flight paths

7.4.1 New Campus Roads

The works include the construction of internal road networks as shown in blue on in Figure 5 which includes:

- Western Link Road
- Carpark 4 Extension
- Northern Access Road
- Southern Roundabout
- ASB Driveway

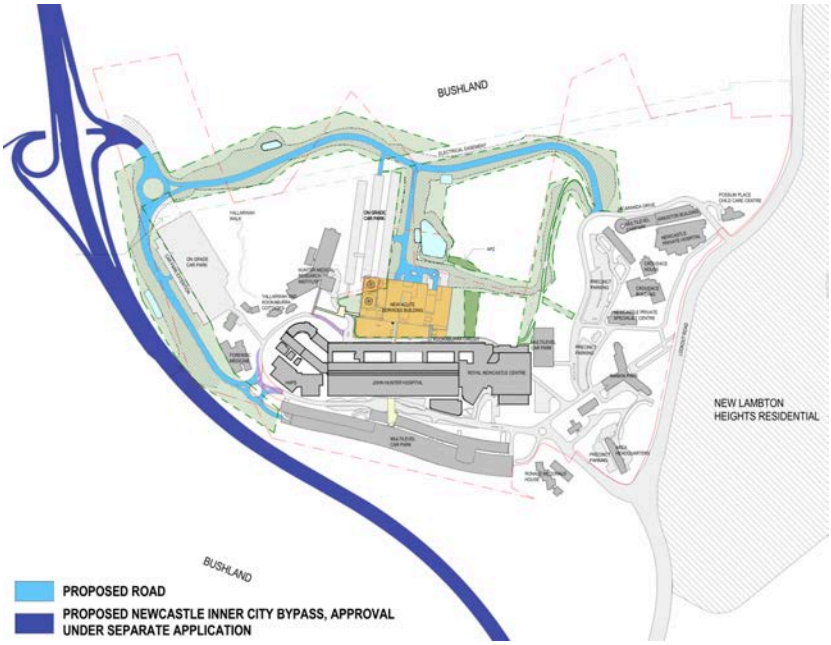


Figure 5: Proposed New Roads

We make the following comments with regard to the noise impact from the new Western Link and Northern Road as the main thoroughfare roads as part of the new network.

- When considering the existing Kookaburra Circuit we note the following:
  - Current peak hour volumes are 1531 (am) and 1345 (pm).
  - Afternoon peak traffic was measured to be 62 dB(A) @ 7m from the road.
- Following completion of the NICB, vehicles entering the site from the bypass and Western Link will account for the majority of existing JHHC traffic generation.
- The following outlines predicted traffic flows and corresponding noise levels from the new Western Link, Western and Northern Road.

Road / Street		Peak Hour Traffic Volume (With Bypass + ASB)	Predicted Traffic Noise (dBA @ 7m)	Complies?
Western Road	am	954	60	Yes
	pm	920	60	Yes
Northern Road	am	252	54	Yes
	pm	460	57	Yes

Table 27: Traffic generation and noise from proposed Western and Northern Roads

- Based on the above, noise impact from traffic generation on the new campus roads are within the relevant criteria when predicted at 7m and therefore will be well within the relevant targets at residential receiver locations.

7.4.1 Traffic Noise Generation (Off Campus)

Acoustic Studio has considered additional traffic noise generation impacts (associated with the new ASB and new internal roads) on streets surrounding the Project.

Following a review of the Traffic Impact Assessment[9] and data provided by GTA, we make the following comments:

- The new inner-city bypass is expected to be completed and operational at a similar time to the proposed ASB. Redistribution of traffic as a result of the inner-city bypass will reduce traffic volumes on existing roads as follows:
    - Traffic on Lookout Road north of McCaffrey Drive reduced by up to 39%.
    - Traffic on the existing John Hunter Health Campus access (Kookaburra Circuit) reduced by around 62%.

Based on the above comments, the predicted increase in traffic and activities associated with traffic have been considered to assess the traffic noise expected to be generated by the Project.

The predicted worst-case traffic volumes on streets surrounding the Project are presented in Table 28, which are based on the Traffic Impact Assessment[9].

Road / Street	Scenario	Peak Hour Vehicle Trips			
		Existing Traffic 2019		Predicted Traffic 2026	
		am	pm	am	pm
Lookout Road	No ASB Traffic	4031	3928	2459	2396
	Additional ASB Generated Traffic	-	-	105	56
Kookaburra Circuit	No ASB Traffic	1531	1345	582	511
	Additional ASB Generated Traffic	-	-	74	39
Jacaranda Drive	No ASB Traffic	272	251	227	251
	Additional ASB Generated Traffic	-	-	31	17

Table 28: Predicted traffic volumes on streets surrounding the Project

[9] *"John Hunter Health and Innovation Precinct, State Significant Development Application, Traffic Impact Assessment"* prepared by GTA.

Considering the predicted traffic volumes in Table 28, the increase in traffic noise is predicted and compared against the RNP criteria of relative traffic noise increase as presented in Table 29.

Road / Street		Peak Hour Traffic Volume		Increase in Traffic Noise (dBA)	Complies?
		Existing 2019 (no ASB)	2026 (With ASB + Inner City Bypass)	Target ≤ + 2dB(A)	
Lookout Road	am	4031	2564	-1.9	Yes
	pm	3928	2452	-2.0	Yes
Kookaburra Circuit	am	1531	655	-3.7	Yes
	pm	1345	550	-3.9	Yes
Jacaranda Drive	am	272	281	+0.1	Yes
	pm	251	259	+0.1	Yes

Table 29: Predicted traffic noise levels increase streets surrounding the Project.

Based on the above predictions, general traffic generated on Lookout Road, Kookaburra Circuit and Jacaranda Drive associated with the ASB will have no adverse noise impacts on surrounding roads.

7.4.2 Traffic Noise Generation (On Campus)

The following areas have the potential to generate traffic noise.

- Ambulance bay
- Emergency Department (ED) drop-off area
- ASB Carpark

NOISE DATA

Acoustic Studio has compiled the noise level data in Table 30 from previous projects for similar traffic noise sources. Noise levels are presented in a range as they depend on vehicle type, driving behaviour, operational conditions, and conversational voice levels.

Noise Source / Vehicle Activities	Noise Levels at 7 metres, in dB(A)	
	$L_{Aeq,event}$	L_{AFmax}
Vehicle door closing	45-50	60-65
Vehicle engine starting	45-50	50-55
Vehicle accelerating	45-50	50-55
Vehicle moving, uniform speed	60-70	65-75
Vehicle moving, slowly	45-55	45-55
People talking	45-50	50-60

Table 30: Noise Data for Traffic Assessment

ASSESSMENT METHODOLOGY

The predictions in the following sections consider the following:

- Distance attenuation.
- Ground and building reflections
- Noise shielding from intervening structures
- Reverberant effects of enclosed areas and facade loss via openings from enclosed to open areas (ASB car park).

AMBULANCE BAY

The new ASB will provide a total of nine ambulance parking bays. Four car parking spaces will also be provided within this area for authorised vehicles.

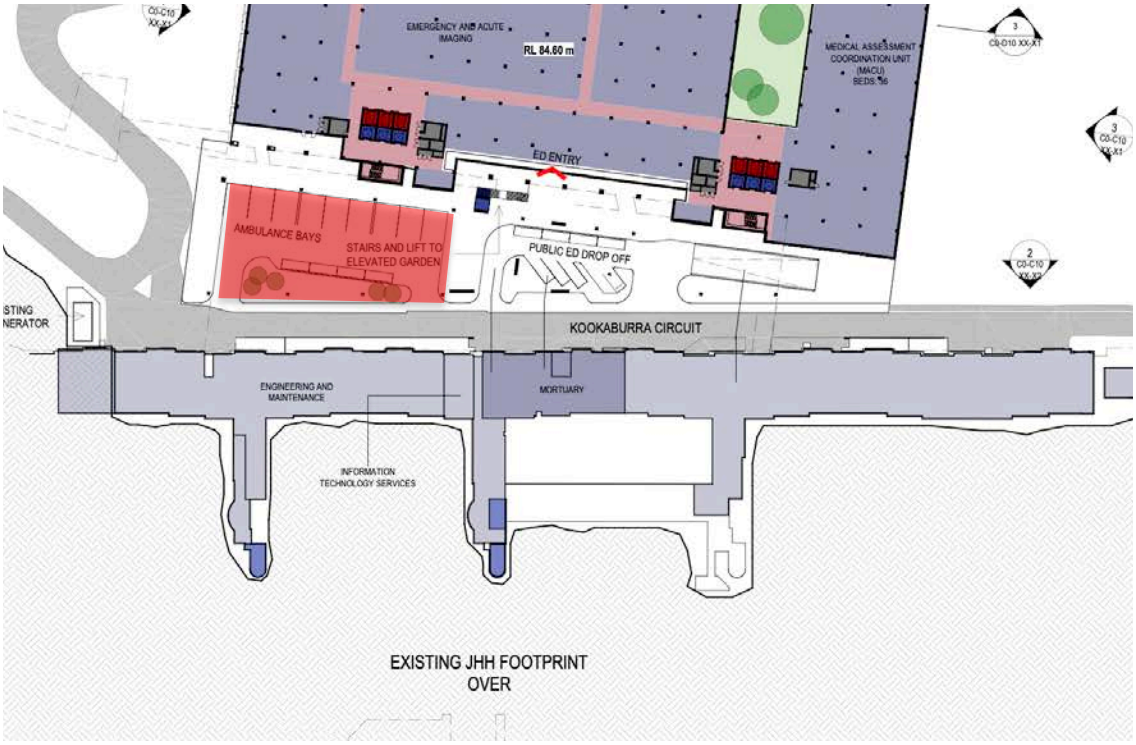


Figure 6: Proposed Ambulance Bay (in red)

Assessment of Noise Impact on Surrounding Receivers

The noise level associated with ambulance bay operations has been predicted to the boundary of the most affected residential receivers located to the west of the site along Sygna Close. Achieving compliance at these receiver locations will also achieve compliance at all other receiver locations.

As a worst-case scenario the ambulance bay noise assessment has considered the following, with input from the Traffic Consultant:

- Ambulance bay operating for all time periods, including night-time when the background noise level in the area is at its lowest.
- Ambulance bay in operation at full capacity.
- Vehicle movements within the bay limited to 9 movements per 15-minute period.

The predicted operational noise levels associated with Ambulance Bay are provided below.

Assessment Location	$L_{Aeq,15min}$ Noise Levels at Receiver Boundary, in dB(A)		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
	NPI Criteria		
	40 dB(A)	38 dB(A)	33 dB(A)
Nearest Residential Receiver Sygna Close	< 30	< 30	< 30

Table 31: Ambulance bay operational noise assessment.

Based on the results above, ambulance bay operational noise levels are predicted to satisfy NSW NPI operational noise criteria for all periods.

Assessment of Sleep Disturbance on Surrounding Receivers

The results of the operational noise assessment for the night time period are compared against the sleep disturbance criteria as shown in Table 32 below.

Assessment Location	Noise Levels at Receiver Boundary, in dB(A)	
	Sleep Disturbance Screening Criteria	
	40 dB(A) $L_{Aeq,15min}$	52 dB(A) L_{AFmax}
Nearest Residential Receiver Sygna Close	< 30	< 30

Table 32: Predicted operational noise levels at the nearest residential receiver from ambulance bay and Sleep Disturbance Screening Criteria.

Based on the above, ambulance bay operational noise emissions are not expected to cause sleep disturbance.

Ambulance Siren Noise Impact on Surrounding Receivers

Noise from sirens is not specifically addressed in relevant regulations.

When in use, noise levels from ambulance sirens will be audible at the nearest sensitive receivers.

Events identified as Priority One events (Life Threatening Emergencies), require that warning devices must be used, including warning lights and sirens. The *Emergency Driving and Use of Warning Devices Policy of NSW Ambulance Service* states that:

"NSW Ambulance personnel who drive a vehicle under emergency response conditions shall use safety equipment provided by NSW Ambulance for that purpose which includes warning devices: lights and sirens. Lights can be used in isolation without the use of a siren if the driver of the vehicle deems the circumstances are safe to do so and can justify reasonable cause to do so."

Based on the above, Acoustic Studio understands that ambulance drivers will make a judgement call on whether to use ambulance sirens on case-by-case basis. We further understand that it is the practice of Paramedics to minimise the use of sirens when it will cause a noise disturbance and the sirens are deemed unnecessary.

For reference, Appendix A contains the *NSW Ambulance – Emergency Driving and Use of Warning Devices Policy Directive*.

ED DROP-OFF

Access to the ED is proposed to be via the Level 00 entrance at the southern end of the ASB off Kookaburra Circuit.

The proposed ED drop off and pick up areas provide for a total of eight spaces and one accessible space. Visitors wishing to proceed to on-site car parking facilities will able to access the car park directly via an adjacent ramp or exit back to Kookaburra Circuit.

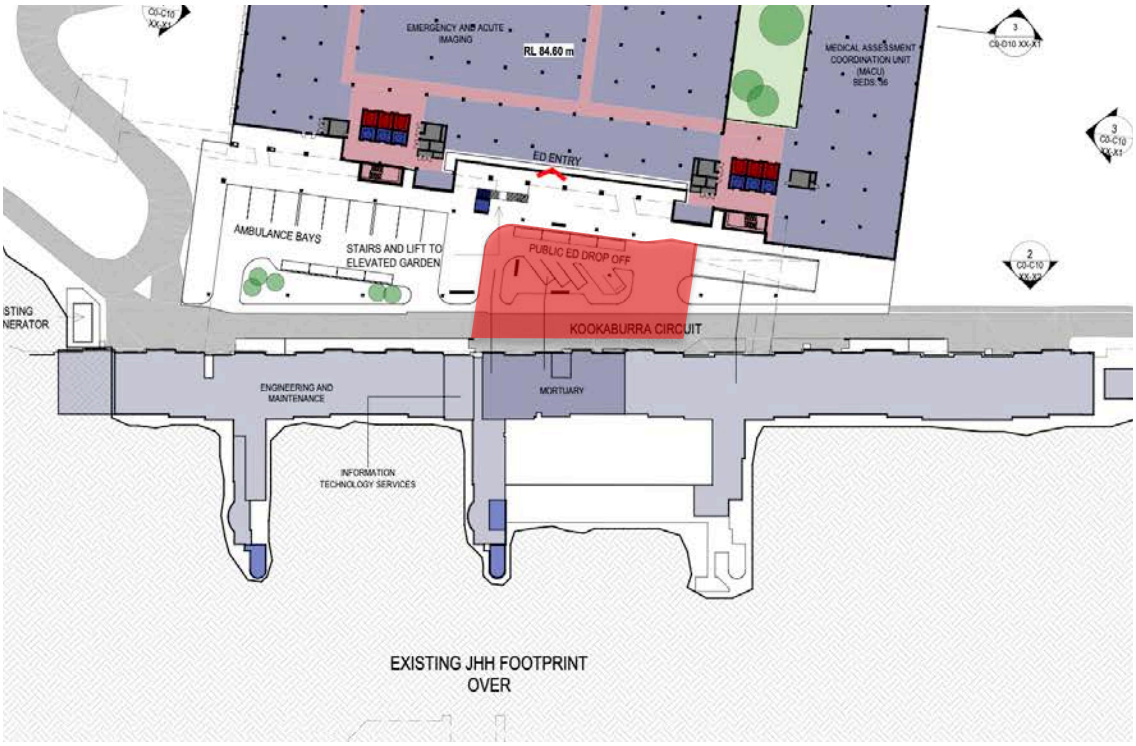


Figure 7: Proposed Public ED Drop Off (in red)

Assessment of Noise Impact on Surrounding Receivers

The noise level associated with ED drop-off operations has been calculated at the boundary of the most affected residential receivers located to the west of the site along Sygna Close. Achieving compliance at these receiver locations will also achieve compliance at all other receiver locations.

As a worst-case scenario the ED drop-off noise assessment has considered the following, with input from the Traffic Consultant:

- ED drop-off area operating for all time periods, including night-time when the background noise level in the area is at its lowest.
- ED drop-off in operation at full capacity.
- Vehicle movements within the drop-off area limited to 16 movements per 15-minute period.

The predicted operational noise levels associated with ED drop-off are provided below.

Assessment Location	$L_{Aeq,15min}$ Noise Levels at Receiver Boundary, in dB(A)		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
	NPI Criteria		
	40 dB(A)	38 dB(A)	33 dB(A)
Nearest Residential Receiver Sygna Close	< 30	< 30	< 30

Table 33: ED drop-off operational noise assessment results.

Based on the results above, ED drop-off operational noise levels are predicted to satisfy NSW NPI operational noise criteria for all periods.

Assessment of Sleep Disturbance on Surrounding Receivers

The results of the operational noise assessment for the night time period are compared against the sleep disturbance criteria as shown in Table 34 below.

Assessment Location	Noise Levels at Receiver Boundary, in dB(A)	
	Sleep Disturbance Screening Criteria	
	40 dB(A) $L_{Aeq,15min}$	52 dB(A) L_{AFmax}
Nearest Residential Receiver Sygna Close	< 30	< 30

Table 34: Predicted ED drop-off operational noise levels at the nearest residential receiver and Sleep Disturbance Screening Criteria.

Based on the above, ED drop-off operational noise emissions are not expected to cause sleep disturbance.

ASB CARPARK

The majority of vehicles accessing the new ASB car park will enter via the proposed Northern Access Road. An assessment of noise emissions from the ASB car park is provided below.

Assessment of Noise Impact on Surrounding Receivers

As a worst-case scenario the ASB car park noise assessment has considered the following, with input from the Traffic Consultant:

- Assessment of the ASB car park operating for all time periods, including night-time when the background noise level in the area is at its lowest.
- An early morning shoulder period has also been predicted for early morning peak hour traffic.
- Vehicle movements as follows from the Northern Access Road data:
    - Up to 50 vehicles over a 15-minute period (200 vehicles movements per hour as a worst case peak hour) assessed for Early morning Shoulder, Day and Evening periods.
    - Up to 10 vehicles over a 15-minute period as a conservative worst case during the night period.

The predicted operational noise levels associated with the ASB carp park are provided below.

Assessment Location	$L_{Aeq,15min}$ Noise Levels at Receiver Boundary, in dB(A)			
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)	Early Morning Shoulder (5am to 7am)
	NPI Criteria			
	40 dB(A)	38 dB(A)	33 dB(A)	37 dB(A)
Nearest Residential Receiver Roberts Close	<35	<35	< 30	<35

Table 35: Northern Access Road operational noise assessment results.

Based on the results above, operational noise from the proposed ASB car park is predicted to satisfy NSW NPI operational noise criteria for all periods.

The results of the operational noise assessment for the night time period are compared against the sleep disturbance criteria as shown in Table 34 below.

Assessment Location	Noise Levels at Receiver Boundary, in dB(A)	
	Sleep Disturbance Screening Criteria	
	40 dB(A) $L_{Aeq,15min}$	52 dB(A) L_{AFmax}
Nearest Residential Receiver Roberts Close	< 35	< 40

Table 36: Predicted Northern Road operational noise levels at the nearest residential receiver and Sleep Disturbance Screening Criteria.

Based on the above, the proposed ASB car park operational noise emissions are not expected to cause sleep disturbance.

7.5 Emergency Helicopter Operations

Helicopter operations generate high levels of transient noise, with substantial low frequency content and, therefore, pose a risk of noise impacts to nearby buildings.

Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an EIS for Designated Development, which would include a detailed assessment of noise impacts in the surrounding community.

Acoustic Studio has reviewed the Helicopter Operations Assessment prepared by the aviation consultant (Avipro) for the new ASB. We make the following comments.

7.5.1 Current JHHIP Helicopter Landing Site (HLS)

The existing HLS is located at street level on an existing carpark roof as shown in Figure 8. Currently the existing HLS movements annually are 1052.

Figure 8: Existing HLS and flight paths

7.5.2 Future JHH HLS and Operations

- The new ASB will incorporate a rooftop HLS.
- Figure 9 shows proposed flight paths for the new ASB.

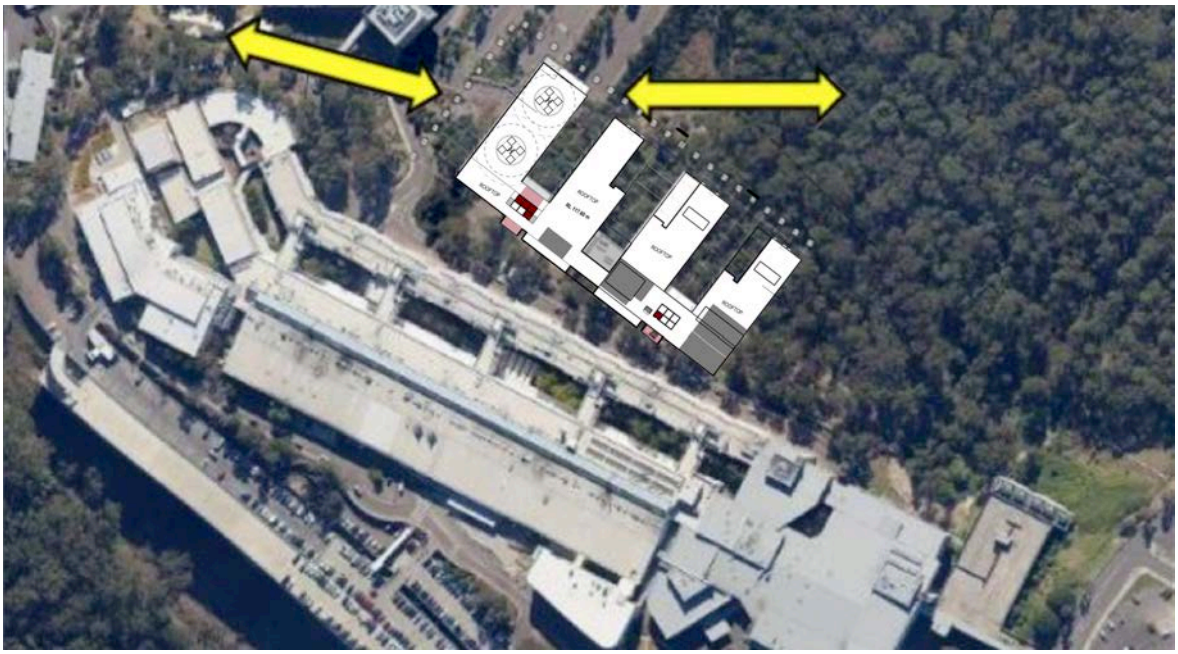


Figure 9: Proposed HLS flight paths

7.5.3 Noise Impact on Noise Sensitive Receivers

Based on the information above, Acoustic Studio has considered noise impacts on surrounding receivers as follows:

- Residential receivers to the North - noise from the new HLS will be 3 dB louder than the existing HLS. However, noise from the new HLS will be significantly lower than flyover noise, which will be unchanged.
- Residential receivers to the East and West – noise impact will be similar to existing.

8 External Noise Intrusion and Vibration

8.1 Helicopter Noise Intrusion

Noise from Helicopters and the new HLS located on roof of the ASB is the driving noise source for determining external noise intrusion requirements. Therefore, control of helicopter noise will also ensure that all other external noise sources (including road traffic and plant and equipment noise) are addressed.

As the proposed HLS will be located on the roof of the new ASB, helicopter noise levels incident on the majority of the ASB building envelope and northern façade of the existing JHH will be high.

Acoustic Studio has carried out a review of helicopter noise impacts and identified that acoustic glazing and wall constructions will be included as follows:

- The ASB and will include systems such as double glazing with design performances up to R_w 45.
- Areas along the northern façade of the proposed JHH refurbishment areas, glazing upgrades may be required with either replacement or secondary glazing, having a design performance of up to R_w 35.

Final details and extent of the façade that may require this type of glazing performance will be determined with input from the Acoustic Engineer at the detailed design stage as layouts and façade details are developed.

8.2 Vibration

Acoustic Studio has carried out surveys of pre-existing vibration levels at and around the proposed ASB site and note that measured pre-existing levels at the site are not expected to adversely impact on the operation of the ASB or require any special structural vibration control measures than normally required.

9 Discussion and Recommendations

A noise and vibration assessment report has been produced to determine the potential noise impacts and considerations for the ASB and refurbishment of existing hospital facilities as part of the JHHIP.

The existing noise environment has been established based on long-term and short-term monitoring data.

Appropriate criteria for both noise and vibration have been established based on relevant guidelines and standards. A summary of the outcomes and recommendations of this noise and vibration assessment are as follows:

Construction Noise

- Proposed construction hours (including Outside Recommended Standard Hours) are as follows:
    - Monday to Friday - 6:00am to 6:00pm.
    - Saturday - 7:00am to 5:00pm.
    - Sunday and Public Holidays – No works.
- Based on the results from the high-level assessment based on the indicative works, we make the following comments:
    - Construction works noise impacts will be greatest at on Campus noise receivers including the existing JHH and HMRI buildings. Noise from various plant and equipment operating individually are generally predicted to be above the NMLs due to the proximity to the nearest affected receivers. The worst-case noise impacts are for excavators with hammers with noise levels predicted to be above the NMLs by up to 20 dB.
    - Noise levels from operations of various plant and equipment are predicted to be up to 15 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NMLs depending on the distance to the receiver.
    - Construction noise impacts at residential receivers are the highest beyond bushland to the west and north of the JHH. The worst-case noise impacts are for excavators with hammers which are up to 16 dB above NMLs (construction noise target) during Recommended Standard Hours and 21dB during Outside Recommended Standard Hours due to the low RBL (background noise level) at these residential receiver locations. These levels between 50 to 60dB are not loud in an absolute sense and are consistent with the pre-existing ambient noise levels at these receiver locations. Further attenuation can be expected from absorption across bushland which

is not included in predictions. Therefore, noise impact is not expected to be significant. It is also noted that these noise levels are also well below the 75dB(A) Highly Affected Noise Levels outlined in the ICNG.

- Generally, for all other receivers identified (both on and off campus), the noise generated from the construction works noise from individual equipment operating is below the Highly Noise Affected Level and generally able to meet the NMLs when further away from the perimeter boundary.
- Where NMLs are exceeded, mitigation measures to be considered and incorporated where reasonable and feasible would include:
  - Schedule noisy activities to less sensitive times of the day for each nominated receiver (i.e. daytime hours).
  - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on and 1 hour off.
- The predictions for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and hammers, and the proximity to on campus sensitive receivers (some of which are within 20m).
- Construction traffic along the roads surrounding the site will meet applicable road noise targets on nearby receivers during the day-time period.
- Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when NMLs cannot be met due to safety or space constraints.

Construction Vibration

- Based on the scope of works and typical equipment required, some human perception vibration impacts are expected and there is requirement to review works processes during detailed works planning to ensure that minor cosmetic impacts to structures are avoided – particularly from the use of excavators with hammers near the existing JHHC buildings. In addition, there is potential for vibration impacts on sensitive equipment. The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

  It is recommended that, at the commencement of vibration-generating Works, vibration surveys be carried out of each key vibration-generating-activity / equipment.

In addition to the assessment of structural and human perception vibration, the CNVMP prepared by the Contractor must ensure, at the relevant on campus buildings (including but not limited to the existing JHH, HMRI, Private Hospital) and other Hospital campus areas where sensitive equipment is operated, that the equipment-specific vibration criteria are set and managed accordingly.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. Site law tests will help determine allowable working distances from structures to manage vibration.

If the assessment indicates that vibration levels might exceed the relevant criteria then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures.

A method of monitoring vibration levels must then be put in place. Additionally, vibration monitors must also be put in place to manage sensitive areas. Vibration mitigation measures and vibration criteria will then need to be reviewed.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

Operational Noise

Once the Project is completed, the premises are to operate 24 hours a day, seven days per week.

- Mechanical Plant

Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 5 of this report.

Criteria has been established in Section 7.3.1 of this report.

At this stage, final plant selections have not been made. A preliminary assessment has been carried out which outlines noise control that will be incorporated as required and identifies noise controls for key equipment including Cooling Towers and Emergency Generators.

During the Detailed Design, Acoustic Studio will provide detailed design advice to the architect and services engineers to ensure that noise emissions from plant and

equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

- Traffic Noise Generation

  Off Campus - General traffic increase along Lookout Road, Kookaburra Circuit and Jacaranda Drive, as a result of the new ASB, is unlikely to have adverse noise impacts on receivers surrounding the site.

  On Campus – A quantitative assessment has been carried out to assess traffic noise generation on campus from proposed ambulance bays, ED drop off, ASB carpark and new campus roads. The assessment has determined that on campus traffic noise generation will be below the relevant operational noise emission criteria.

- Emergency Helicopter Operations

  Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an EIS for Designated Development, which would include a detailed assessment of noise impacts in the surrounding community. A high-level assessment has been carried out, regardless, in order to understand likely changes in noise levels expected from the proposed HLS on the ASB rooftop. Further details are provided in Section 7.5.

Appendix A – NSW Ambulance – Emergency Driving and Use of Warning Devices Policy Directive

NSW Ambulance

POLICY DIRECTIVE

EMERGENCY DRIVING AND USE OF WARNING DEVICES POLICY DIRECTIVE

Document No.	PD2016-033
File No.	16/623 (D16/23847)
Date issued	13 January 2017
Contents	**Policy Directive** Policy Directive - Emergency Driving and Use of Warning Devices
	Attachments Nil
Directorate	Service Delivery
Author Branch	Service Delivery
Branch Contact	Executive Staff Officer 9320 7873
Summary	The purpose of this policy is to outline the correct use of warning devices for all operational staff.
Applies to	All NSW Ambulance operational staff
Review Date	February 2022
Previous Reference	SOP2014-001
Status	Active
Approved by	Chief Executive

Related Documents

Australian Road Rules Part 19 Rule 306 – Exemptions for Drivers of Emergency Vehicles
Roads & Traffic Authority Vehicle Standards Information 10.366 Cat No. 45070588 Rev. 4.1
SOP2013-015 Self Responding to Incidents Policy
NSW Work Health and Safety Act 2011
SOP2013-014 Dispatch – Emergency Response Standards Policy
Fleet Manual Policy Directive PD2016-034
Fleet Manual Operating Procedure PRO2016-039

Compliance with this work instruction is **mandatory**

Emergency Driving & Use of Warning Devices Policy Directive

1. Background

This policy directive has been created to minimise risk to operational personnel and the Public and to ensure legal compliance under Road Traffic Act 1909 No. 5 and The Australian Road Rules 2008 whilst engaged in emergency response driving.

NSW Ambulance personnel driving a NSW Ambulance vehicle under emergency response conditions can claim exemptions in certain circumstances. Specifically the driver must be able to prove, in the circumstances:

- they were taking reasonable care; and
- it was reasonable that the rule should not apply; and
- If the vehicle is a motor vehicle that is moving - the vehicle is displaying a blue or red flashing light and sounding an alarm. Alternatively, displaying a blue or red flashing light only.

The Australian Road Rules refer to the driver of any emergency vehicle, where it is expedient and safe to do so, may:

- Drive in any direction on part of a public street or overtake or pass on either side of another vehicle, but only with due care
- Stop, leave standing or park the emergency vehicle at any time or place
- Exceed the speeds prescribed by the Traffic Act 1909 No. 5 only when safe to do so

2. Use Of Warning Devices

When driving a NSW Ambulance vehicle under emergency response conditions, the driver shall:

- Be solely responsible for the vehicle and afford maximum safety of its occupants and any other road users, at all times.
- Comply with requirements of the Traffic Act 1909 No. 5 and Australian Road Rules 2008.
- Drive at a speed and manner appropriate to traffic, road and prevailing weather conditions.
- Drive in a professional manner at all times.
- Not proceed through a railway or tram crossing when the warning signals are in operation unless directed to do so by an authorised person.

- Wear a seat belt at all times. Seat belts must be worn at all times in the rear patient compartment unless immediate lifesaving intervention is required.
- Not enter an intersection or junction that is controlled by a traffic sign, light or other road marking, at a speed where the driver cannot stop the vehicle in order to avoid a crash or causing a crash.
- On approach to a traffic light controlled intersection faced with a red light, the driver must slow down and stop if necessary until all other traffic has completely stopped. Once all other traffic has stopped, and it is safe to do so, enter and proceed through the intersection with caution.
- Particular care must be exercised when transiting through school zones as the unpredictability of children; especially at the sight of an emergency vehicle approaching is heightened.

2.1 Category One response

- NSW Ambulance personnel who drive a vehicle under emergency response conditions shall use safety equipment provided by NSW Ambulance for that purpose which includes warning devices: lights and sirens. Lights can be used in isolation without the use of a siren if the driver of the vehicle deems the circumstances are safe to do so and can justify reasonable cause to do so.
- Blue or red flashing lights shall be activated at the commencement of all emergency drives. Blue or red flashing lights shall remain active when parked at the emergency scene, unless parked in a position that affords maximum safety without the need to display the lights.
- Where the highest clinical level paramedic responsible for the patient decides that the patient's condition warrants the use of emergency driving procedures during transfer (this decision must be communicated to the control centre immediately).
- A crew decision to upgrade the response in order to expedite to a location as described in SOP2013-014 for priority two (2) incidents (this decision must be communicated to the control centre immediately).
- The siren should be considered on the approach to any hazard, in particular:
    - Physical hazards such as junctions, roundabouts, bends or hill crests
    - Those created by the presence, position or movement of other road users
- Deactivation of the siren during an emergency drive should only be considered if the driver can justify reasonable cause to do so, there is no benefit to be gained from the use of the siren and there is no compromise to the safety of other road users.
- The driver's decision to use all warning devices will always be supported by NSW Ambulance should a complaint be received due to noise made when responding to an emergency

- When exceeding the prescribed speed limit:
    - Drive so that you are able to stop safely in the distance you can see to be clear
    - Drive at a speed which is appropriate to the conditions
    - Remember if you double your speed, quadruple your stopping distance
    - No emergency is so great to justify an accident

3. COLLISION

Personnel involved in a collision must:

- Stop at the scene
- Notify control immediately
- Ensure safety of personnel
- Give all possible assistance to any person involved in the incident
- If extra resources are needed, notify control
- Give all “required particulars” to:
    - any other driver (or that driver’s representative) involved in the collision; and
    - any other person involved who is injured (or that person’s representative)
    - the owner of any property (including any vehicle) damaged in the collision (or the owner’s representative), unless, in the case of damage to a vehicle, the particulars are given to the driver of the other vehicle
- The driver’s responsibility
    - the driver must give the driver’s required particulars, within the required time, to a police officer; that is not more than 90 minutes after the collision
    - present himself or herself to a police officer at the scene of the collision or at a police station for the purpose of providing particulars of the collision
    - submit to any requirement to undertake a test relating to the presence of alcohol or a drug in his or her blood or oral fluid

4. SELF RESPONDING

It is an organisational mandate that no self-responding to incidents is to occur, however, operational managers and on road supervisors may initiate a response within their geographic area of responsibility provided appropriate notification is given to the control centre so that a tasking record can be produced.

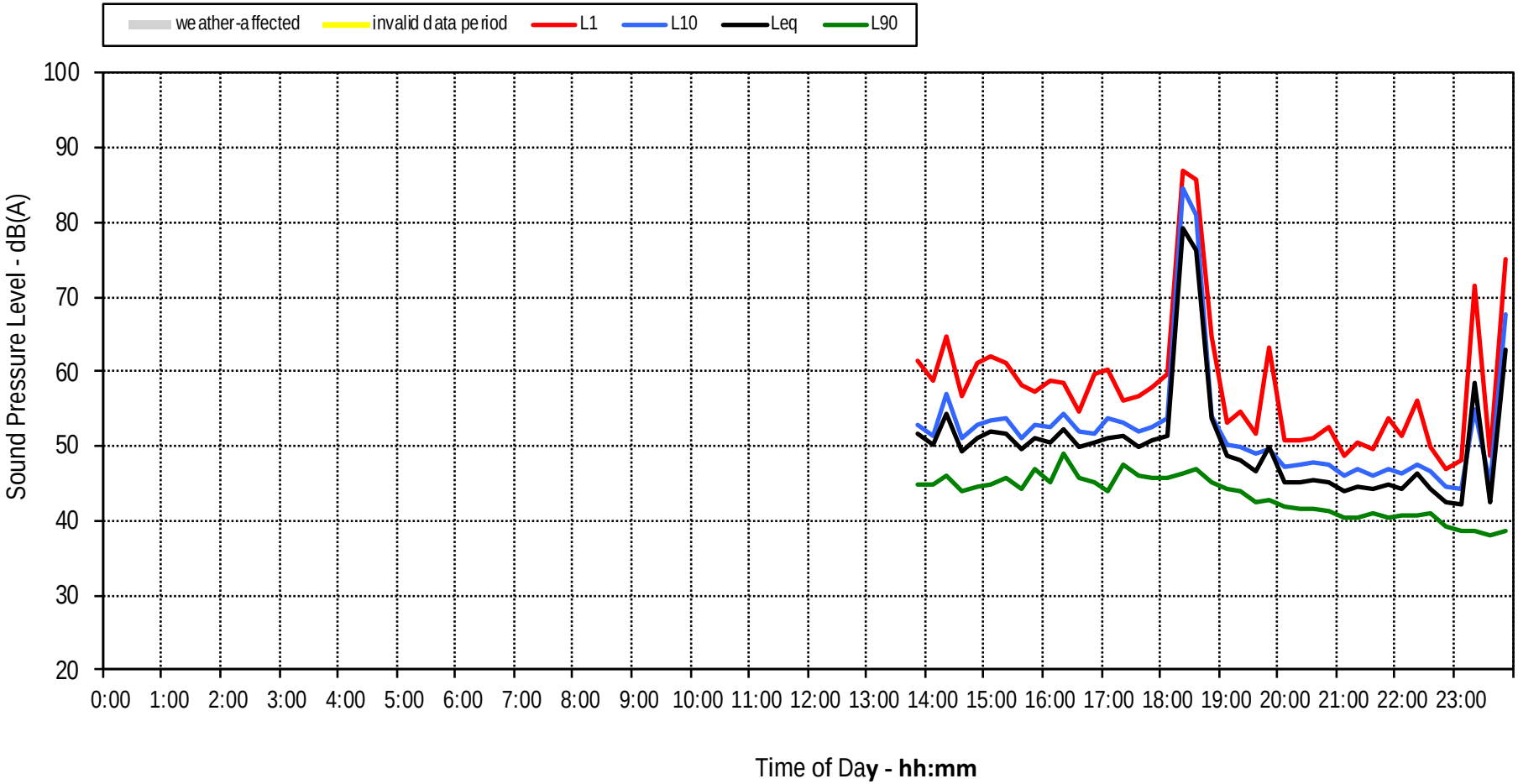
REVISION HISTORY

Version (Document #)	Amendment notes
12/2016 (PD2016-033)	Policy transferred to new template nil changes made
10 April 2014 (SOP2014-001	Endorsed by Chief Executive. Updating of SOP to make requirement of using warning devices (lights / sirens) as AND / OR + examples of when one or the other might be used as opposed to both. Change to recognise that an Operational Manager can instigate a response to an incident but must advise the Control Centre
5 September 2012 (SOP2012-018)	Endorsed by the Chief Executive

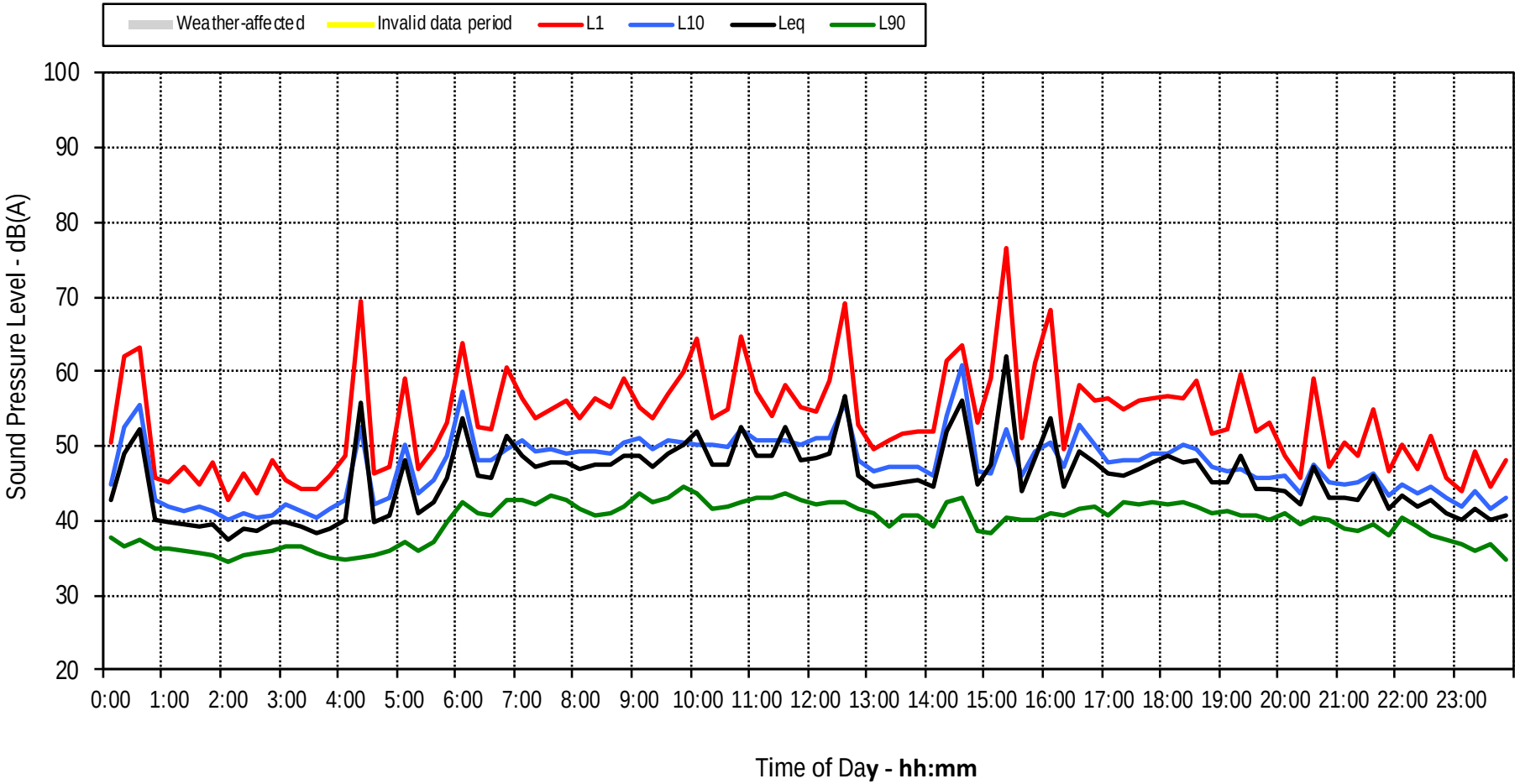
Appendix B – Ambient Noise Monitoring Data

Location 1 – Ardlessa Way

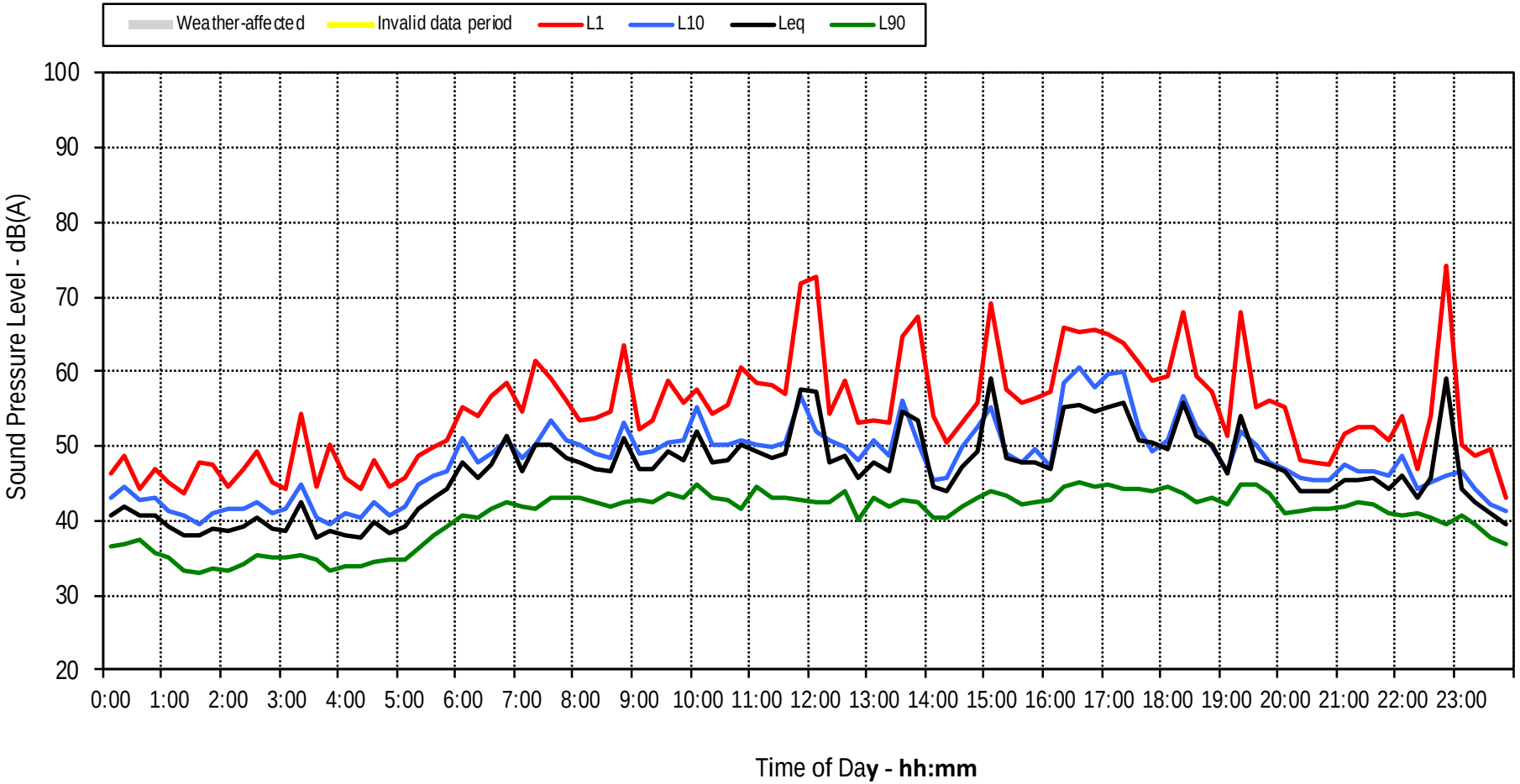
Location 1 - 9 Ardlessa Way - Friday 09 October 2020



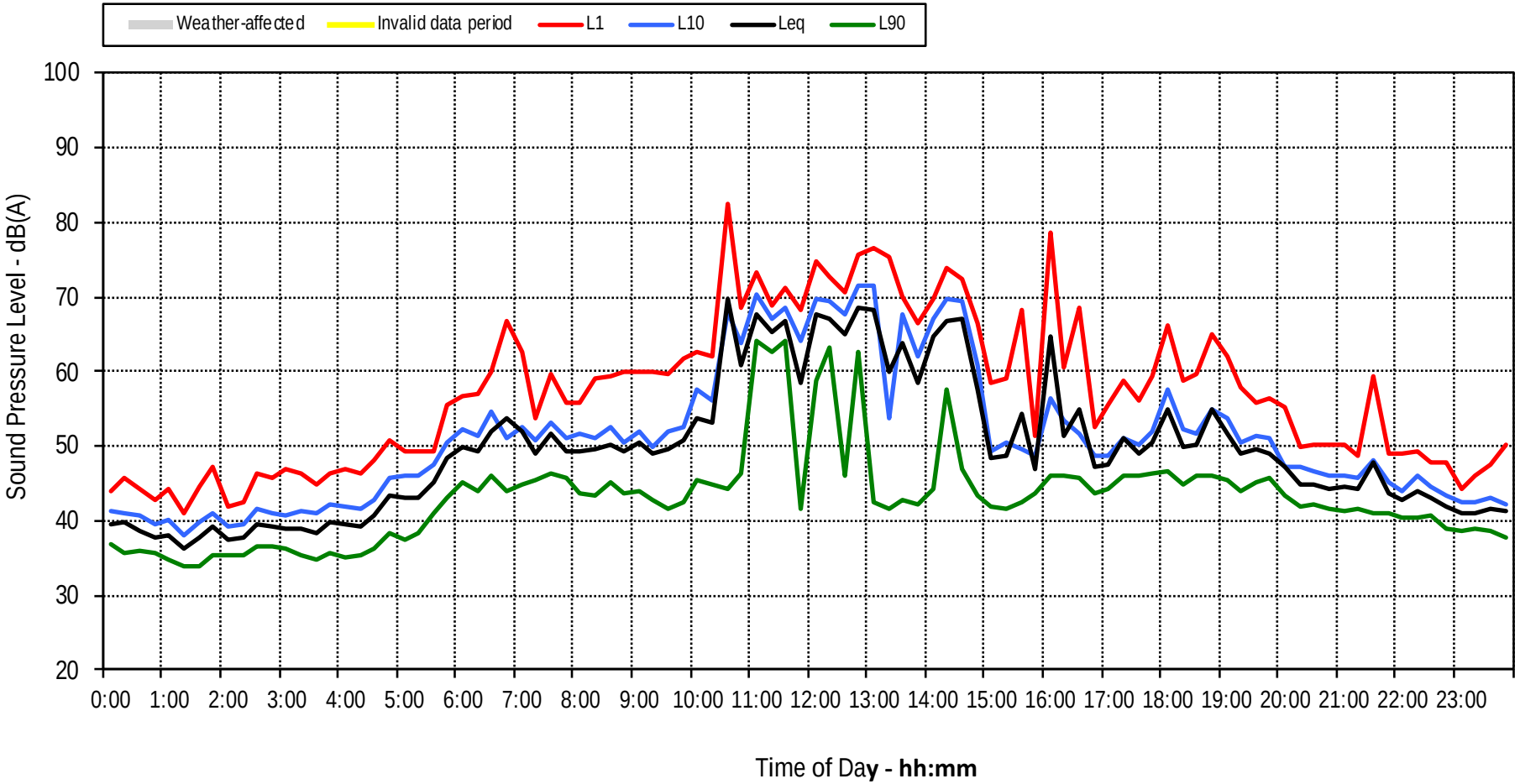
Location 1 - 9 Ardlessa Way - Saturday 10 October 2020



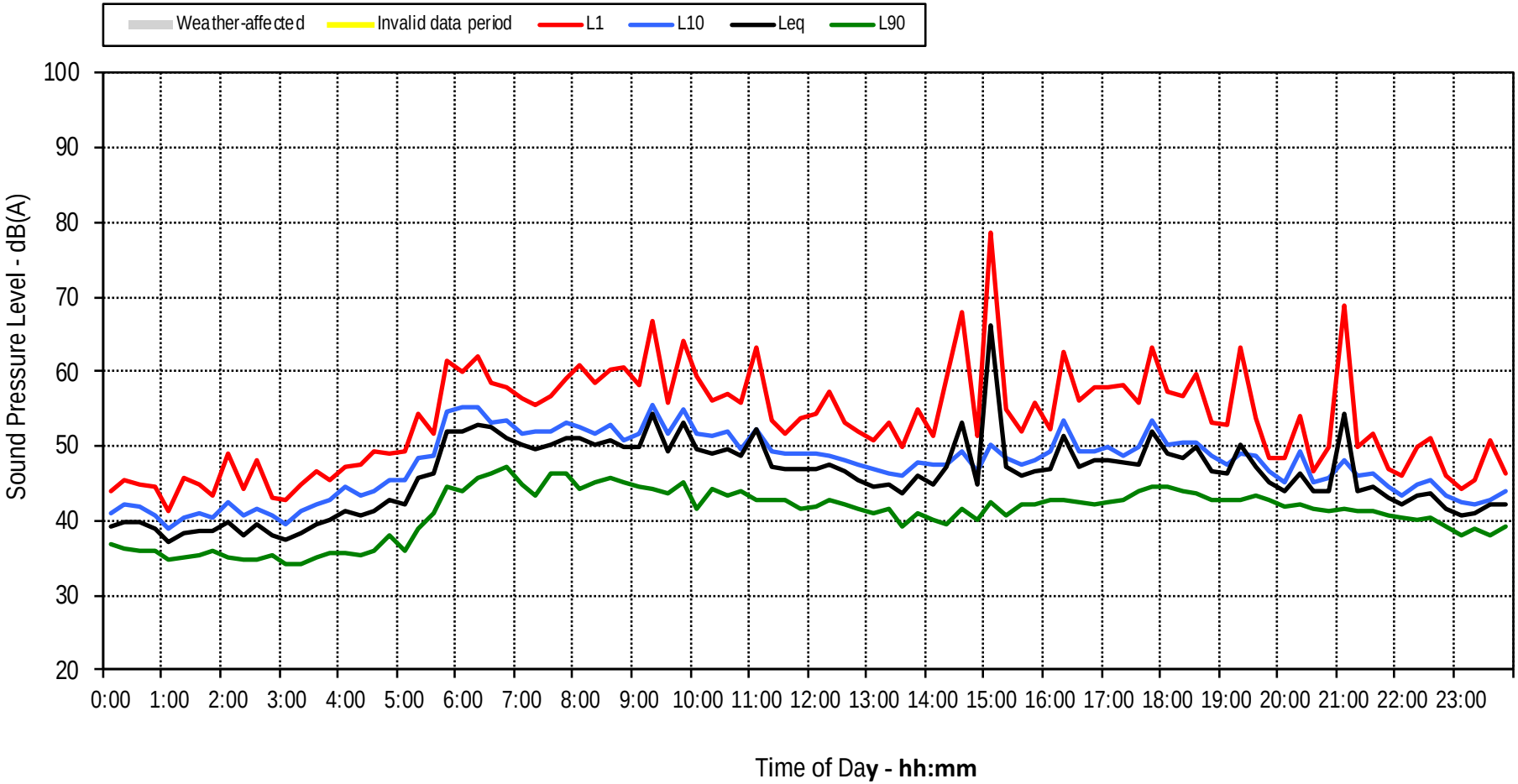
Location 1 - 9 Ardlessa Way - Sunday 11 October 2020



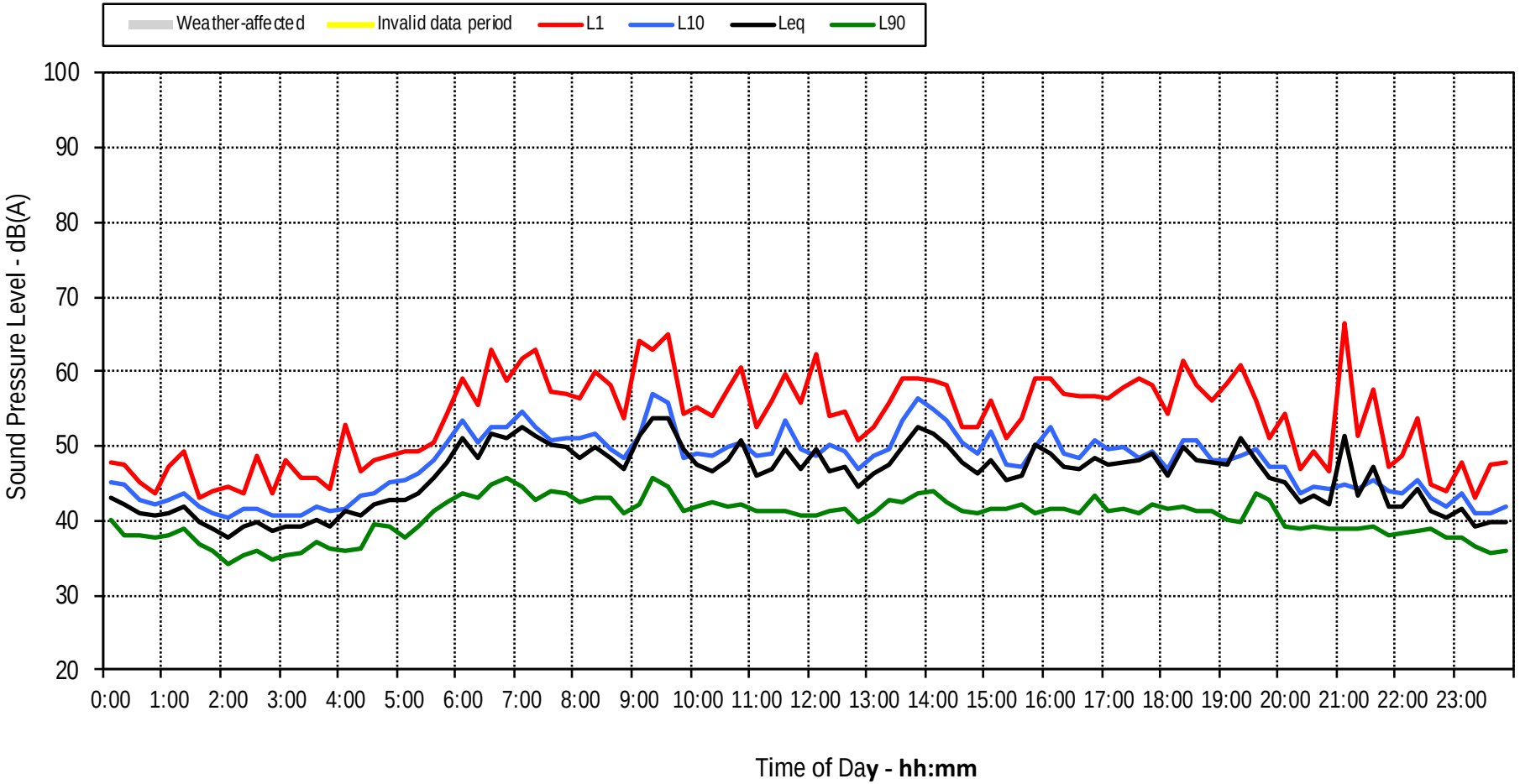
Location 1 - 9 Ardlessa Way - Monday 12 October 2020



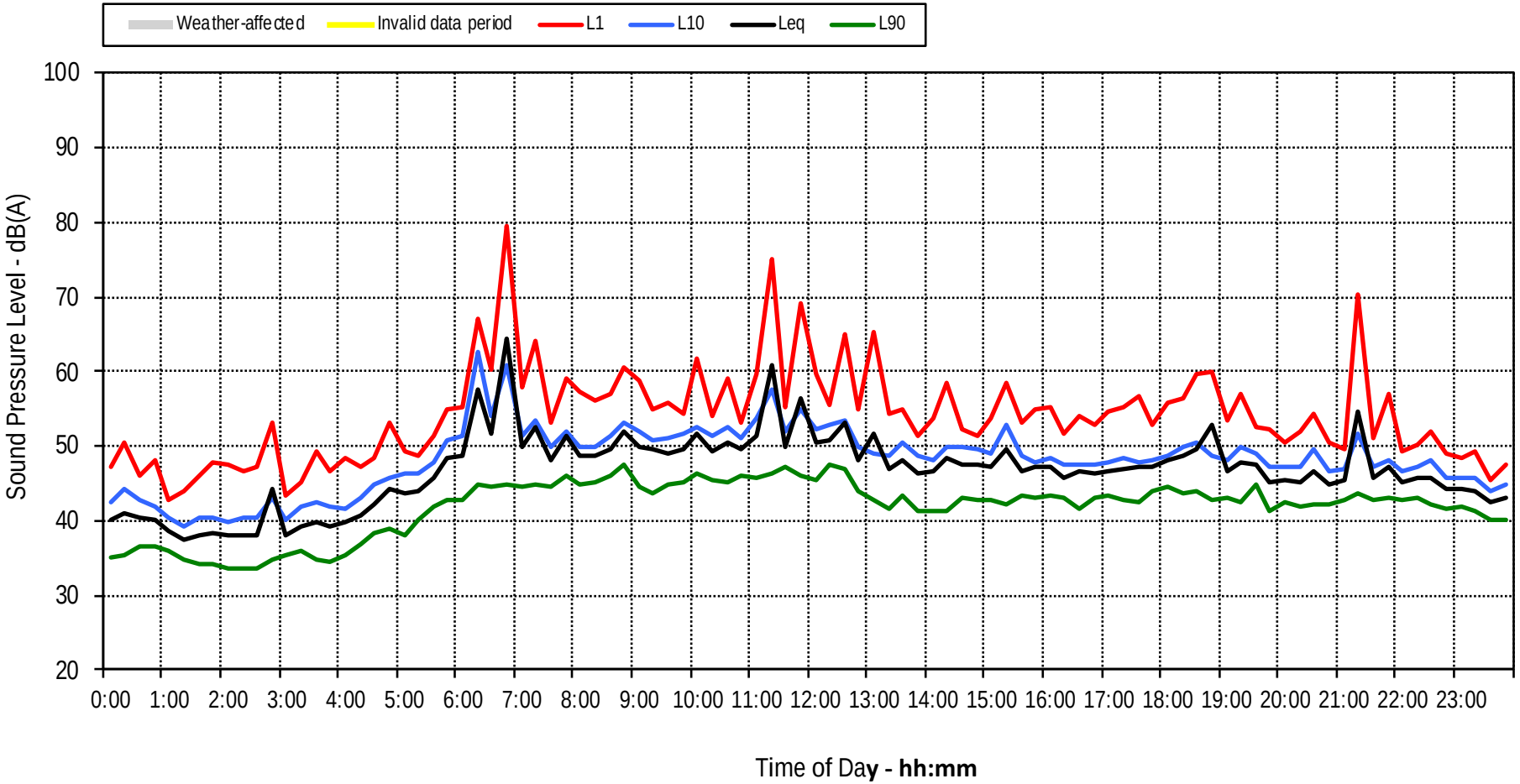
Location 1 - 9 Ardlessa Way - Tuesday 13 October 2020



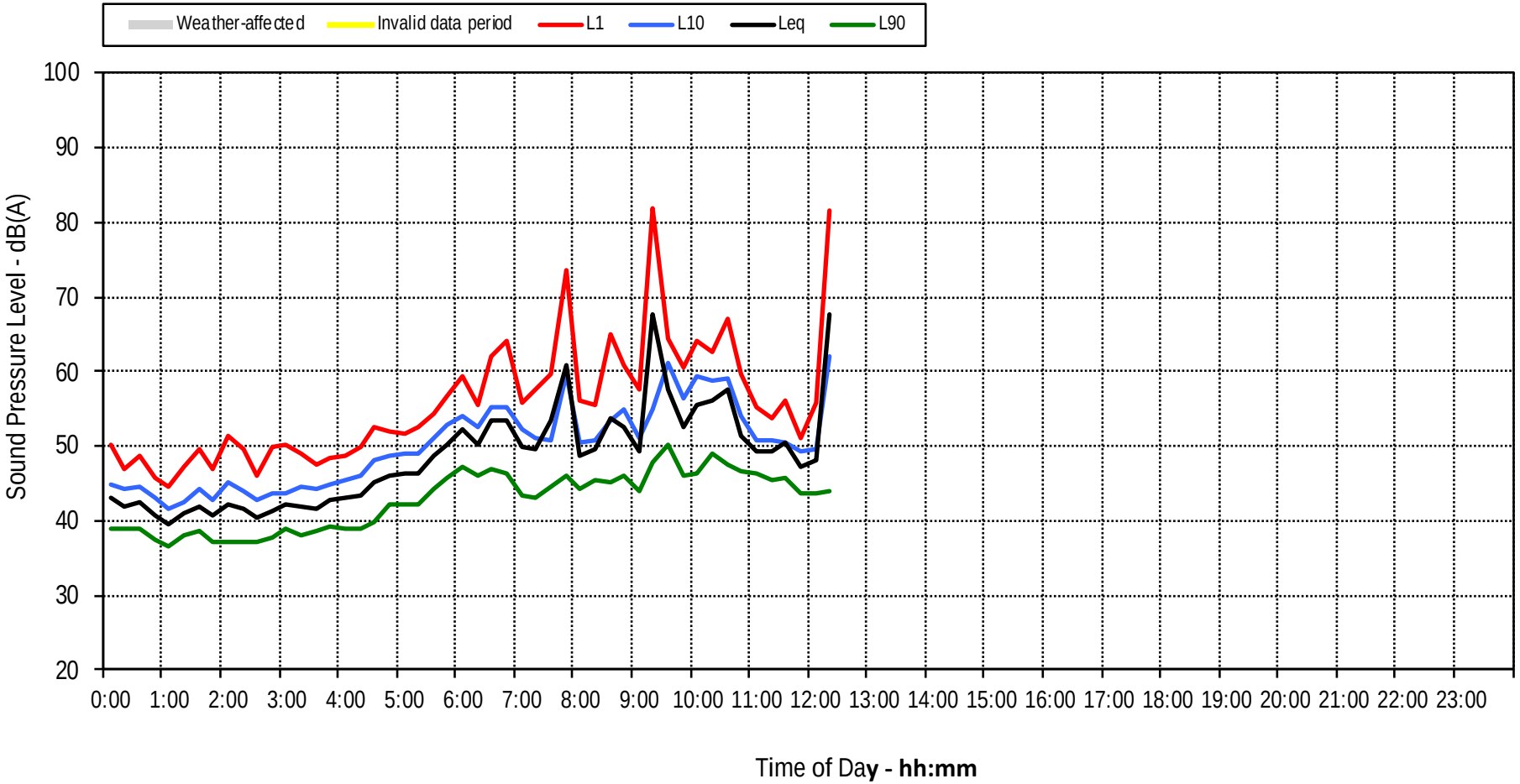
Location 1 - 9 Ardlessa Way - Wednesday 14 October 2020



Location 1 - 9 Ardlessa Way - Thursday 15 October 2020

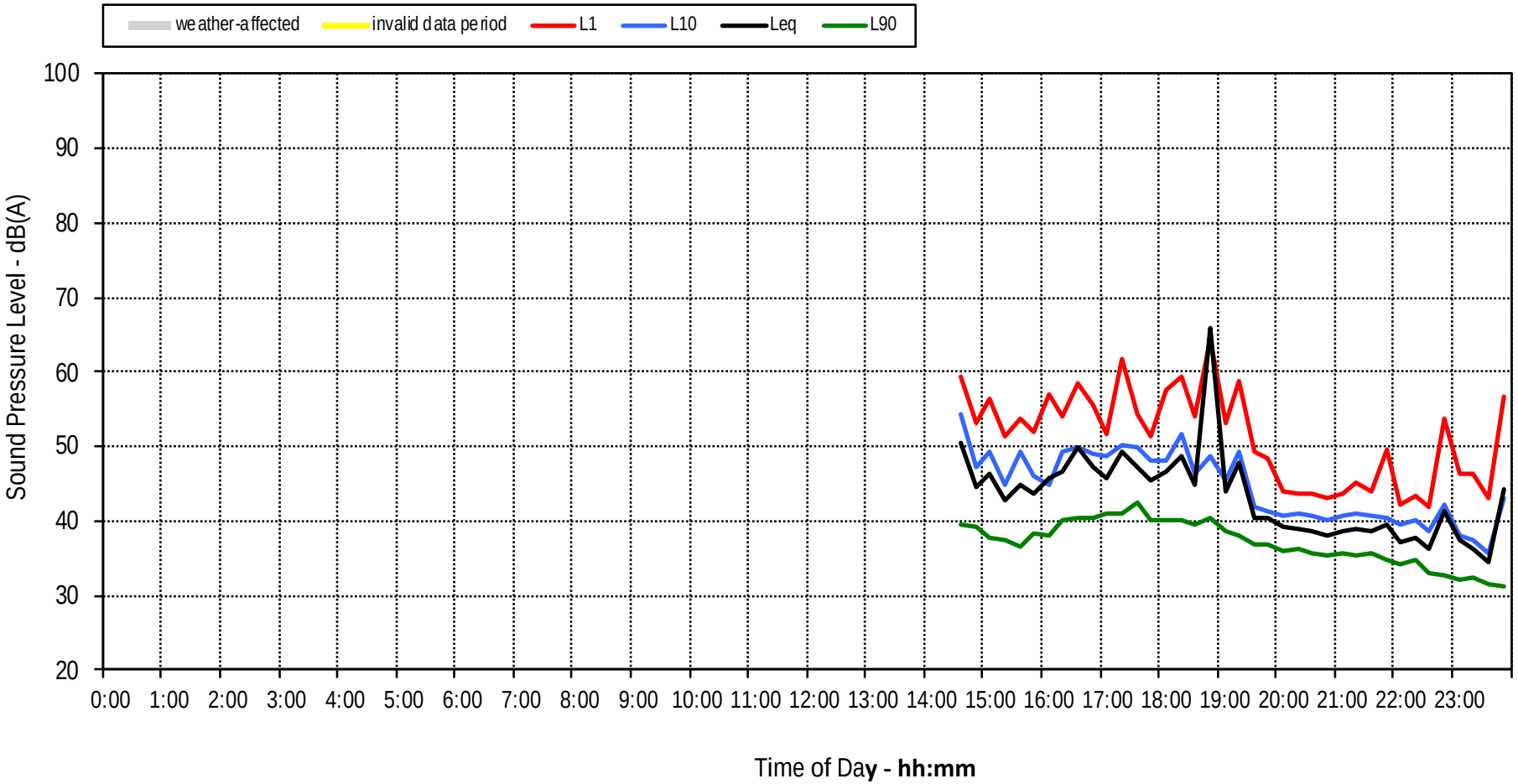


Location 1 - 9 Ardlessa Way - Friday 16 October 2020



Location 2 – Sygna Close

Location 2 - Sygna Close - Friday 09 October 2020



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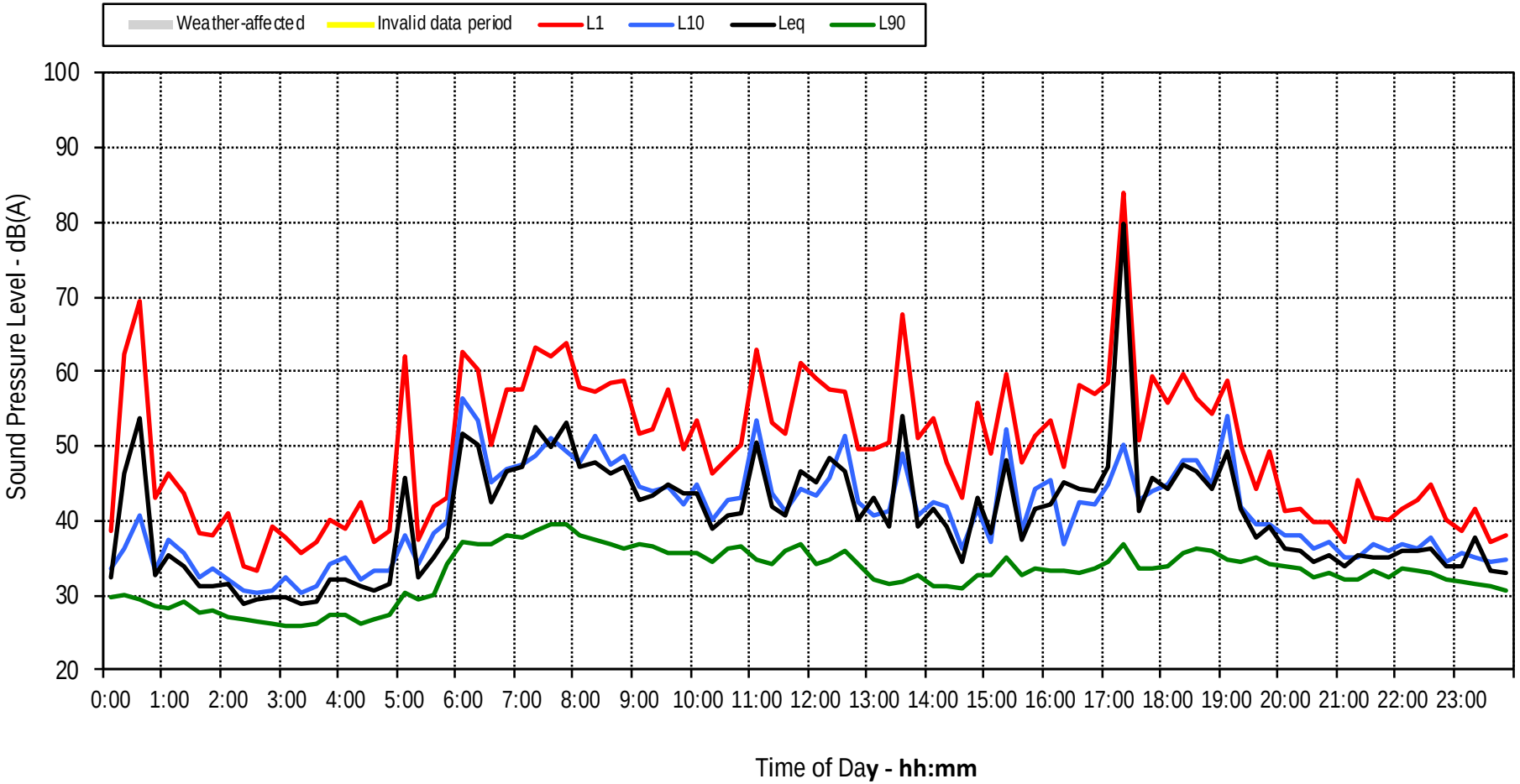
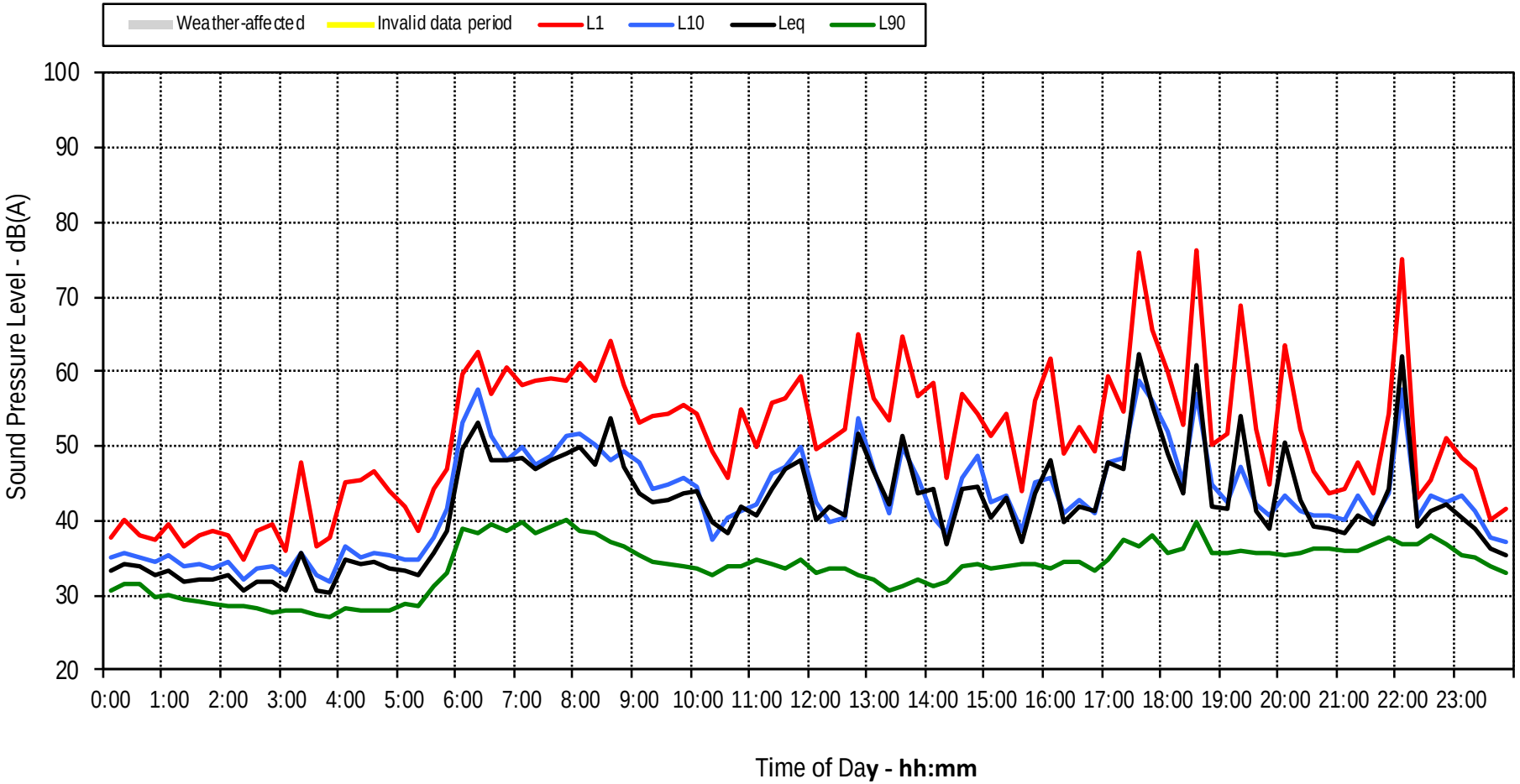
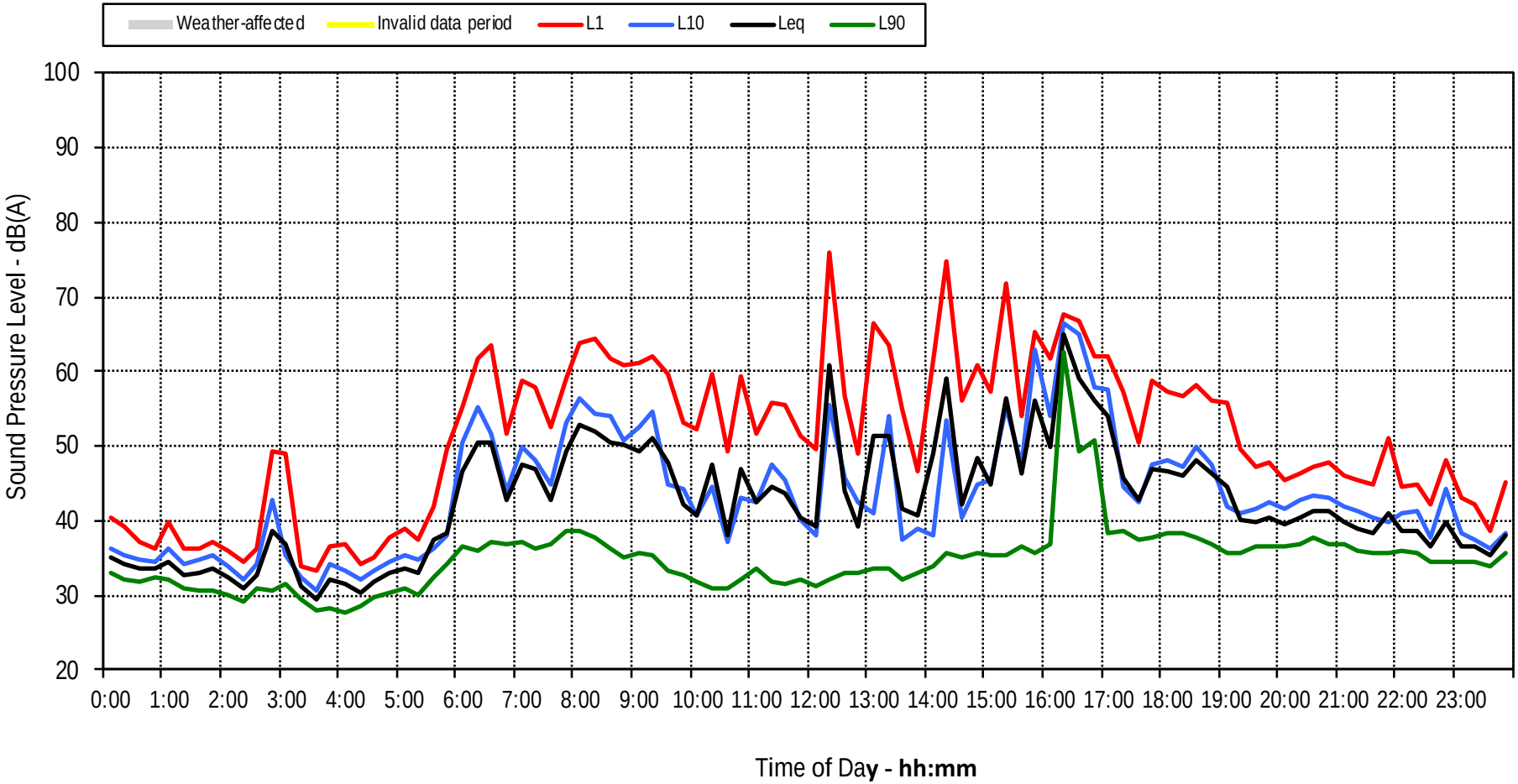


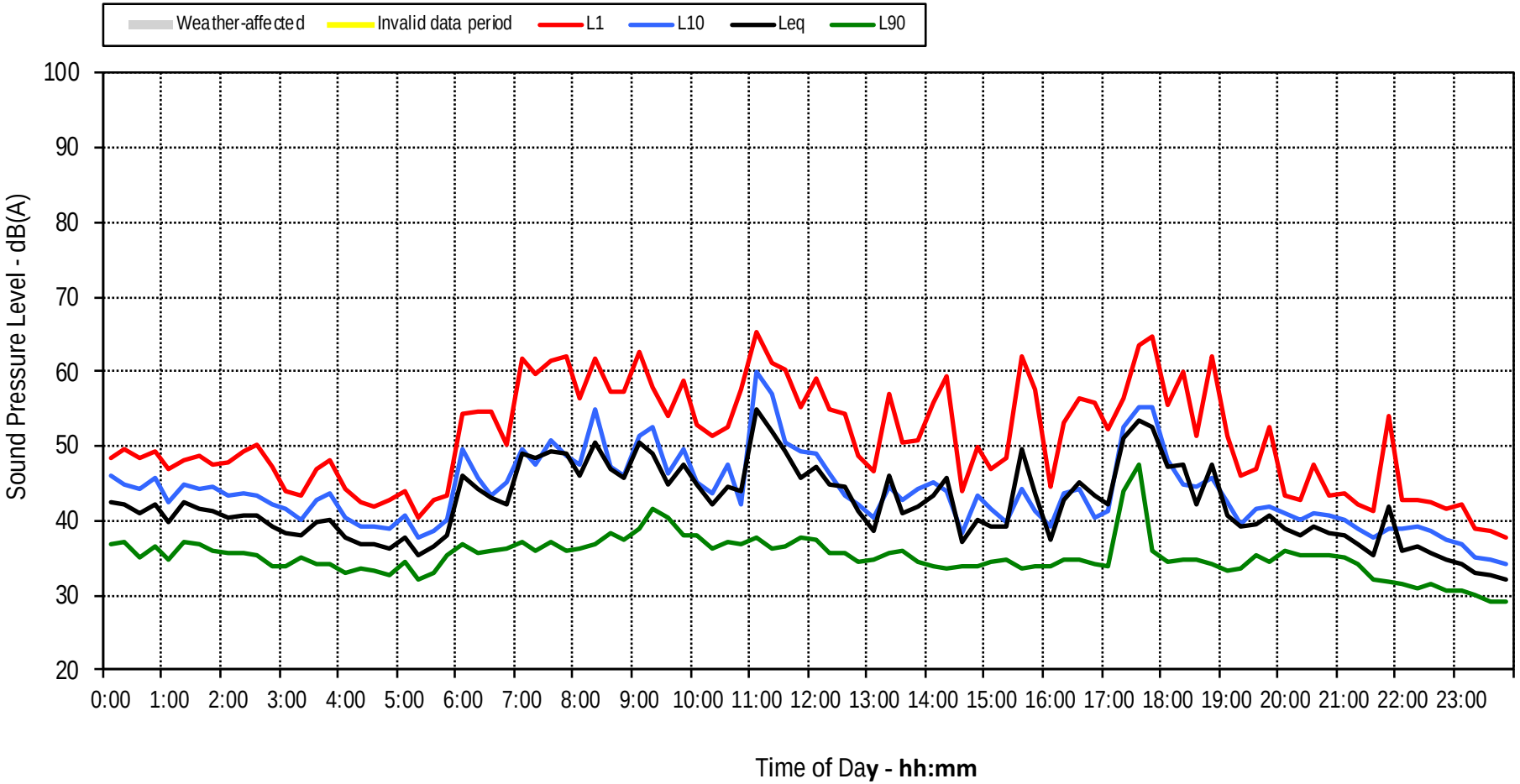
Location 2 - Sygna Close - Sunday 11 October 2020



Location 2 - Sygna Close - Monday 12 October 2020



Location 2 - Sygna Close - Wednesday 14 October 2020



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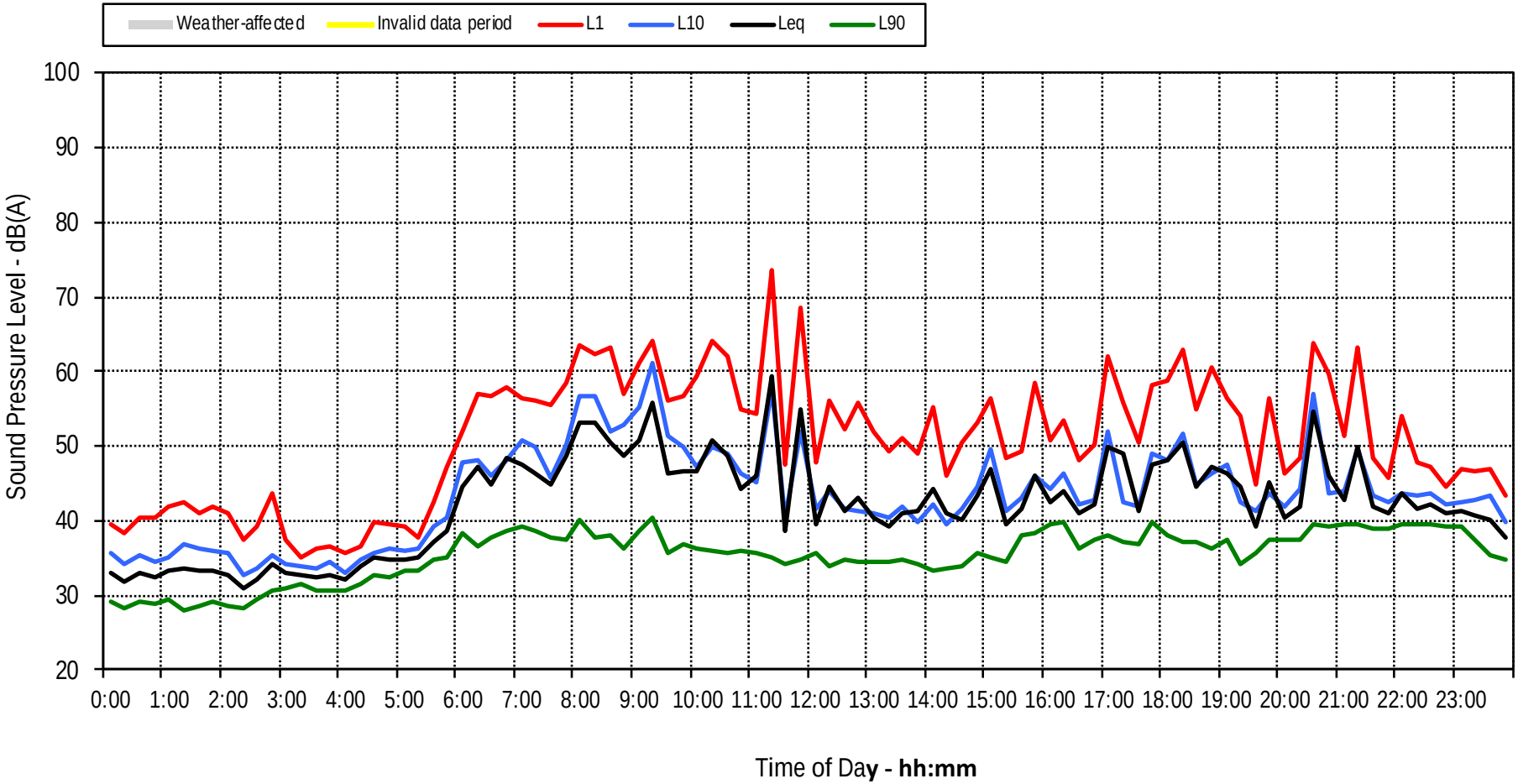
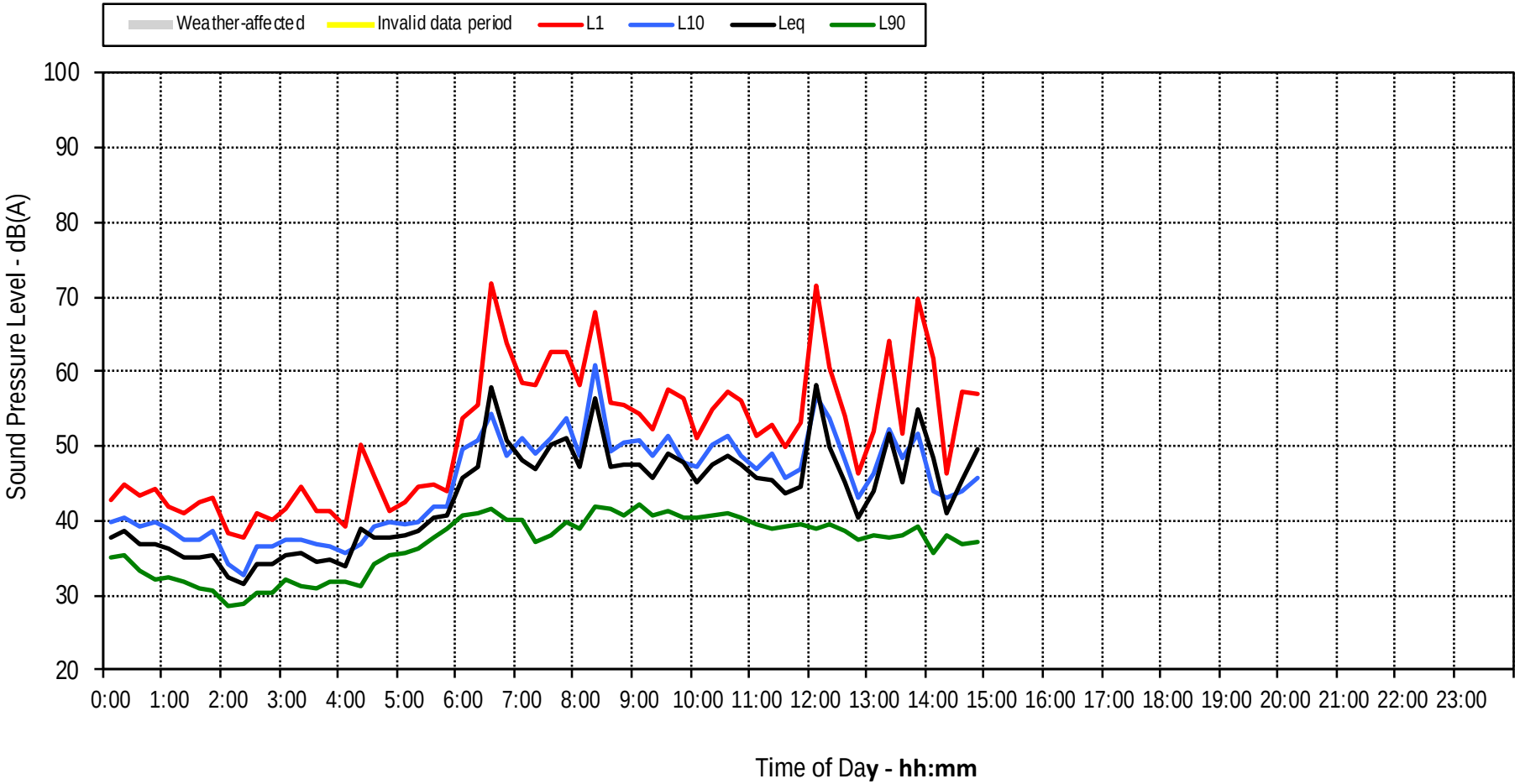
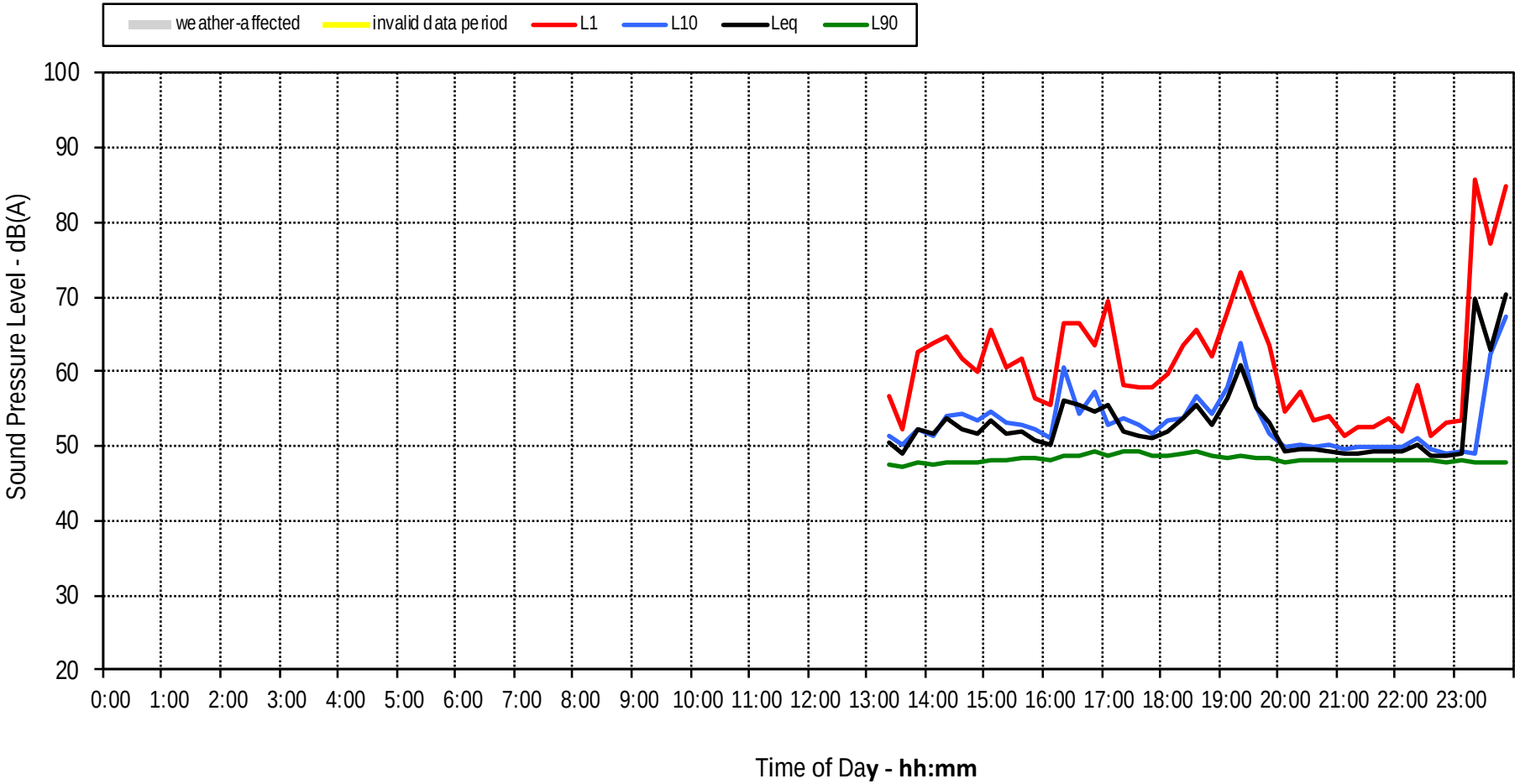


Location 2 - Sygna Close - Friday 16 October 2020

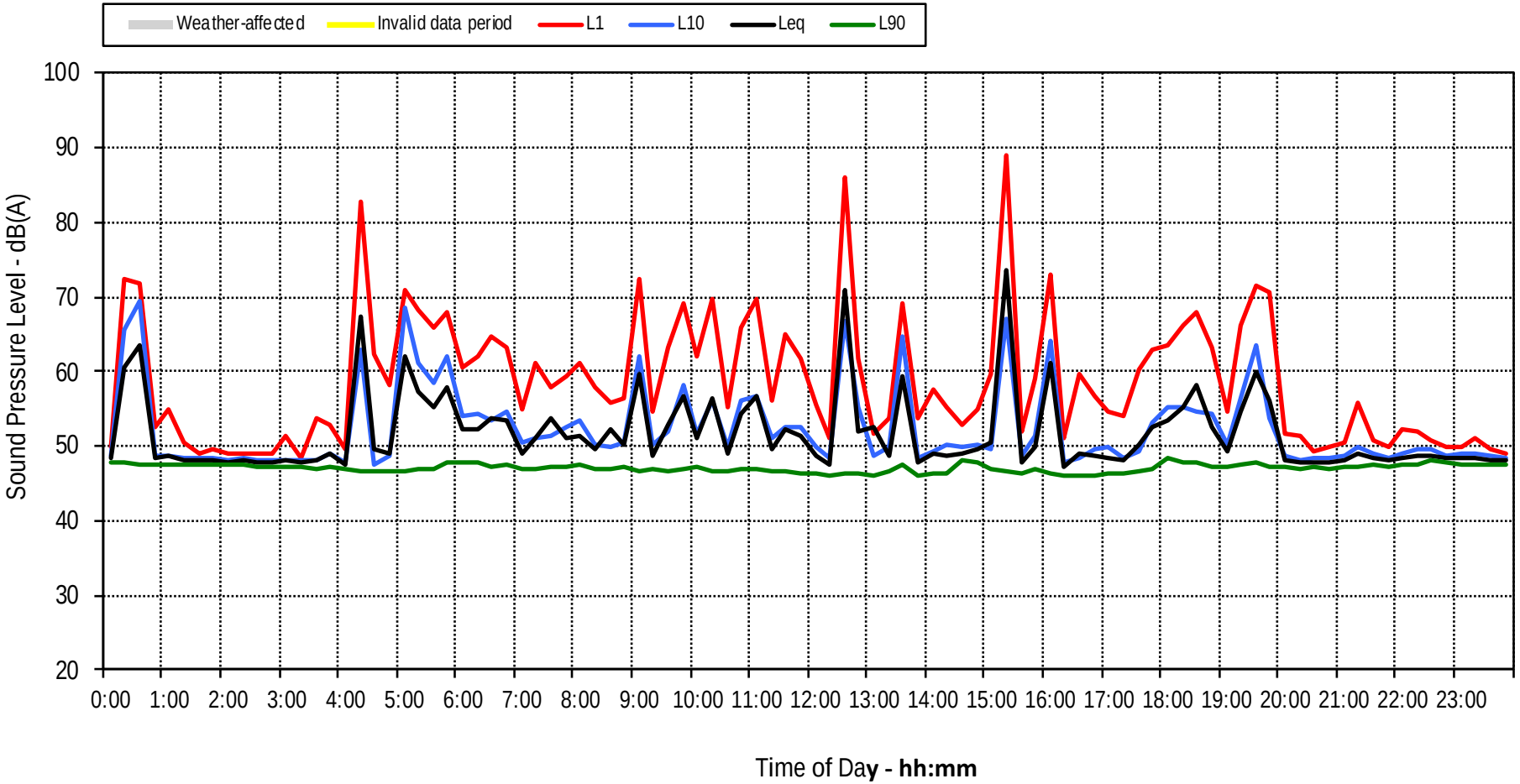


Location 3 – John Hunter Hospital Campus

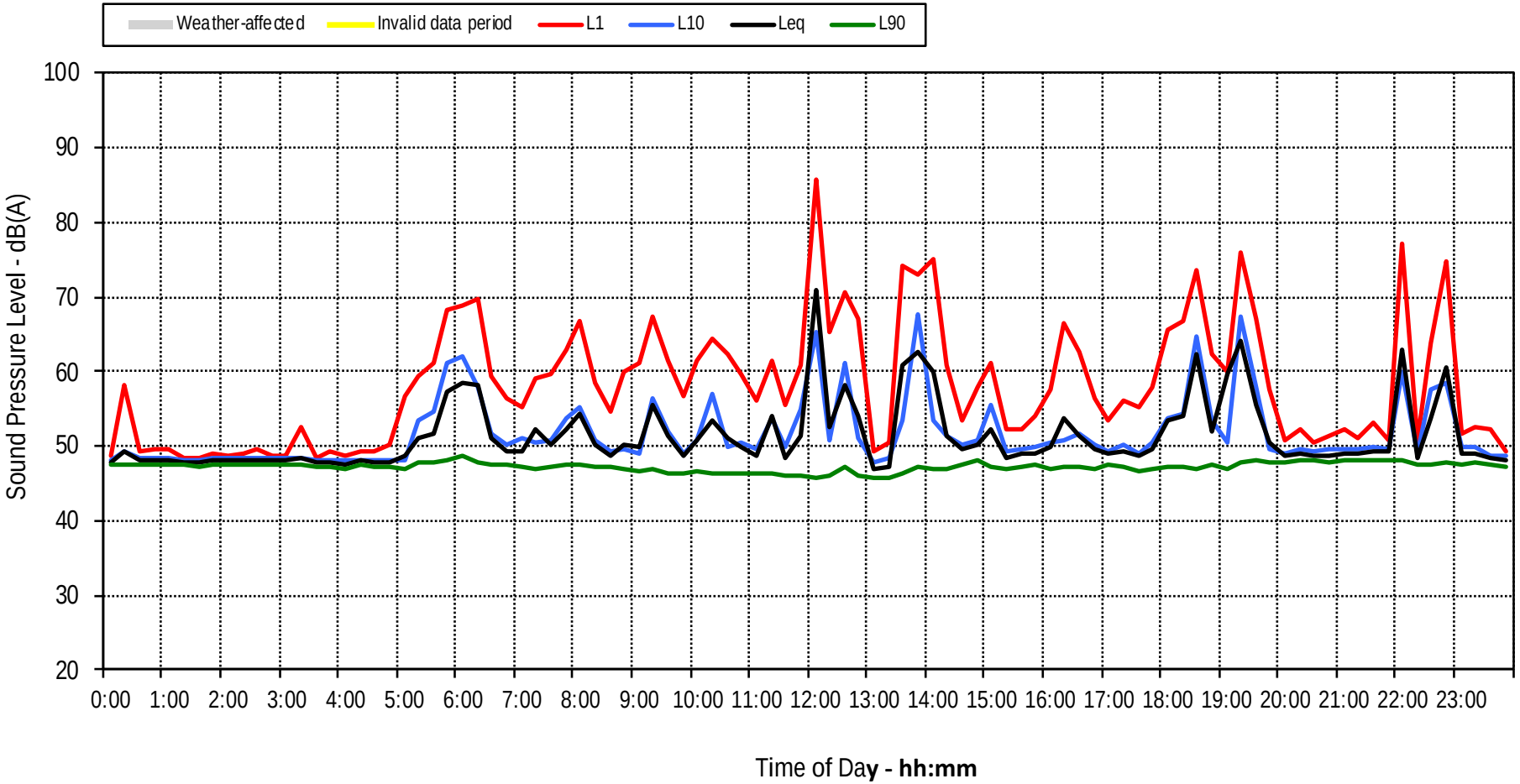
Location 3 - John Hunter Hospital Campus - Friday 09 October 2020



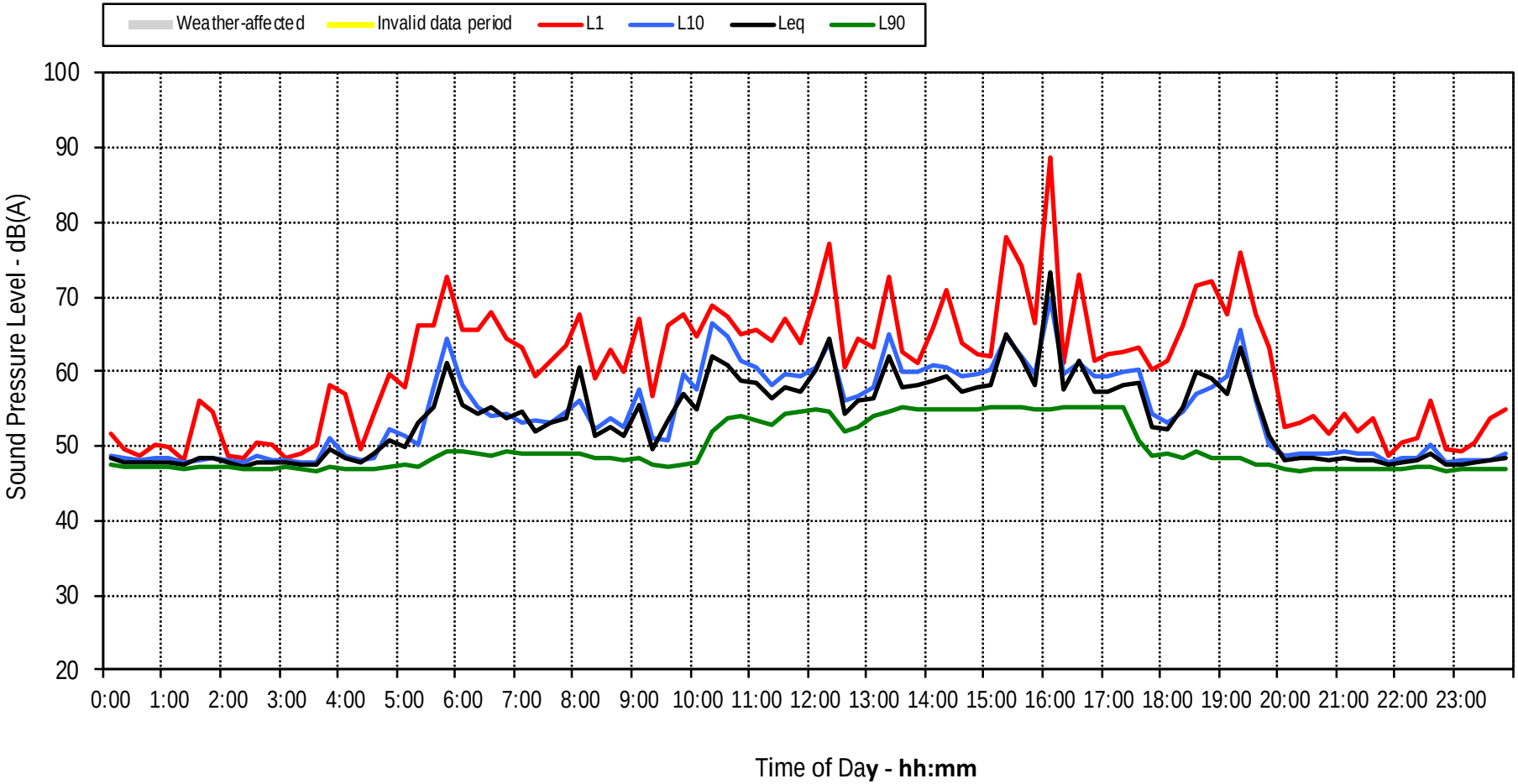
Location 3 - John Hunter Hospital Campus - Saturday 10 October 2020



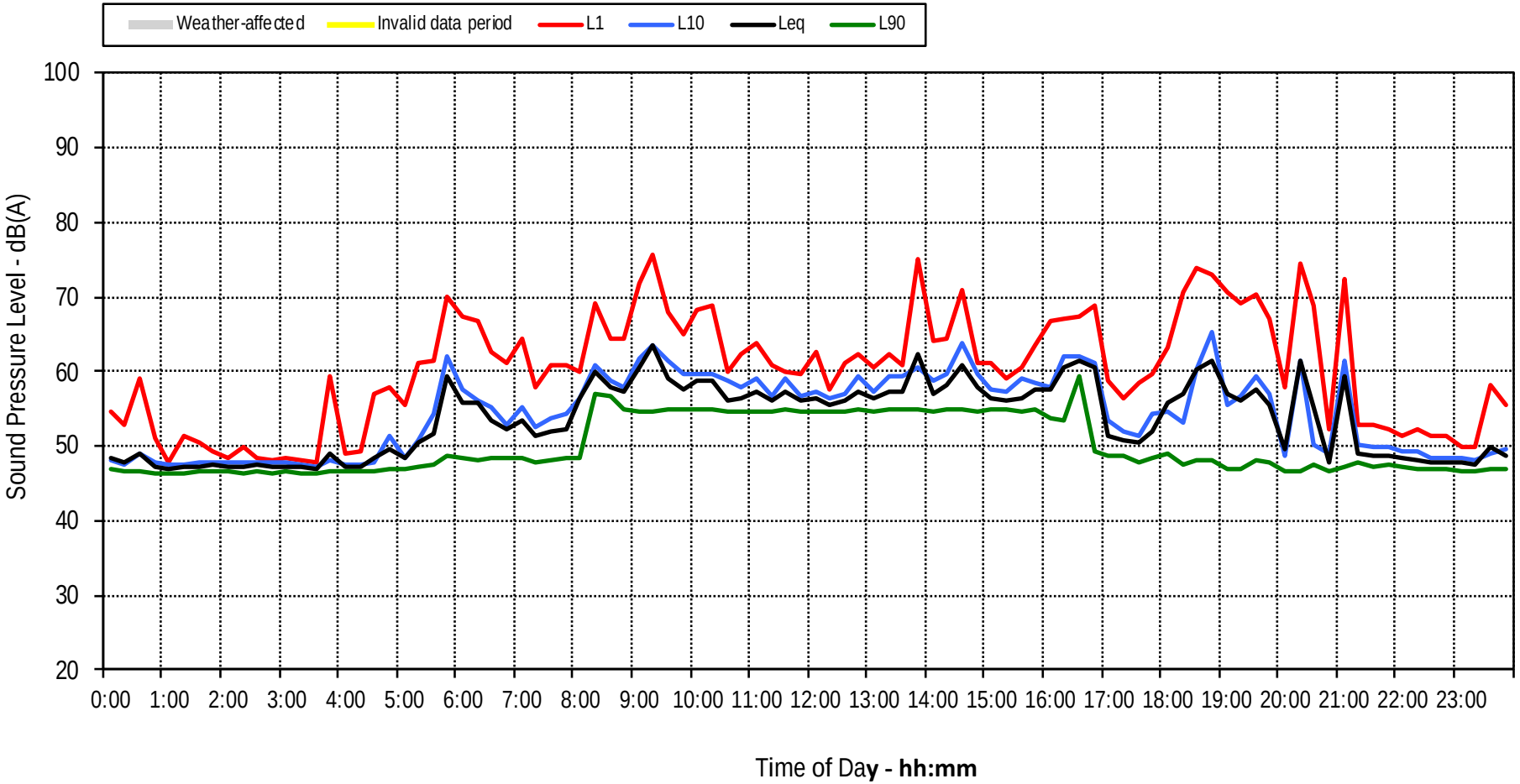
Location 3 - John Hunter Hospital Campus - Sunday 11 October 2020



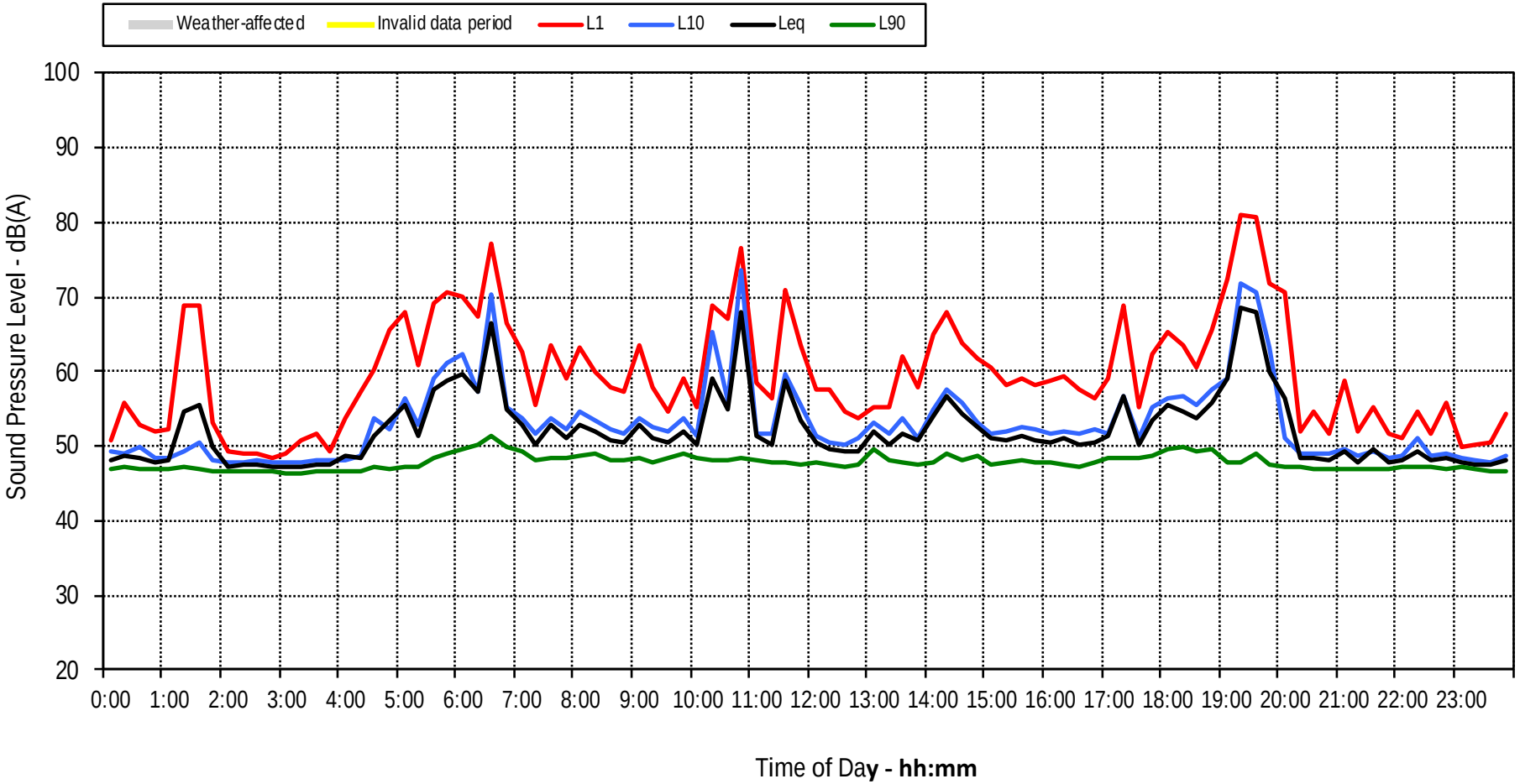
Location 3 - John Hunter Hospital Campus - Monday 12 October 2020



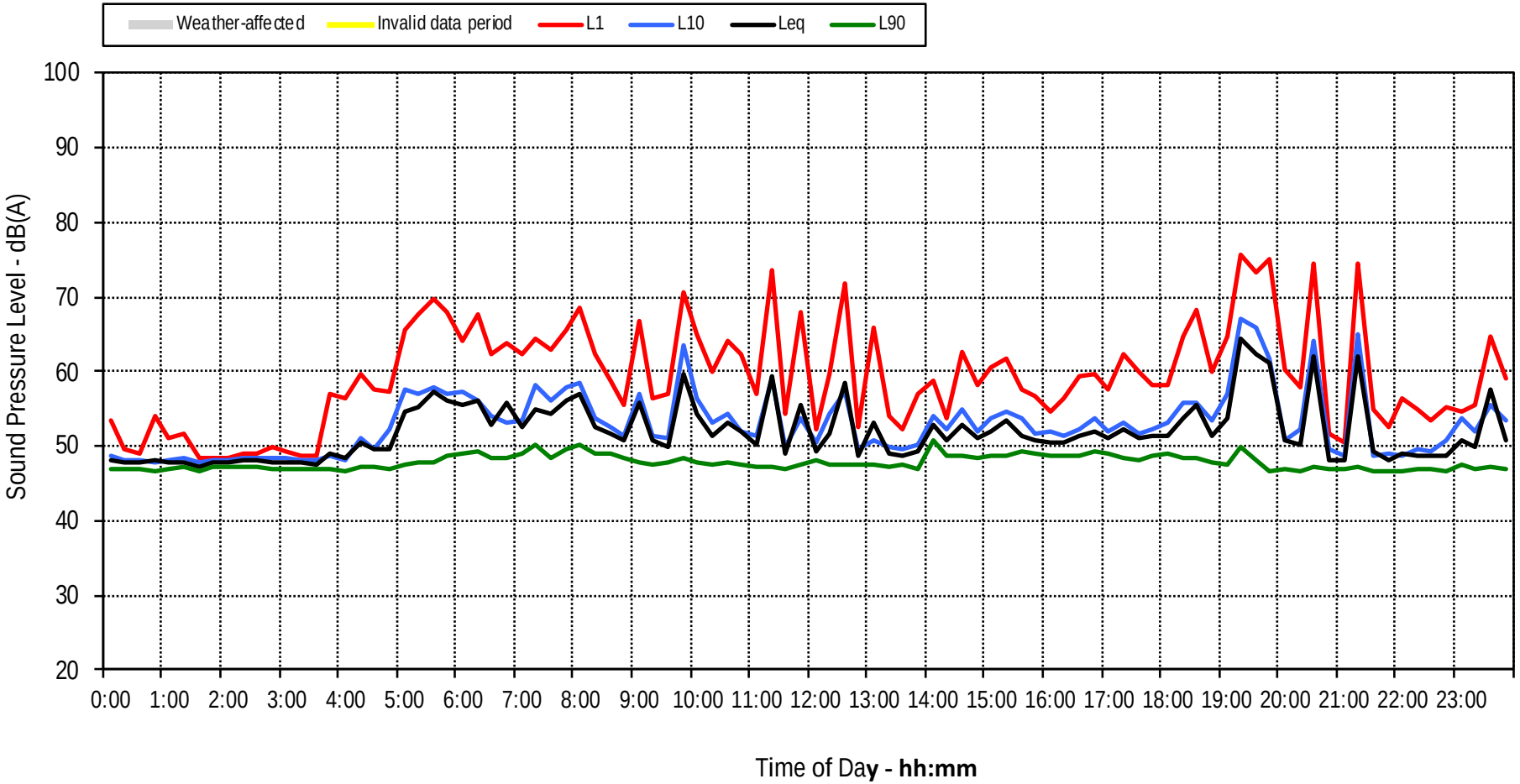
Location 3 - John Hunter Hospital Campus - Tuesday 13 October 2020



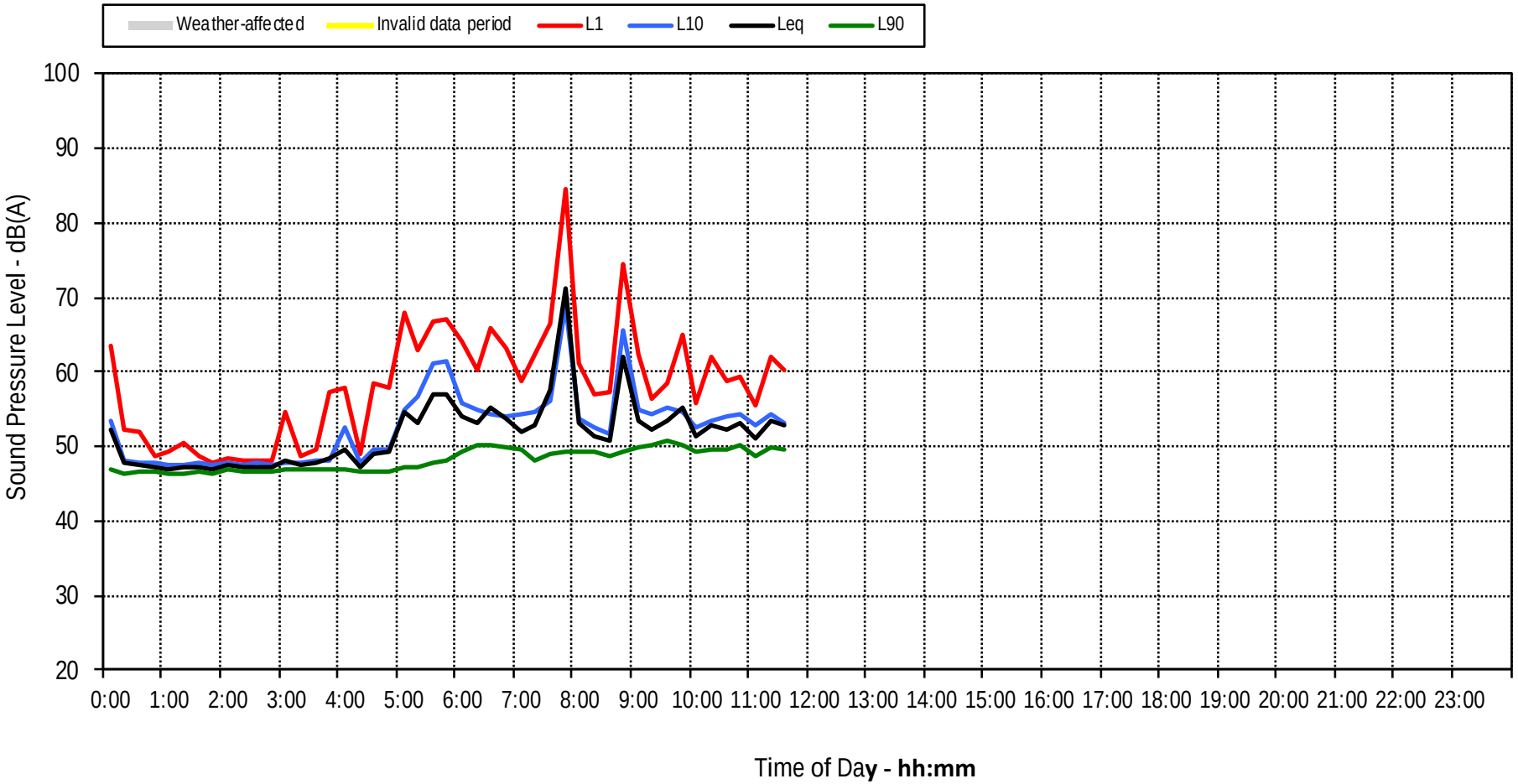
Location 3 - John Hunter Hospital Campus - Wednesday 14 October 2020



Location 3 - John Hunter Hospital Campus - Thursday 15 October 2020



Location 3 - John Hunter Hospital Campus - Friday 16 October 2020



Appendix C – Establishing NSW NPI Criteria

The main source of noise break-out from the proposed development to the environment will be activities noise from the premises and noise from the mechanical plant.

The environmental noise impact of the site has been assessed in accordance with the NSW EPA Noise Policy for Industry 2017 (NSW NPI).

The NSW NPI sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the Project Noise Trigger Level (PNTL).

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source is not to be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria only relate to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured – if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project noise trigger level

For the new plant in ASB premises, the more stringent of the intrusive and the amenity criteria sets the PNTL.

The derivation of the PNTL is provided below.

C.1 Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in NSW NPI.

Three time periods are considered (consistent with the operating times and the time of day classifications in the NSW NPI):

- Day - 7am to 6pm
- Evening - 6pm to 10pm
- Night - 10pm to 7am

The estimated RBL's and ambient noise levels are shown below in Table B1.

Location	L_{90} RBL Background Noise Levels, dB(A)			L_{eq} Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger Location 1	41	41	35	56	48	47
Logger Location 2	32	35	29	57	50	42
Logger Location 3	47	47	47	58	57	55

Table C1 : Long-term background and ambient noise levels based on NSW NPI around the site

We make the following comments with regard to the summary above:

- Review of the data and weather observations during the monitoring period confirmed that the data was not affected by adverse weather conditions.
- There were instances of extraneous noise that was removed from the data. This only affects the ambient noise level summary which does not affect the amenity criteria established for the project.
- Part of the monitoring was carried out at the end of the school holiday period (Friday 9th October), review of data showed no evidence of variation in noise levels when compared to existing noise data.
- Acoustic Studio has reviewed previous noise monitoring at nearby locations used as part of the EIS for the NICB *" Newcastle Inner city Bypass – Ranking Park to Jesmond, Environmental Impact Statement, Technical Paper 3 – Noise and Vibration Assessment 2016"*, prepared by Aurecon for RMS. Comparison of data show no clear impacts / notable change in noise levels associated with COVID-19.
- With consideration of the above it was noted that 90% of the data captured was consistent daily and the data collected is considered representative of the existing conditions at site (i.e. additional monitoring will not change the long term background summary).
- Based on the unattended and attended noise monitoring, the data from the follow loggers is representative of the following locations and used to establish the respective criteria:
    - Logger 1 – Pre-existing ambient and background noise levels at residential receivers to the east of the site.
    - Logger 2 – Pre-existing ambient and background noise levels at residential receivers to the west and north of the hospital campus
    - Logger 3 – Pre-existing ambient and background levels typical of the John Hunter Hospital Campus.

C.2 Determination of project intrusiveness noise level

The intrusiveness noise level is defined as:

$$L_{Aeq,15minute} = \text{RBL plus 5 dB(A)} \quad \text{(Equation 1)}$$

The intrusiveness noise level has been determined from the RBL's presented in table C1 for each period.

East (based on Logger Location 1)

- Day Intrusiveness criterion of - 41 + 5 = **46 dB(A)**
- Evening Intrusiveness criterion of - 41 + 5 = **46 dB(A)**
- Night Intrusiveness criterion of - 35 + 5 = **40 dB(A)**

West / North (based on Logger Location 2)

- Day Intrusiveness criterion of - 35[10] + 5 = **40 dB(A)**
- Evening Intrusiveness criterion of - 35 + 5 = **40 dB(A)**
- Night Intrusiveness criterion of - 30[11] + 5 = **35 dB(A)**

The Intrusiveness noise levels are only applied to residential receivers.

[10] Minimum NPI Day RBL's

[11] Minimum NPI Night RBL's

C.3 Determination of project amenity noise levels

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 is to remain below the recommended Amenity Noise Levels (ANL) specified in Table 2.2 of the NSW NPI where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended ANL represents the objective for total industrial noise at a receiver location, whereas the project ANL represents the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended ANL for an area, a project ANL applies for each new source of industrial noise from an industrial development as follows:

Project ANL = Recommended ANL minus 5 dB(A) (Equation 2)

The nearest residential receivers to the project are considered to be – as per NSW NPI Table 2.3 – in a Noise Amenity Area characterised by the NSW NPI as urban.

The recommended ANLs relevant to this project are specified in Table B3.

Receiver[12]	*Time of Day*	L_{Aeq}, *dB(A)*
		Recommended ANL
Residential (Suburban)	Day	55
	Evening	45
	Night	40
Hospital Ward - External	When in Use	50
Commercial	When in use	65

Table C3 : Recommended L_{Aeq} noise levels from industrial noise sources at residential and non-residential receivers

[12] The NSW NPI states, "Where internal noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and are to apply with the windows opened sufficiently to provide adequate ventilation, except where means of ventilation complying with the Building Code of Australia are provided. In cases where gaining internal access for monitoring is difficult, then external noise levels 10 dB(A) above internal levels apply".

The following exceptions to the above method to derive the project ANL apply:

- **Exception A – In areas with high traffic noise levels**

  The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the LAeq noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the $L_{Aeq,\ period(traffic)}$ minus 15 dB(A).

  This high traffic project amenity noise level may be applied only if all the following apply:

  - traffic noise is identified as the dominant noise source at the site,
  - the existing traffic noise level (determined using the procedure outlined in Section A2, Fact Sheet A of NSW NPI, measuring traffic instead of industrial noise) is 10 dB or more above the recommended ANL for the area, and
  - it is highly unlikely traffic noise levels will decrease in the future,

  for each assessment period where these traffic noise provisions apply, the High Traffic Project ANL is to be used for industrial development, derived from the $L_{Aeq,period(traffic)}$ as:

  High Traffic Project ANL = $L_{Aeq,period(traffic)}$ minus 15 dB(A) (Equation 3)

- **Exception B – In proposed developments in major industrial clusters**

  The recommended amenity noise level from Table B3 represents the total industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.

  The approach of deriving the project amenity noise level resulting from a new development on the basis of the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources.

Where an existing cluster of industry, for example, an industrial estate or port area, is undergoing redevelopment and/or expansion and the development constitutes a single premises addition or expansion, with no other redevelopment planned in the foreseeable future, the project amenity noise level approach procedure in Section B.3 can be applied.

However, where a greenfield or redevelopment of an existing cluster of industry consisting of multiple new noise-generating premises is proposed, the approach for determining the project amenity noise level in Section B.3 is not applicable and the approach below is to be applied.

For the new multiple premises or redevelopment of existing clusters of industry, for each individual premise,

$$\text{Individual Project ANL} = 10\text{Log}_{10}(10^{(L - 5\ dB/10)}/N)\ dB(A) \quad \text{(Equation 4)}$$

where L is the relevant recommended ANL from Table B3 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing L_{Aeq} industrial noise levels are more than 5 dB lower than the relevant recommended ANL, the above equation can be modified to reflect "L" in lieu of "L – 5 dB".

- **Exception C**

  Where the resultant project ANL is 10 dB or more lower than the existing industrial noise level. In this case the project ANL can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

- **Exception D**

  Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant ANL is assigned as the project ANL for the development.

Where the project ANL applies and it can be met, no additional consideration of cumulative industrial noise is required. However, in circumstances where this level cannot be feasibly and reasonably met, an assessment of existing industrial noise, and the combined resulting noise level from existing and the proposed industries, is required so the impact of the residual noise levels can be determined in accordance with Section 4.2 of the NSW NPI.

Receiver - External	*Time of Day*	*Recommended ANL*	*Adjustment*	*Project ANL*[13]
Residential (West / North)	Day	55	Equation 4	48
	Evening	45	Equation 4	38
	Night	40	Equation 4	33
Residential (East)	Day	55	Equation 4	48
	Evening	45	Equation 4	38
	Night	40	Equation 4	33
Hospital Ward	When in use	50	Equation 4	43
Commercial Premises	When in use	65	Equation 4	58

Table C4: Determination of Project Amenity Noise Levels for residential and commercial receivers

[13] The L_{Aeq} is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the Project ANL. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardize the time periods for the intrusiveness and amenity noise levels, the Policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3dB(A).

C.4 Project noise trigger level

The PNTL is defined as the lower of the project intrusiveness and amenity noise levels. On this basis, the PNTL are shown in Table C5 below (PNTLs shown shaded).

Receiver - External	*Period*	*Project Intrusiveness Noise Level*	*Project Amenity Noise Level*
Residential (East)	Day	46	48
	Evening	46	38
	Night	40	33
Residential (West / North)	Day	40	48
	Evening	40	38
	Night	35	33
Hospital Ward	When in use	-	43
Commercial Premises	When in use	-	58

Table C5 : Determination of Project Noise Trigger Levels for the site