

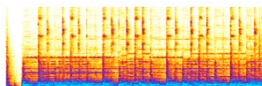
North Rocks Commuter Car Park

Commuter Car Park Program

Noise and Vibration Impact Assessment for Review of Environmental Factors (REF)

Issued

16 November 2020

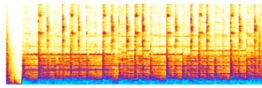


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Glossary

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. It is noted that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.
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.
$L_{1(\text{period})}$	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
$L_{10(\text{period})}$	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
$L_{90(\text{period})}$	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
$L_{\text{Aeq}(\text{period})}$	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

INITIALISM	Definition
CCP	Commuter Car Park
CNVMP	Construction Noise and Vibration Management Plan
CNVS	Construction Noise and Vibration Strategy
EPA	Environment Protection Authority
ICNG	Interim Construction Noise Guideline
NML	Noise Management Level
NPI	Noise Policy for Industry
PNTLs	Project Noise Trigger Levels
REF	Review of Environmental Factors
TfNSW	Transport for New South Wales
VML	Vibration Management Level

Executive Summary

Transport for NSW proposes the construction of a new North Rocks Commuter Car Park (CCP). This acoustic report:

- presents an assessment of the potential noise and vibration impacts of the Proposal
- has been prepared to support the Review of Environmental Factors (REF).

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 (NPI), 2017
- NSW EPA - Interim Construction Noise Guideline (ICNG), 2009
- NSW Department of Environment and Conservation (DEC) - Assessing Vibration: A Technical Guideline, 2006
- Transport for NSW (TfNSW) - Construction Noise and Vibration Strategy (CNVS), 2019.

We make the following comments and recommendations with regard to the noise and vibration assessment:

Construction Phase - Noise

Proposed construction hours for the project are as follows:

- Monday to Friday - 7:00am to 6:00pm
- Saturday - 8:00am to 1:00pm
- Sunday and Public Holidays – No works.

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

- Construction works noise impacts will be greatest adjacent to the site at the residential sensitive receiver (R01) in the Perry Street Noise Catchment Area (NCA). This is associated with various activities which are generally predicted to exceed the Noise Management Levels (NMLs), and at times exceed the highly noise affected NML, due to the proximity to the nearest affected receivers. The worst-case noise impacts are predicted to be from the operation of excavators with hammers and from the clearance of vegetation, both of which individually exceed the NMLs by up to 28 dB when at the closest position to the receiver.

- Noise levels from operations of various plant and equipment are predicted to be up to 8 dB lower when the location of activities within the site boundary are further away from a particular receiver (i.e., central to the construction site).
- Across Perry Street, at the nearest active recreation sensitive receiver (AR01) in the Barclay Road East NCA, noise level predictions at the boundary exceed NMLs by up to 16 dB when considering the closest position from the construction site.
- Noise levels at the residential sensitive receiver (R02) in the Barclay Road East NCA are predicted to exceed the NMLs by up to 10 dB but less than the highly noise affected NML when considering the closest position from the construction site.
- Generally, for all other receivers (including residential receivers to the north across the Hills M2 Motorway), the noise generated from the construction works is below the highly noise affected NML, and able to meet the NMLs to achieve the relevant criteria when further away from the perimeter boundary.
- The predictions exceeding NMLs are not unusual given the heavy plant and equipment that must be used such as excavators, plant for clearing vegetation, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site are within the relevant noise targets.
- Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding receivers are minimised when NMLs cannot be met due to safety or space constraints. These mitigation measures will further be considered in the detailed design phase.
- Standard mitigation measures to be considered as per recommendations in the ICNG and TfNSW CNVS where reasonable and feasible including (but not limited to):
 - applying Standard Hours
 - Consideration of including Respite Periods where activities are found to exceed the 75 dB(A) highly noise affected NML at receivers, such as 3 hours on, 1 hour off.
 - Consideration of including temporary solid fencing to provide additional shielding at the boundary of the site adjacent to residential sensitive receiver (R01) in the Perry Street NCA.
- Additional mitigation measures are determined in accordance with the TfNSW CNVS and include Periodic Notification (PN), Specific Notification (SN) and Verification Monitoring (V), as further described in Section 6.6.

Construction Phase - Vibration

At this stage, we anticipate that construction works will result in some human perception vibration impacts at surrounding receivers – particularly from the use of excavators with hammers and vibratory rollers nearest to the residential receiver location (R01) in the Perry Street NCA.

The degree of these impacts will need to be determined as part of the Construction Noise and Vibration Management Plan (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, based on the contractors chosen plant, equipment and construction method details.

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 substantial vibration levels justifies a more detailed investigation.

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

The following shall be considered:

- 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.

Operational Phase – Traffic Noise Generation

Traffic noise generation from the CCP is predicted to comply with the relevant noise increase criteria.

Operational Phase – CCP Noise Emission

Operation of the CCP is predicted to generate noise levels exceeding the Project Noise Trigger Level (PNTL) in the NPI for the night period when considering vehicle movements at the nearest sensitive receiver (R01) in the Perry Street Noise Catchment Area (NCA).

It is also predicted that maximum noise levels from the CCP will exceed the sleep disturbance screening and sleep awakening levels at the nearest residential sensitive

receiver (R01). Mitigation measures such as a noise barrier / fencing described in Section 7.2.2 should be considered in the detailed design.

The table below provide a summary of the assessment findings and noise mitigation measures to be considered.

Potential Impact		Assessment Results	Mitigation Measures
Construction Phase	Noise	R01 and AR01 - Exceeds NMLs and highly noise affected level for most construction activities when works are nearest to sensitive receivers	Standard mitigation measures (including consideration of temporary solid fencing) Additional mitigation measures as per Section 6.6.1
		R02 - Exceeds NMLs for most construction activities when works are nearest to sensitive receivers. Potential to exceed highly noise affected level during excavation when at the closest position to receiver from site.	Standard mitigation measures Additional mitigation measures as per Section 6.6.1
		R03 - Generally complies, potential for minor exceedance of NMLs during excavation when at the closest position to receiver from site.	Standard mitigation measures
	Vibration	R01 - Potential for equipment to be used within recommended minimum working distances - (particularly excavators with hammers, vibratory rollers)	Modifications to equipment, methods of work, rescheduling
Operational Phase	Traffic Noise Generation	Complies with relevant criteria at all receivers	-
	CCP Noise Emission	R01 - exceeds night PTNL + potential for sleep disturbance impacts	Consider noise barrier / fence at receiver boundary

1 Introduction

Acoustic Studio has been engaged by Advisian on behalf of Transport for NSW (TfNSW) to assess the potential noise and vibration impacts of the proposed North Rocks Commuter Car Park (CCP). The Proposal Site is located on at the corner of Barclay Road and Perry Street, North Rocks.

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
- identifying the main noise and vibration generating sources for construction and operation of the development
- 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 Scope of Assessment

This acoustic report has been prepared to support the Review of Environmental Factors (REF). It provides a review and assessment of potential noise and vibration impacts associated with the Project for noise and vibration emissions, both:

- during **construction of the CCP**
- associated with the **operation of the CCP.**

1.2 Overview

The Proposal involves the construction of an at-grade car park in North Rocks, Sydney, as part of the Commuter Car Park Program which would provide customers with more convenient access to public transport at the M2 Barclay Road Bus Interchange and help ease congestion on the roads.

The Proposal would include the following key features:

- enabling works including cut and fill bulk earthworks and site clearance of existing landscaping and perimeter trees
- provision of an at-grade car park, comprising:
 - around 135 car parking spaces
 - 3 accessible parking spaces, either within the existing Barclay Road Commuter Car Park or within the new commuter car park
 - wayfinding signage for pedestrian and vehicular circulation
 - new line-marking
 - retaining walls between car parking terraces
 - Transport Park&Ride infrastructure
- landscaping works, including:
 - retaining wall along Perry Street
 - soft landscaping
 - pedestrian footpaths and lighting within the Proposal
- ancillary works including site investigations, stormwater drainage and on-site detention tank, services relocation and/or adjustments, installation of boom gates and handrails
- new infrastructure including CCTV cameras, subject to requirements resulting from the detailed design security risk workshop
- new driveway crossing and layback for vehicular entry and exit on Perry Street
- temporary site compounds for storage of equipment and materials, as well as site offices and amenities.

Subject to approval, construction is expected to commence in mid-2021 and take around 12 months to complete.

2 Surrounding Land Uses

The project site is situated within suburban area with the following existing land uses surround the existing the project boundaries:

- E2 – Environmental Conservation
- R2 – Low Density Residential
- RE1 – Public Recreation
- RE2 – Private Recreation
- SP2 – Infrastructure.

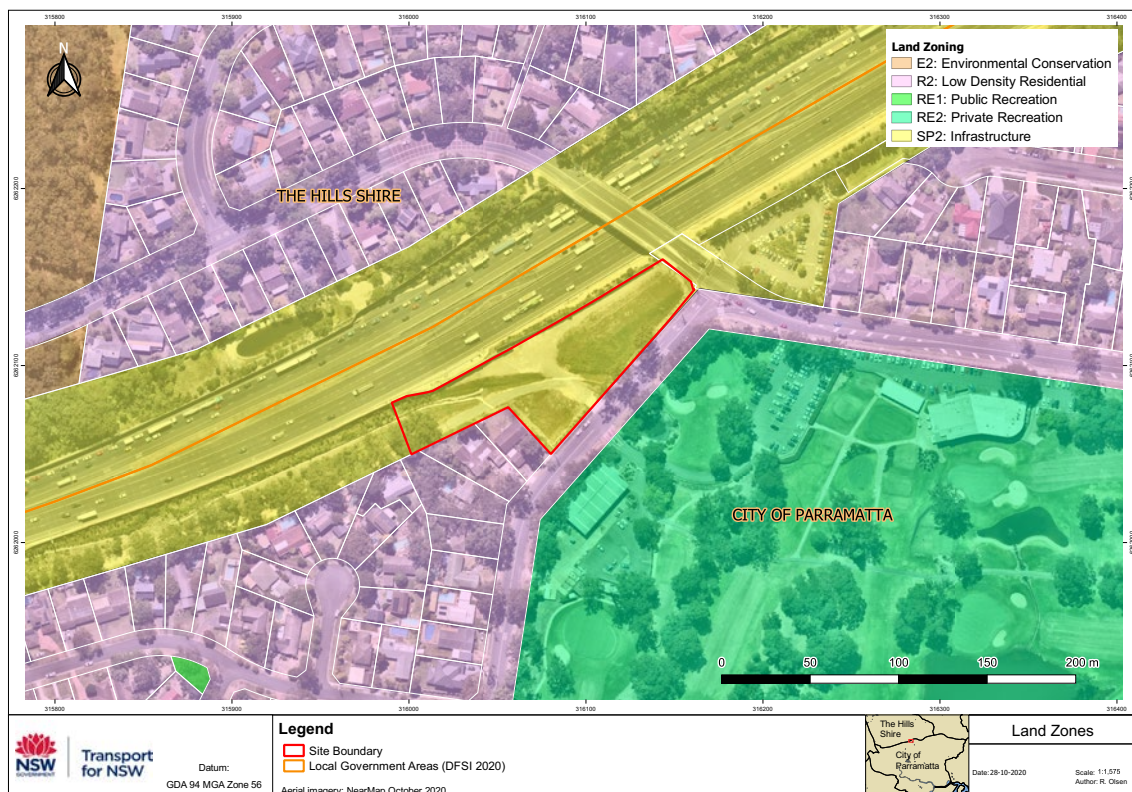


Figure 2-1: Surrounding Land Uses

2.1 Potentially Noise Sensitive Receivers

Acoustic Studio has identified the following potentially noise sensitive receivers around the Proposal Site, which are grouped into Noise Catchment Areas (NCA) with representative potentially worst-case locations identified with receiver ID's as follows.

Table 2-1: Potentially Noise Sensitive Receivers

Noise Catchment Area	ID	Description Address	Type
Perry Street	R01	Perry Street	Residential
	IND01	Lenton Place	Industrial
Barclay Road East	R02	Barclay Road (East)	Residential
	AR01	Muirfield Golf Club	Active Recreation
	SC01	Muirfield High School	School Classroom
Barclay Road West	R03	Barclay Road (West)	Residential

Figure 2-2 presents the project site in context of the surrounding land uses, monitoring locations and receiver ID.

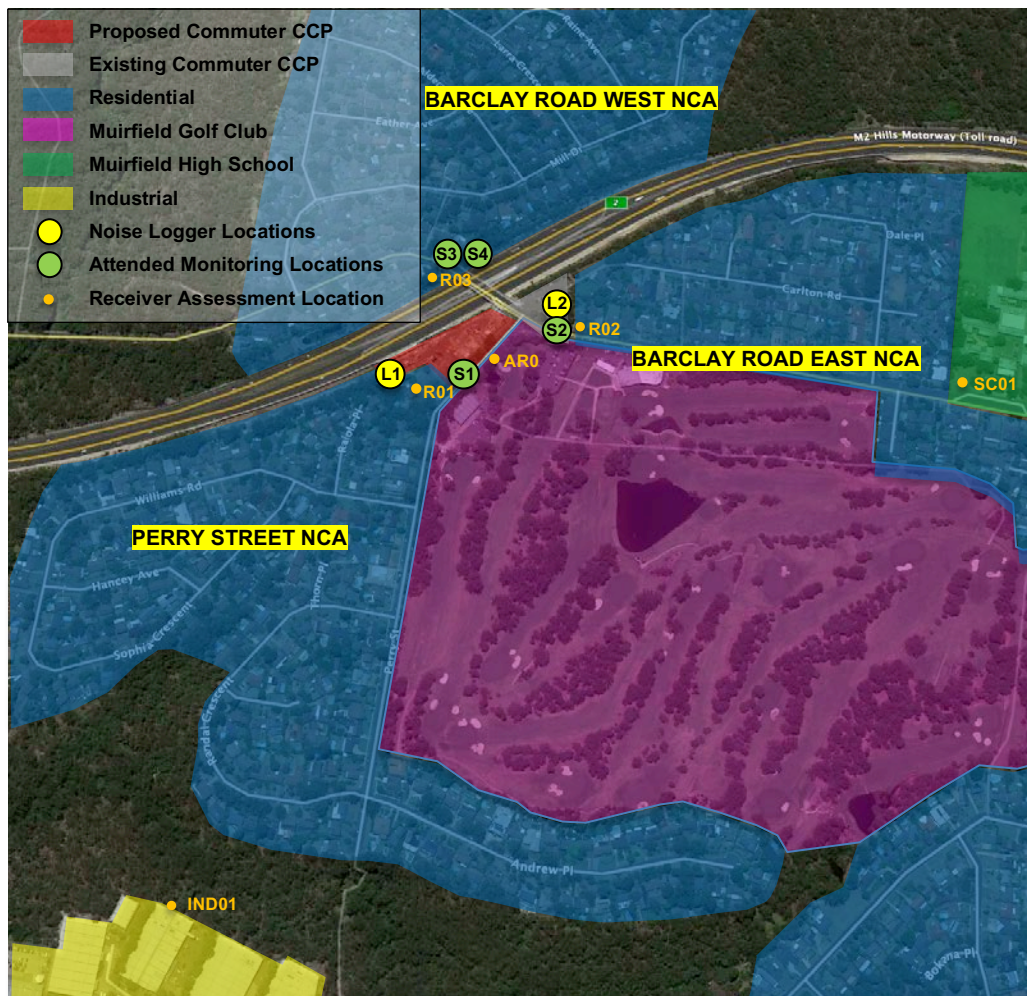


Figure 2-2: Aerial View showing the Proposed CCP Site in relation to noise-sensitive receivers and monitoring locations

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

3 The Key Acoustic Issues

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

External Noise Emissions - noise emissions from the Proposal are to be managed to limit environmental noise impacts on sensitive receivers resulting from the operation of the proposed development. In particular, this applies to:

- Traffic noise generation - the impact of operational traffic noise on surrounding receivers from changes in traffic flow as a result of the new development.
- CCP Noise Emission – the impact of noise emitted from the use of the CCP including vehicles.

Noise and Vibration Emissions from Construction - the impact of noise and vibration generated during the construction stage 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 the construction stage. 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 limits have been set for the Proposal and construction noise impacts have been anticipated from standard construction procedures.

The construction noise and vibration limits 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 Noise Management Levels (NMLs), then all reasonable and feasible noise and vibration mitigation measures must be considered as detailed in Section 6.5. Additional noise mitigation measures are also provided in Section 6.6.

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
 - reporting noise surveys which determine the existing ambient and background noise and vibration levels at the nearest sensitive receivers that surround the proposed development site
 - establishing the appropriate construction noise and vibration criteria based on the measurement results from the surveys
 - 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 criteria
 - 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 within established criteria.

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 at the proposal site and 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 878190, last calibrated in a NATA-accredited facility on 12th August, 2020). Monitoring was carried out at this location between:
 - Thursday 8th October to Wednesday 14th October, 2020
- Logger 2: Bruel and Kjaer 2250 (Serial Number 2832406, last calibrated in a NATA-accredited facility on 3rd March, 2020). Monitoring was carried out at this location between:
 - Thursday 8th October to Wednesday 14th October, 2020
 - Extended monitoring - Friday 16th and Tuesday 20th.

The 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.

The unattended long-term noise monitoring locations are shown in Figure 2-2. These locations were chosen in consultation with TfNSW as they:

- were secure places to leave the noise loggers unattended
- were judged to provide representative of background and ambient noise levels at the nearest noise sensitive receivers plus traffic noise levels affecting the development site.

Operator attended, short-term monitoring was also carried out on 16th October 2020 & 20th October 2020 in order to supplement the long-term outdoor data across the site and at key surrounding receivers, and to obtain data for traffic noise and establish transfer functions to unattended noise logger locations. These short-term measurements included measurements at the Barclay Road East NCA which were used to confirm that the long-term monitoring at logger locations could be used as representative of the background and ambient noise levels at the nearest noise sensitive receivers for this catchment.

Attended short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 3010373, last calibrated in a NATA-accredited facility on 6th

November, 2018). The calibration 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 from wind turbulence noise, in accordance with Australian and International Standards.

Monica Saralertsophon and Anthony Cano of Acoustic Studio Pty Ltd carried out the surveys.

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

4.2 Unattended Long-term Monitoring Results

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

- Location L1 – Development Site / Residential Boundary – 1 Perry Street, North Rock
- Location L2 – Existing CCP / Residential Boundary – 53 Barclay Road, North Rocks.

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

The detailed results of the unattended long-term noise monitoring at the two (2) logger locations are shown in Appendix A.

4.2.1 Traffic Noise

Traffic noise monitoring results are summarised in Table 4-1 below. These levels are corrected to the distance from the road centreline to the closest (potentially most affected) residences, approximately 17m for Perry Street residences and 20m for Barclay Road residences.

Table 4-1: Summary of measured traffic noise levels

Location	Traffic Noise Levels, dB(A)			
	1 Hour Period		Period	
	Day L _{eq} , (1 hr)	Night L _{eq} , (1 hr)	Day L _{eq} , (15 hr)	Night L _{eq} , (9 hr)
Barclay Road	66	59	66	58
Perry Street	59	52	-	-

4.2.2 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 limiting criteria for noise emitted from the construction and operation of the new CCP.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L_{90} . The ambient noise level 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 4-2 below, together with the L_{Aeq} ambient noise levels measured for each period.

In accordance with the NSW NPI, any data likely to be affected by rain, wind or other extraneous noise have been excluded from the calculations.

Table 4-2: Long-term background and ambient noise levels

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 L1	52	43	36	57	52	52
Logger Location L2	52	48	37	66	64	58

Based on our observations during the site inspections, both ambient and background noise levels around the Proposal Site are generally dominated by traffic noise and general urban hum around the site at the two logger locations.

4.3 Short-term Monitoring Results

Four (4) short-term noise monitoring locations were chosen as representative of the site and surrounds as follows:

- Location S1 – Perry Street opposite the project site at the Muirfield Golf Course Entry
- Location S2 – 53 Barclay Road
- Location S3 – 71 Barclay Road
- Location S4 – 71 Barclay Road setback from the road behind the Hills M2 Motorway noise barrier.

The attended short-term monitoring locations are shown in Figure 2-2.

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

Table 4-3: Summary of short-term traffic, background and ambient noise levels

Location	Time	Descriptor	Measured sound level, dB re 20 µPa									
			Overall dB(A)	Octave band centre frequency ¹ , Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
S1	4.40pm 16 th Oct. 2020	L _{eq}	62	64	65	59	55	56	59	54	53	46
		L ₉₀	50	59	59	51	45	48	46	41	36	26
	2.45pm 20 th Oct. 2020	L _{eq}	61	63	67	59	57	54	58	54	46	37
		L ₉₀	49	60	61	55	49	46	45	40	34	24
S2	3.30pm 16 th Oct. 2020	L _{eq}	68	70	73	69	64	62	65	61	54	47
		L ₉₀	58	61	60	56	55	52	54	52	44	34
	3.05pm 20 th Oct. 2020	L _{eq}	69	70	72	67	64	63	66	63	55	48
		L ₉₀	57	61	61	56	53	52	53	2	43	33
S3	4pm 16 th Oct. 2020	L _{eq}	69	69	74	72	64	65	66	61	53	45
		L ₉₀	58	63	65	60	56	57	55	50	42	33
S4	4.20pm 16 th Oct. 2020	L _{eq}	59	65	68	62	56	57	54	50	48	41
		L ₉₀	56	61	64	57	53	54	51	47	40	30

5 Project Noise and Vibration Criteria

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:

- Paramatta Local Environmental Plan (LEP) 2011
- Paramatta Development Control Plan (DCP) 2011
- NSW Environment Protection Authority (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
- Transport for NSW “Construction Noise and Vibration Strategy” (CNVS) 2019
- 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.

5.2 Construction Noise and Vibration

5.2.1 ICNG 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 5-1 outlines the methodology for determining construction NMLs at nearby residential receivers surrounding the development site based on existing background noise levels.

Table 5-1: Residential construction NMLs for airborne noise as outlined in the ICNG

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 holiday	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> 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: <ol style="list-style-type: none"> 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) 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	<ul style="list-style-type: none"> 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.

The project-specific construction NMLs are shown in Table 5-2 based on the measured background noise levels at the site (displayed in Section 4 – also refer to Appendix B).

Table 5-2: Project Specific residential construction NMLs for airborne noise

Location	Period	Rating Background Level RBL, dB(A)	Noise Management Level L _{eq} (15 min) dB(A)
Residential	Monday to Friday	52	RBL + 10
	7am to 6pm		
	Saturday	52	
8am to 1pm	62		

The ICNG also recommends *ground-borne* NMLs at residences affected by nearby construction activities. Ground-borne noise levels are for evening and night-time periods only. Therefore, these are not included as part of this assessment.

Non-Residential Receivers: Commercial, Industrial and Educational Receivers

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

Table 5-3: NMLs for airborne noise – Non-Residential Receivers

Occupancy	NMLs L _{Aeq} (15 min) dB(A)
Classrooms at schools and other educational institutions	45 – Internal
Active Recreation Area	65
Commercial	70
Industrial	75

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 5-4 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.

Table 5-4: RNP assessment criteria for additional traffic on local roads generated by land use development including construction vehicles / traffic

Receiver	Assessment Criteria (external – unless otherwise specified)	
	Day (7am to 10pm) L _{Aeq} (period)	Night (10pm to 7am) L _{Aeq} (period)
Residential (Sub Arterial)	60 (15 hour)	55 (9 hour)
Residential (Local)	55 (1 hour)	50 (1 hour)
School classrooms (Educational)	40 (1 hour) internally when in use	-
Open Space (Active Use)	60 (15 hour) when in use	-

Results from the traffic noise level measurements along Barclay Road and Perry Street are presented in Table 4-1 and show that the existing traffic noise levels are currently equal to or exceeding the dB L_{Aeq} (1hr) RNP criteria for all receiver types surrounding the site. 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”*.

5.2.2 Vibration Criteria

Construction vibration is to be assessed in terms of:

- human comfort
- disruption to sensitive equipment
- structural damage.

Relevant criteria 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 limits for critical areas in hospital and educational buildings, and provides recommendations for measurement and evaluation techniques.

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Vibration in buildings may also occur from internal sources (within a building structure), such as building services and plant. As well as being sensitive to vibration, medical equipment can also be the source of vibration within the building.

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.

The criterion also considers the type of vibration being assessed, namely continuous, impulsive and intermittent vibration. Examples of these vibration types are provided in below.

Table 5-5: Examples of vibration types

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.

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 5-6. 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.

Table 5-6: Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
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
Impulsive vibration					
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

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 5-7 sets out the acceptable VDV values for intermittent vibration.

Table 5-7: Acceptable vibration dose values for intermittent vibration (m/s^{1.75})

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

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. Reference is made to the relevant British Standard.

British Standard

The relevant standard is BS7385: Part 2: 1993. 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:

Table 5-8: Transient Vibration Guide Values for Cosmetic Damage

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
Reinforced or framed structures Industrial & Heavy commercial buildings	50mm/s at 4Hz and above	

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.

5.2.3 TfNSW CNVS and Additional Airborne Noise Management Measures

The implementation of standard mitigation measures, compliance with maximum sound power levels for plant and equipment, construction hour management and stakeholder consultation measures should substantially reduce noise and vibration impacts on nearby sensitive receivers.

The TfNSW CNVS recognises that due to the variability of construction activities and limitations of feasible and reasonable measures, exceedance of noise and vibration management levels are still likely to occur. After the application of standard, reasonable and feasible mitigation measures the Additional Mitigation Measures Matrices (AMMM) shall be applied to determine additional measures where reasonable and feasible and in consultation with TfNSW communications representatives.

For construction activities during standard hours, the following additional management measures will need to be considered depending on the level of exceedance as shown in Table 5-9 to Table 5-11.

Table 5-9: Additional Management Measures (Standard Construction Hours)

Measure	Abbreviation
Alternate Construction Methodology	AC
Periodic Notification	PN
Respite Offer	RO
Specific Notification	SN
Verification Monitoring	V

Table 5-10: How to implement additional Airborne Noise Management Measures

Construction Hours	Receiver Perception	dB(A) exceeding RBL	dB(A) exceeding NML	Additional Management Measures
	Noticeable	5 to 10	0	-
Standard Hours	Clearly Audible	> 10 to 20	< 10	-
Monday to Friday 7 am to 6 pm	Moderately Intrusive	> 20 to 30	> 10 to 20	PN, V
Saturday 8 am to 1 pm	Highly Intrusive	> 30	> 20	PN, V
	75 dB(A) or Greater	N/A	N/A	PN, V, SN

Table 5-11: How to implement additional Vibration Management Measures

Construction Hours	Receiver Perception	Exceeds Vibration Management Level (VML)	Additional Management Measures
Standard Hours Monday to Friday 7 am to 6 pm	Human disturbance	> VML	PN, V, RO
Saturday 8 am to 1 pm	Building Damage	> VML	V, AC

5.3 Operational Noise Emissions

5.3.1 General Noise

Noise Policy for Industry

The NSW NPI provides guidance on methodology for determining limiting noise criteria for external noise emissions from an industrial premises including vehicle movements on that premises.

As the CCP is a public car park, the NSW NPI is not directly applicable, however in the absence of other specific guidelines can be used to provide guidance in assessing noise impacts.

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 B), Table 5-12 details the corresponding limits of allowable noise emission to the nearest receiver boundaries from the CCP.

Table 5-12: NSW NPI Project Noise Trigger Levels for external noise emissions from proposed development

Receiver (external boundary)	Period	Project Noise Trigger Level ¹ dB(A)
Residential (Perry Street Noise Catchment)	Day	53
	Evening	48
	Night	40
Residential (Barclay Road East and West Noise Catchment)	Day	54
	Evening	52
	Night	46
School classroom - internal	When in use	33 (internal)
Passive Recreation Area	When in use	48
Active Recreation Area	When in use	53
Commercial Premises	When in use	63
Industrial Premises	When in use	68

¹ Project Noise Trigger Level is based on the more stringent of the Project Amenity and Intrusiveness Noise Levels.

5.3.2 Sleep Disturbance

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 REF. It suggests sleep disturbance screening criteria to include both:

- Event $L_{Aeq,15min}$ 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater
- 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 5-13.

Table 5-13: Sleep Disturbance Screening Criteria

Residential Receiver Location	Period	Sleep Disturbance Screening Criteria	
		$L_{Aeq,15min}$ dBA	L_{AFmax} dBA
All	Night (10pm to 7am)	41	52

The sleep disturbance screening criteria $L_{Aeq,15min}$ and L_{AFmax} not exceeding the $L_{A90,(15\text{ minute})}$ 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.

Table 5-14: Sleep Awakening Level

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

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 are as per construction traffic noise criteria outlined in Section 5.2.1.

6 Construction Phase

6.1 Proposed Hours

It is proposed that the majority of the CCP would be built during standard construction hours as follows and in line with the ICNG:

- Monday to Friday - 7:00am to 6:00pm
- Saturday - 8:00am to 1:00pm
- Sunday and Public Holidays – no works.

Certain works may need to occur outside standard hours and would include night works.

Out of hours works are required in some cases to minimise disruptions to customers, pedestrians, motorists and nearby sensitive receivers.

Approval from TfNSW would be required for any out of hours work and the affected community would be notified as outlined in TfNSW's CNVS.

6.2 Description of Proposed Works

The required work sequence for the CCP is as follows:

- Enabling Works (3 weeks) includes:
 - Secure site perimeter boundary with temporary fencing
 - Undertake survey to identify site boundary and mark out existing services
 - Clear site of any existing vegetation not being retained and remove any spoil stockpiles
 - Establish site office, amenities and plant/material storage areas
 - Establish environmental controls, such as erosion and sediment controls
 - Install protective overhead wiring conductor flagging along Perry Street
- Major Works (approximately 49 weeks)
 - Provide necessary services to various points within the car park footprint
 - Undertake excavation works, test and remove all spoil from site to a licenced tipping facility.
 - Construct retaining walls, backfill of retaining walls
 - Construction of sub-base layer asphalt and drainage
 - Footpath and ramp construction and installation of new fencing

- Modifications to Perry Street as required for entrance and exist to car park
- Line marking, kerb guttering, lighting and landscape signage
- Site clean-up works, demobilisation for equipment and disassemble temporary fencing.

Figure 6-1 below provide detail of the proposal with respect the site and surrounds.

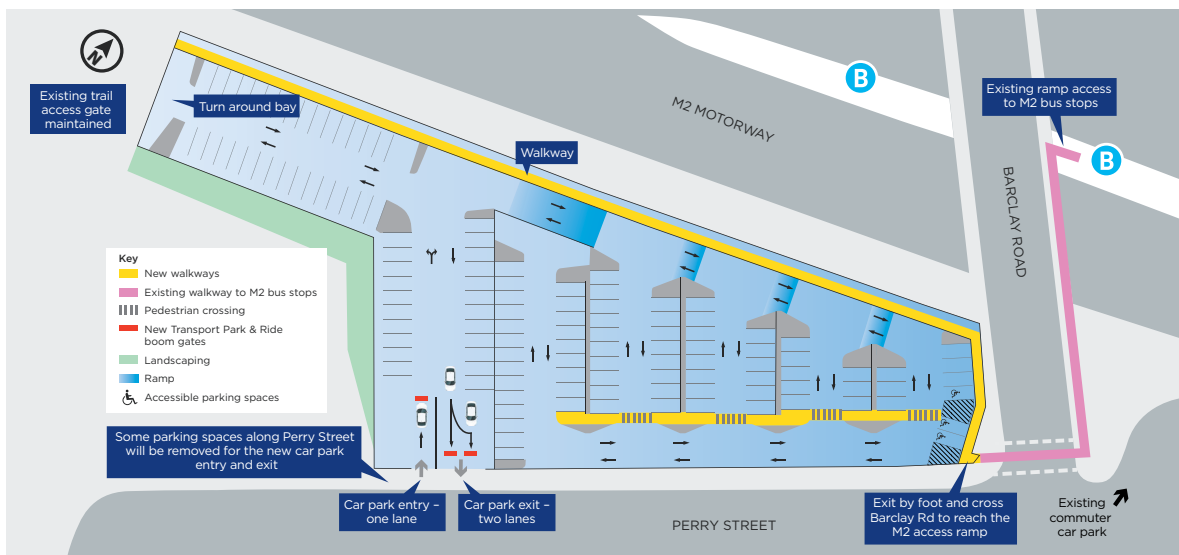


Figure 6-1: CCP Proposal

Typical construction equipment to be used is as follows:

- 30-45 t excavator (with rock breaker attachments)
- 14 t excavators
- 5 t excavators
- 10 t articulated dump trucks
- 30 t truck and trailer
- D6 dozer
- D4 skid steer loader
- grader
- 12 t smooth drum roller
- 12 t pad foot roller
- Forklift
- 120 t front end loader
- road sweeper
- water Cart
- asphalt trucks
- concrete trucks
- generator
- bobcat
- hand tools
- mulcher
- chainsaw
- helicopter (smoothing out concrete)
- rattle gun
- lighting towers
- vibratory roller
- jack hammer
- grinder
- continuous flight auger rod
- small mobile crane
- hand-held soil compactor or wacker rammer
- nail gun
- paving machine
- coring machine
- grinder
- stump grinder
- elevated working platform
- scissor lift.

A summary of works staging, tasks and typical equipment is provided below.

Table 6-1: Enabling and Major Works

Stage of Work (Period)	Main Tasks	Typical Plant
Enabling Works (3 weeks)	Site Perimeter Fencing	Hiab Trucks / Truck medium Rigid / Hand Tools / Forklift / Chain Saw / Mulcher /
	Clear vegetation	Stump grinder / Bobcats / Skip Trucks Mobile Crane / Rattle Gun / Nail Gun /
	Site office and Amenities	Generator / Demo Saw Elevated Work Platform
Major Works (approximately 49 weeks)	Services	Grinder / Saws / Hand Tools
	Excavation	Excavators / Backhoe /
	Retaining Walls	Skid Steer / Dozer / Loaders /
	Asphalting	Dump Trucks / Water Cart / Jackhammer / Mobile Crane /
	Footpath Ramp and Fencing	Concrete Truck / Concrete Pump / Vibrator
	Perry Street Modifications	Compactor / Rollers /
	Line Marking and Kerb Guttering	Asphalt Truck / Paving Machine Line Marking /
	Site Clean Up and Demobilisation	Compactors / / Forklift

6.3 Construction Noise

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

6.3.1 Noise Sources

The TfNSW CNVS outline maximum noise levels for typical plant and equipment that can be used as a guide for prediction of construction noise. Types of plant and associated noise levels are listed in Table 6-2. Where plant data is not provided in the TfNSW CNVS, Acoustic Studio data has been used indicated by an asterisk.

Table 6-2: Anticipated airborne noise levels for equipment / plant during construction works

Equipment Type	Item	Highest Permissible Noise Level L _{Aeq,15min} SWL
Heavy Vehicles	Asphalt – Truck and Sprayer	106
	Truck - Concrete	109
	Truck - Hiab	110*
	Truck - Dump 25 tonne	110
	Truck - medium Rigid 20 tonne	103
	Truck - Vacuum	109
	Water Cart	107
Site Machinery	Boom (elevated working platform)	97
	Compactor	106
	Compressor	84
	Concrete pump	109
	Dozer	116
	Excavator 10t	100 (118 with hammer)
	Excavator 20t	105
	Excavator 30t	110 (122 with hammer)
	Excavator 40t	110
	Forklift	100*
	Grader	113
Generator (6kW)	103	
Lighting Tower	80	

Equipment Type	Item	Highest Permissible Noise Level
		L _{Aeq,15min} SWL
	Lighting - Daymaker	98
	Line Marking Truck	108
	Loader Front End (wheeled)	112
	Loader Skidsteer ½ t	107
	Loader Skidsteer 1t	110
	Loader Tracked (0-50kW)	115
	Loader Tracked (200-300kW)	121
	Mobile Crane	113
	Pavement Laying Machine	114
	Pavement Profiler	117
	Roller – Vibratory 10 tonne	109
	Roller – smooth drum	107
	Roller – large pad foot	109
	Scissor Lift	98
	Tub Grinder / Mulcher 40-50hp	116
	Vibrator - Concrete	113
	Chain Saw	114
	Grinder	105
	Hand Tools (Electric)	99*
Hand Held Tools	Jackhammer	113
	Nail Gun	116*
	Rattle Gun	104
	Saw - Concrete	118

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

- rock hammering and excavation
- vibratory rollers.

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.

In addition, construction traffic movements around the site on the public roads will have the potential to impact on nearby noise-sensitive receivers.

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 6-3 outlines the most critical receivers surrounding the site for each type of impact.

Table 6-3: Noise sensitive receivers and approximate distance to Project construction works site

Noise Catchment Area	Receiver Type	Impact	ID	Typical Worst-Case Distance from construction site (m)
Perry Street	Residential	Airborne + Vibration	R01	10m to 50m
	Industrial	Airborne	IND01	650m
Barclay Road East	Residential	Airborne	R02	75m
	Classrooms at schools and other educational institutions	Airborne	East	540m
	Active Recreation Area (Golf Course)	Airborne	South East	20 to 50m
Barclay Road West	Residential	Airborne	R03	90m

6.3.3 Construction Noise Assessment Methodology

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

A quantitative assessment of noise emissions for the proposal was predicted using spreadsheet calculations in line with the recommendations in Section 4.5 of the ICNG for simple projects.

The calculations and assessment have considered the following:

- Typical activities considered in the noise impact assessment are as detailed in Section 6.2.
- Project specific NMLs at each sensitive receiver location as outlined in Section 5.2.
- noise level predictions are calculated using the noise data provided in Table 6-2 Calculations and include a 5 dB penalty for equipment identified to be particularly annoying for residents (as per Section 4.5 of the ICNG).
- Noise level predictions consider:
 - distance attenuation
 - building and barrier attenuation
 - building and façade 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 6-3.
- The predictions consider the typical noise range for a particular activity and associated equipment.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period to provide a worst-case assessment, except for hand tools which are generally assumed to operate for 50% of the assessment period.

6.3.4 Assessment Results

Construction Noise

Table 6-4 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.

Table 6-4: Predicted equipment/plant noise levels at the nearest surrounding community receiver locations. Construction noise exceeding NMLs are in **Blue**, and in **Bold** if exceeding highly noise affected NMLs

Construction Activity	Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)					
	Residential			SC01	AR01	IND01
	R01	R02	R03			
	62	62	62	55 ²	65	75
Site Perimeter Fencing	76 - 78	64 - 66	58 - 60	47 - 49	68 - 70	40 - 42
Clear vegetation	86 - 88	69 - 71	57 - 59	51 - 53	72 - 74	45 - 51
Site office and Amenities	77 - 83	66 - 71	50 - 55	48 - 54	69 - 75	42 - 48
Services	69 - 73	60 - 62	48 - 53	42 - 45	63 - 65	36 - 38
Excavation	85 - 90	71 - 76	59 - 64	55 - 59	76 - 79	48 - 52
Retaining Walls	75 - 78	67 - 70	55 - 58	50 - 53	71 - 74	44 - 46
Asphalting	70 - 75	57 - 64	45 - 52	40 - 46	60 - 66	33 - 39
Footpath Ramp and Fencing	63 - 69	63 - 69	51 - 57	46 - 53	63 - 69	40 - 46
Perry Street Modifications	75 - 81	61 - 67	49 - 55	46 - 53	75 - 81	40 - 46
Line Marking and Kerb Guttering	74 - 78	60 - 64	48 - 52	43 - 47	64 - 68	37 - 41
Site Clean Up & Demobilisation	76 - 78	64 - 66	58 - 60	47 - 49	68 - 70	40 - 42

² Assumes a minimum 10 dB from an open window for external noise level.

Construction Traffic Noise

As described in 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.

Based on existing traffic volume data for the roads surrounding the site received from a review of the *North Rocks Commuter Car Park, 102-106 Barclay Road, North Rocks, Transport Assessment*”, and prepared by GTA Consultants, the limit of increase in traffic volume can be predicted such that the resulting increase in traffic noise level over the existing is limited to +2dB. Further, considering the traffic volume data provided by GTA Consultants, Table 6-5 shows the indicative limits of increases in traffic volumes due to construction traffic to maintain an increase in traffic noise levels of less than 2 dB at each receiver.

Table 6-5: 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).

Traffic Source	Existing Traffic Volume (2019)			Limit of Increase in Traffic Volume (Weekday Average)		
	am peak (vph)	pm peak (vph)	Daily (vpd)	am peak (vph)	pm peak (vph)	Daily (vpd)
Barclay Road – East	1943	1732	19808	1100	1010	11500
Barclay Road – West	2074	1790	20827	1200	1040	12100
Perry Street	167	156	1741	97	91	1010

Anticipated construction traffic movements are as follows:

- 2 to 10 trucks per hour and 30 to 50 trucks daily.
- 50% of up to 40 workers per day will drive which equates to nominally 20 light vehicles per day.

The above volumes of construction traffic are well below the allowable limits. Even when factoring in higher noise levels from heavy vehicle plus the low speeds between the site entry / exit to the Perry Street and Barclay Road intersection, the increase above existing traffic noise levels will be less than 2 dB.

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 adjacent to the site at the residential sensitive receiver (R01) in the Perry Street Noise Catchment Area (NCA). This is associated with various activities which are generally predicted to exceed the Noise Management Levels (NMLs), and at times exceed the highly noise affected NML, due to the proximity to the nearest affected receivers. The worst-case noise impacts are predicted to be from the operation of excavators with hammers and from the clearance of vegetation, both of which individually exceed the NMLs by up to 28 dB when at the closest position to the receiver.
- Noise levels from operations of various plant and equipment are predicted to be up to 8 dB lower when the location of activities within the site boundary are further away from a particular receiver (i.e. central to the construction site).
- Across Perry Street, at the nearest active recreation sensitive receiver (AR01) in the Barclay Road East NCA, noise level predictions at the boundary exceed NMLs by up to 16 dB when considering the closest position from the construction site.
- Noise levels at the residential sensitive receiver (R02) in the Barclay Road East NCA are predicted to exceed the NMLs by up to 10 dB but less than the highly noise affected NML when considering the closest position from the construction site.
- Generally, for all other receivers (including residential receivers to the north across the Hills M2 Motorway), the noise generated from the construction works is below the highly noise affected NML, and able to meet the NMLs to achieve the relevant criteria when further away from the perimeter boundary.
- The predictions exceeding NMLs are not unusual given the heavy plant and equipment that must be used such as excavators, plant for clearing vegetation, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site are within the relevant noise targets.
- Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding receivers are minimised when NMLs cannot be met due to safety or space constraints. These mitigation measures will further be considered in the detailed design phase.

- Standard mitigation measures to be considered as per recommendations in the ICNG and TfNSW CNVS where reasonable and feasible including (but not limited to):
 - Applying Standard Hours
 - Consideration of including Respite Periods where activities are found to exceed the 75 dB(A) highly noise affected NML at receivers, such as 3 hours on, 1 hour off.
 - Consideration of including temporary solid fencing to provide additional shielding at the boundary of the site adjacent to residential sensitive receiver (R01) in the Perry Street NCA.
- Additional mitigation measures are determined in accordance with the TfNSW CNVS and include Periodic Notification (PN), Specific Notification (SN) and Verification Monitoring (V), as further described in Section 6.6.

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 noise criteria at any location or the equipment noise level limits, 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:

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, avoiding works during “outside standard hours” at nearby residential receivers.
- 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.
- Consider, for large work areas, solid screening or hoarding as part of the worksite.

- Consider locating 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.
- Limit the number 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.
- 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 Minimum vibration distances

The TfNSW CNVS provides the following guide for minimum working distances for typical items of vibration intensive plant.

Table 6-6: Recommended minimum working distances from vibration intensive plant

Plant	Approx. Size / Weight / Model	Minimum Distance – Cosmetic Damage (BS 7385)	Minimum Distance – Human Response (OE&H Vibration Guideline)
Vibratory Roller	1-2 tonne	5 m	15 m to 20 m
	2-4 tonne	6 m	20 m
	4-6 tonne	12 m	40 m
	7-13 tonne	15 m	100 m
	13 -18 tonne	20 m	100 m
	> 18 tonne	25 m	100 m
Small Hydraulic Hammer	300 kg (5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	900 kg (12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	1600 kg (18 to 34 t excavator)	22 m	73 m
Pile Driver - Vibratory	Sheet piles	2 m to 20 m	20 m
Piling Rig - Bored	< 800 mm	2 m (nominal)	N/A
Piling Rig – Hammer	12 t down force	15 m	50 m
Jackhammer	Hand Held	1 m (nominal)	Avoid contact with structure

6.4.2 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 characteristic
- specific construction equipment used

Activities that have the potential to generate the highest levels of vibration during construction works include:

- larger excavators with hammers
- larger vibratory roller

At this stage, we anticipate that construction works will result in some human perception vibration impacts at surrounding receivers – particularly from the use of excavators with hammers and vibratory rollers near the residential sensitive receiver (R01) in the Perry Street NCA.

The degree 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 construction works, vibration surveys be carried out of each key vibration-generating-activity / equipment.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of substantial 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.

The residential sensitive receiver location (R01) in the Perry Street NCA presents 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 Standard Control elements

The TfNSW CNVS lists standard mitigation measures that should be implemented at all sites. In addition, we make the following comments.

6.5.1 Noise - General

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 considering 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 reversing alarms or provide for alternative systems
 - 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 impact
 - 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 - General

At this stage, we anticipate that construction works will result in some human perception vibration impacts at surrounding receivers – particularly from the use of excavators with hammers and vibratory rollers near the residential sensitive receiver location (R01) in the Perry Street NCA.

Final details of the 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 substantial vibration levels justifies a more detailed investigation.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating substantial 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

The following applies if vibration is considered to be an issue.

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.

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 Project Noise and Vibration Control Considerations

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

If, during construction, an item of equipment exceeds either the noise criteria at any location or the equipment noise level limits, 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 closed 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 Additional Mitigation Measures

6.6.1 Airborne Noise

The following table outlines the additional mitigation measures that needs to be considered based on how far construction noise is predicted to be above the NMLs.

Table 6-7: Additional Mitigation Measures – Perry Street NCA (Residential - R01)

Construction Activity	Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)			
	Predicted construction activity noise levels at R01 $L_{eq,15min}$ dB(A)	NML	Level Exceeding NML dB / > 75 dB(A)	Additional Management Measures
Site Perimeter Fencing	76 - 78	62	> 75	PN, V, SN
Clear vegetation	86 - 88		> 75	PN, V, SN
Site office and Amenities	77 - 83		> 75	PN, V, SN
Services	69 - 73		> 10 to 20	PN, V
Excavation	85 - 90		> 75	PN, V, SN
Retaining Walls	75 - 78		> 75	PN, V, SN
Asphalting	70 - 75		> 10 to 20	PN, V
Footpath Ramp and Fencing	63 - 69		> 10 to 20	PN, V
Perry Street Modifications	75 - 81		> 75	PN, V, SN
Line Marking and Kerb Guttering	74 - 78		> 75	PN, V, SN
Site Clean Up and Demobilisation	76 - 78		> 75	PN, V, SN

Table 6-8: Additional Mitigation Measures – Barclay Road East NCA (Residential - R02)

Construction Activity	Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)			
	Predicted construction activity noise levels at R02 $L_{eq,15min}$ dB(A)	NML	Level Exceeding NML dB / > 75 dB(A)	Additional Management Measures
Site Perimeter Fencing	64 - 66	62	< 10	-
Clear vegetation	69 - 71		< 10	-
Site office and Amenities	66 - 71		< 10	-
Services	60 - 62		< 10	-
Excavation	71 - 76		> 75	PN, V, SN
Retaining Walls	67 - 70		< 10	-
Asphalting	57 - 64		< 10	-
Footpath Ramp and Fencing	63 - 69		< 10	-
Perry Street Modifications	61 - 67		< 10	-
Line Marking and Kerb Guttering	60 - 64		< 10	-
Site Clean Up and Demobilisation	64 - 66		< 10	-

Table 6-9: Additional Mitigation Measures – Barclay Road East NCA (Active Recreation - AR01)

Construction Activity	Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)			
	Predicted construction activity noise levels at AR01 $L_{eq,15min}$ dB(A)	NML	Level Exceeding NML dB	Additional Management Measures
Site Perimeter Fencing	68 - 72	65	< 10	-
Clear vegetation	72 - 74		< 10	-
Site office and Amenities	69 - 75		< 10	-
Services	63 - 65		< 10	-
Excavation	76 - 79		> 10 to 20	PN, V
Retaining Walls	71 - 74		< 10	-
Asphalting	60 - 66		< 10	-
Footpath Ramp and Fencing	63 - 69		< 10	-
Perry Street Modifications	75 - 81		> 10 to 20	PN, V
Line Marking and Kerb Guttering	64 - 68		< 10	-
Site Clean Up and Demobilisation	68 - 72		< 10	-

Notification Areas

The following outlines indicative notification areas that extend to areas where noise levels start to drop below or within 10 dB of the NMLs.



Figure 6-2: Notification Areas

6.7 Noise and vibration monitoring

6.7.1 Noise monitoring

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

- the site boundary near residential sensitive receiver location (R01) in the Perry Street NCA
- the site boundary near residential sensitive receiver (R02) and active recreation (AR01) location in the Barclay Street NCA.

Attended monitoring (attended or unattended) would be used to verify the noise impacts during construction to be reviewed and further action taken / refinement of mitigation measures and CNVMP as relevant.

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 limits appropriate action is to be taken.

6.7.2 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 allowable limits appropriate action is to be taken.

6.8 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 this position has not previously been highlighted but it is determined that the noise levels exceed the allowable limit, 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 limits 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.

6.9 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 Phase

7.1 Operating Hours

Once the construction of the CCP is completed, it will be operational 24 hours a day, seven days per week.

7.2 Operational Noise

Noise emissions associated with the operation of the CCP include:

- **traffic noise generation** on surrounding roads
- noise from **the use** (vehicles movements within the car park).

7.2.1 Traffic Noise Generation

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

Following a review of the “*North Rocks Commuter Car Park, 102-106 Barclay Road, North Rocks, Transport Assessment*”, and prepared by GTA Consultants (plus supplementary information from GTA consultants) the predicted traffic volumes on streets surrounding the Project are presented in Table 7-1.

Table 7-1: Predicted traffic volumes on streets surrounding the Project

Road / Street	Scenario	Peak Hour Vehicle Trips			
		Existing Traffic 2020		Predicted Traffic 2030	
		am	pm	am	pm
Perry Street	Base	167	156	200	186
	With CCP	207	190	240	220
Barclay Road East	Base	1943	1732	2322	2070
	With CCP	1955	1745	2334	2083
Barclay Road West	Base	2074	1790	2479	2139
	With CCP	2099	1817	2507	2166

Assessment of Noise Impact on Surrounding Receivers

Considering the predicted traffic volumes in Table 7-1, the increase in traffic noise is predicted and compared against the RNP criteria of relative traffic noise increase as presented in Table 7-2.

Table 7-2: Predicted traffic noise levels increase streets surrounding the Project.

Road / Street		Peak Hour Traffic Volume		Increase in Traffic Noise (dBA)	Complies?
		Base	With CCP	Criteria $\leq + 2\text{dB(A)}$	
Perry Street	am	167	207	0.9	Yes
	pm	156	190	0.9	Yes
Barclay Road East	am	1943	1955	0.0	Yes
	pm	1732	1745	0.0	Yes
Barclay Road West	am	2074	2099	0.1	Yes
	pm	1790	1817	0.1	Yes

Based on the above predictions, we make the following comments:

- Additional traffic generated on Barclay Road and Perry Street as a result of the CCP will be less than 2 dB and complies with the RNP.

7.2.2 Car Park Noise Emission

Noise Sources

The potential noise sources associated with the proposed CCP will be as follows:

- noise generated by vehicle movements within the car park / entering and exiting parking spaces (i.e. vehicles moving slowly)
- other vehicle operational noises (i.e. doors closing and engines starting).

The following typical noise levels for car park vehicle noise (including engine start, door/boot open and close, acceleration, and general vehicles movements) has been considered in the assessment and is based on Acoustic Studio's database including measurements from similar projects.

- 55 to 65 $L_{eq(event)}$ dB(A) @ 7m
- 75 L_{max} dB(A) @ 7m.

Vehicle Movements

Noise associated with the use will directly correlate to the number of vehicle movements at any given time.

Following a review of the "*North Rocks Commuter Car Park, 102-106 Barclay Road, North Rocks, Transport Assessment*", and prepared by GTA Consultants (plus supplementary information from GTA consultants), the predicted vehicle movements within the CCP are as follows:

- am peak hour – 40 vehicles in
- pm peak hour – 30 vehicles out.

The assessment considers the following

- am peak data (evenly distributed over 15 minutes) has been used for the day and early morning shoulder period
- pm peak data (evenly distributed over 15 minutes) has been used for the evening
- 50% of pm peak data (evenly distributed over 15 minutes) has been assumed for the night period as a conservative assessment in the absence of exact vehicle movement predictions.

Assessment Methodology

A preliminary assessment of the likely noise impacts associated with the use of the CCP at the most-affected residential sensitive receiver location (R01) in the Perry Street NCA has been carried out.

The assessment has considered the following:

- typical activities and noise data in Section 7.2 – Noise Sources
- PNTLs at the nearest sensitive receiver location as outlined in Table 5-12 Section 5.3.1. In addition, an early morning shoulder period between 5am and 7am has been considered.
- sleep disturbance screening criteria at the nearest sensitive receiver location as outlined in Section 5.3.2
- noise level predictions consider distance attenuation
- The noise level predictions are based on assumptions that represent the worst-case scenario (including car park spaces nearest to the noise sensitive receivers being used).
- predictions consider the typical worst-case distances
- There is no mechanical plant and equipment proposed for the site. Therefore, no assessment is carried out for this.

Assessment – Operational Noise

The predicted operational noise levels associated with the CCP are provided below.

Table 7-3: CCP operational noise assessment results during all time periods

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)
	NSW NPI Criteria			
	53 dB(A)	48 dB(A)	40 dB(A)	52 dB(A)
R01	48	47	44	48

Assessment - Sleep Disturbance

Table 7-4: CCP operational noise assessment against Sleep Disturbance Screening Criteria.

Assessment Location	Noise Levels at Receiver Boundary, in dB(A)	
	Sleep Disturbance Screening Criteria	
	41 dB(A) L _{Aeq,15min}	52 dB(A) L _{AFmax}
R01	44	67

The sleep disturbance study shows that the predicted L_{Fmax} noise levels exceed the Sleep Disturbance Screening Criteria by up to 15 dB(A) further assessment has been undertaken against the sleep awakening level to assess the extent of impacts on sleep at the nearest residential sensitive receiver location (R01) in the Perry Street NCA. Assessment against the sleep awakening level is outlined below.

Table 7-5: CCP operational noise assessment against Sleep Awakening Level.

Assessment Location	Noise Levels at Receiver Boundary, in dB(A)
	Sleep Awakening Level
	65 dB(A) L _{AFmax}
R01	67

Summary

Results and Discussion

We make the following notes:

- Operational Noise:
 - The predicted operational noise levels associated with the operation of the CCP is predicted to exceed the criteria for the night period at the nearest residential sensitive receiver location (R01) in the Perry Street NCA. It is noted that these levels are below the pre-existing ambient noise levels at the site (generally driven by the M2 motorway noise).
 - Operational noise levels at all other receivers are predicted to comply with the relevant criteria.
- Sleep Disturbance:
 - The predicted levels marginally exceed (2 dB) the sleep awakening level at the nearest residential sensitive receiver location (R01) in the Perry Street NCA.
 - All other locations are predicted to be below the Sleep Awakening Level.
 - It is noted that the 65 dB(A) sleep awakening level is based on a worst-case window opened sufficiently to provide adequate natural ventilation.
 - Predictions consider the nearest window at the residential sensitive receiver location (R01) in the Perry Street NCA as a potential bedroom as a worst-case assessment.
 - The exceedance is based on vehicles moving and parked at the nearest parking space adjacent to the residential sensitive receiver location (R01) in the Perry Street NCA.
 - When considering the M2 bus timetable, the time of night that these events are likely to occur are between 10pm to 1am and 4am to 7am. The background noise level during these periods will be 5 to 10 dB higher than in the middle of the night (i.e. 2am to 3am).

Noise Mitigation Measures

The CCP is designed to be an open-air car park with existing mesh fence which may be retained at the perimeter boundaries adjacent to residential noise receivers.

Noise mitigation that could be considered includes installation of a fence or noise barrier in addition of, or to replace the existing mesh fence at the boundary of Perry Street NCA (R01).

The fence / noise barrier could incorporate vegetation to improve visual amenity and reduce the potential for anti-social behaviours such as graffiti.

The above will be considered as part of the detailed design and reasonable and feasible measures will be implemented to minimise noise impact and sleep disturbance risks.

8 Discussion and Recommendations

A noise and vibration assessment report has been produced to determine the potential noise impacts and considerations for the proposed North Rocks CCP.

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 Phase - Noise

Proposed construction hours for the project are as follows:

- Monday to Friday - 7:00am to 6:00pm
- Saturday - 8:00am to 1:00pm
- Sunday and Public Holidays – No works.

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

- Construction works noise impacts will be greatest adjacent to the site at the residential sensitive receiver (R01) in the Perry Street NCA. This is associated with various activities which are generally predicted to exceed the Noise Management Levels (NMLs), and at times exceed the highly noise affected NML, due to the proximity to the nearest affected receivers. The worst-case noise impacts are predicted to be from the operation of excavators with hammers and from the clearance of vegetation, both of which individually exceed the NMLs by up to 28 dB when at the closest position to the receiver.
- Noise levels from operations of various plant and equipment are predicted to be up to 8 dB lower when the location of activities within the site boundary are further away from a particular receiver (i.e. central to the construction site).
- Across Perry Street, at the nearest active recreation sensitive receiver (AR01) in the Barclay Road East NCA, noise level predictions at the boundary exceed NMLs by up to 16 dB when considering the closest position from the construction site.
- Noise levels at the residential sensitive receiver (R02) in the Barclay Road East NCA are predicted to exceed the NMLs by up to 10 dB but less than the highly noise affected NML when considering the closest position from the construction site.

- Generally, for all other receivers (including residential receivers to the north across the Hills M2 Motorway), the noise generated from the construction works is below the highly noise affected NML, and able to meet the NMLs to achieve the relevant criteria when further away from the perimeter boundary.
- The predictions exceeding NMLs are not unusual given the heavy plant and equipment that must be used such as excavators, plant for clearing vegetation, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site are within the relevant noise targets.
- Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding receivers are minimised when NMLs cannot be met due to safety or space constraints. These mitigation measures will further be considered in the detailed design phase.
- Standard mitigation measures to be considered as per recommendations in the ICNG and TfNSW CNVS where reasonable and feasible including (but not limited to):
 - Applying Standard Hours
 - Consideration of including Respite Periods where activities are found to exceed the 75 dB(A) highly noise affected NML at receivers, such as 3 hours on, 1 hour off.
 - Consideration of including temporary solid fencing to provide additional shielding at the boundary of the site adjacent to residential sensitive receiver (R01) in the Perry Street NCA.
- Additional mitigation measures are determined in accordance with the TfNSW CNVS and include Periodic Notification (PN), Specific Notification (SN) and Verification Monitoring (V), as further described in Section 6.6.

Construction Phase - Vibration

At this stage, we anticipate that construction works will result in some human perception vibration impacts at surrounding receivers – particularly from the use of excavators with hammers and vibratory rollers near at the nearest sensitive receiver (R01) in the Perry Street NCA.

The degree 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.

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.

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.

Operational Phase – Traffic Noise Generation

Traffic noise generation from the CCP is predicted to comply with the relevant noise increase criteria.

Operational Phase – CCP Noise Emission

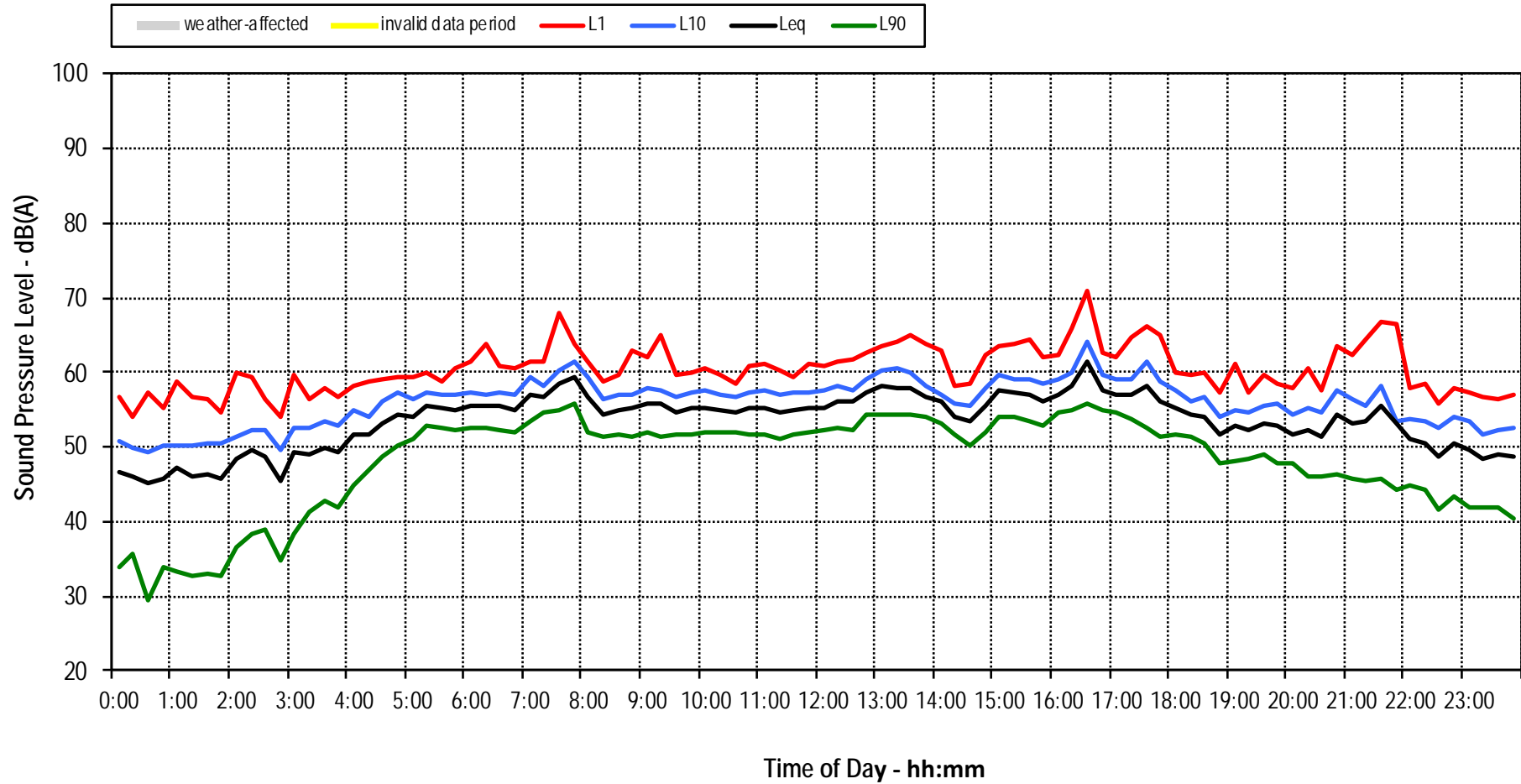
Operation of the CCP is predicted to generate noise levels exceeding the PNTL in the NPI for the night period when considering vehicle movements at the nearest sensitive receiver (R01) in the Perry Street Noise Catchment Area (NCA).

It is also predicted that maximum noise levels from the CCP will exceed the sleep disturbance screening and sleep awakening levels at the nearest residential receivers. Mitigation measures such as a noise barrier / fencing described in Section 7.2.2 should be considered in the detailed design.

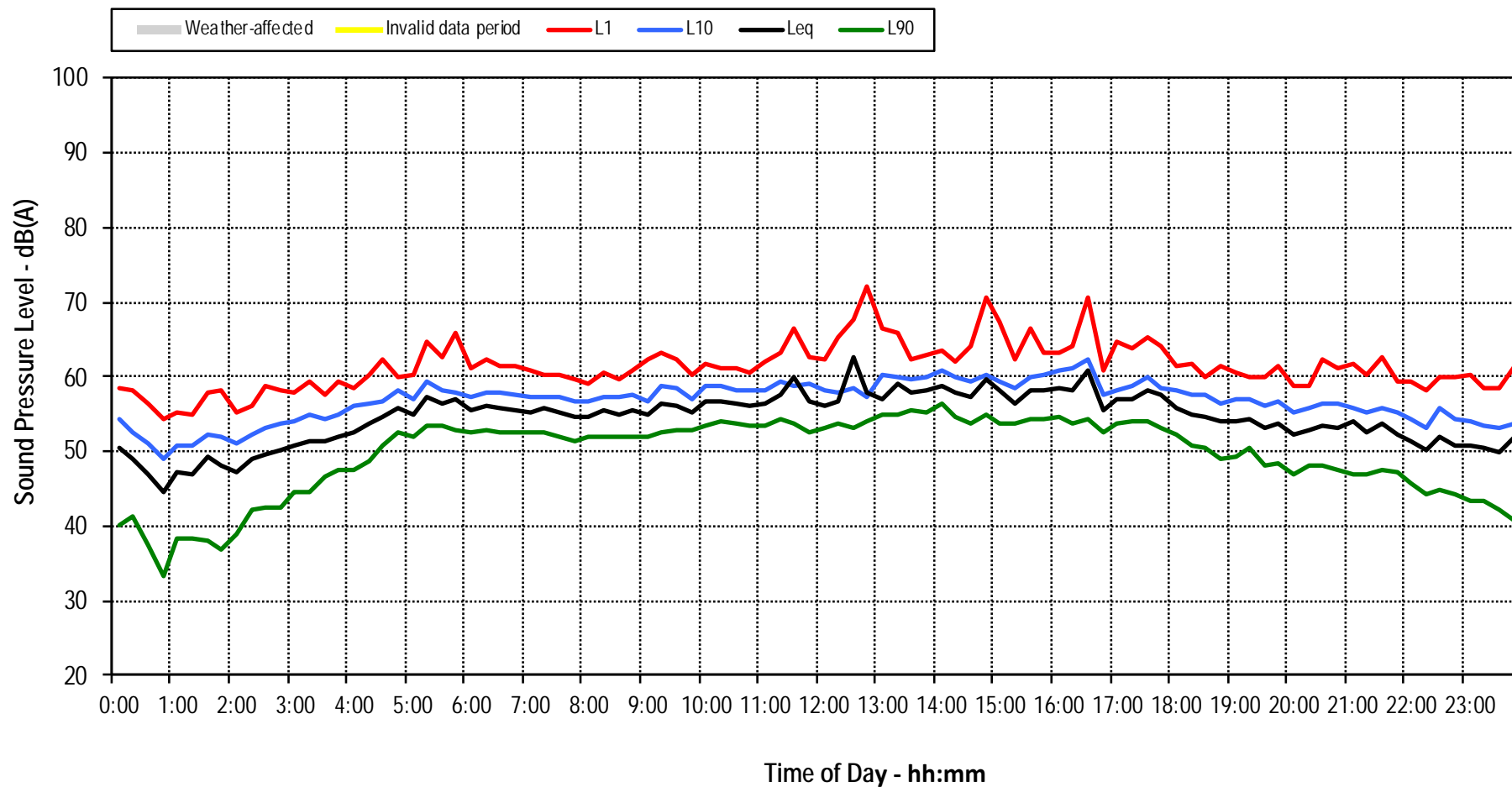
Appendix A – Ambient Noise Monitoring Data

Location L1

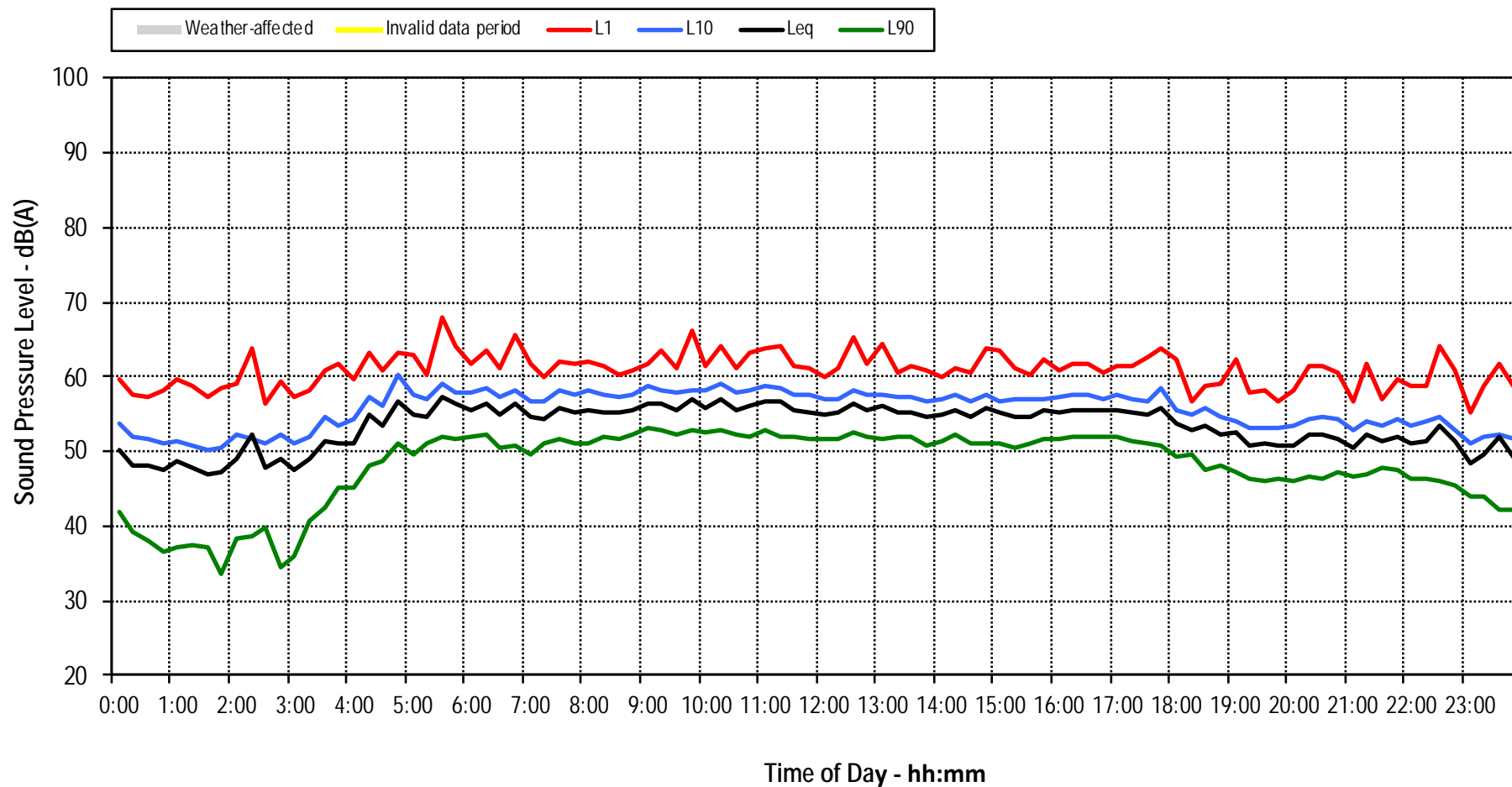
Location 1 - Proposed Carpark Site / 1 Perry Street Residential Boundary - Thursday 08 October 2020



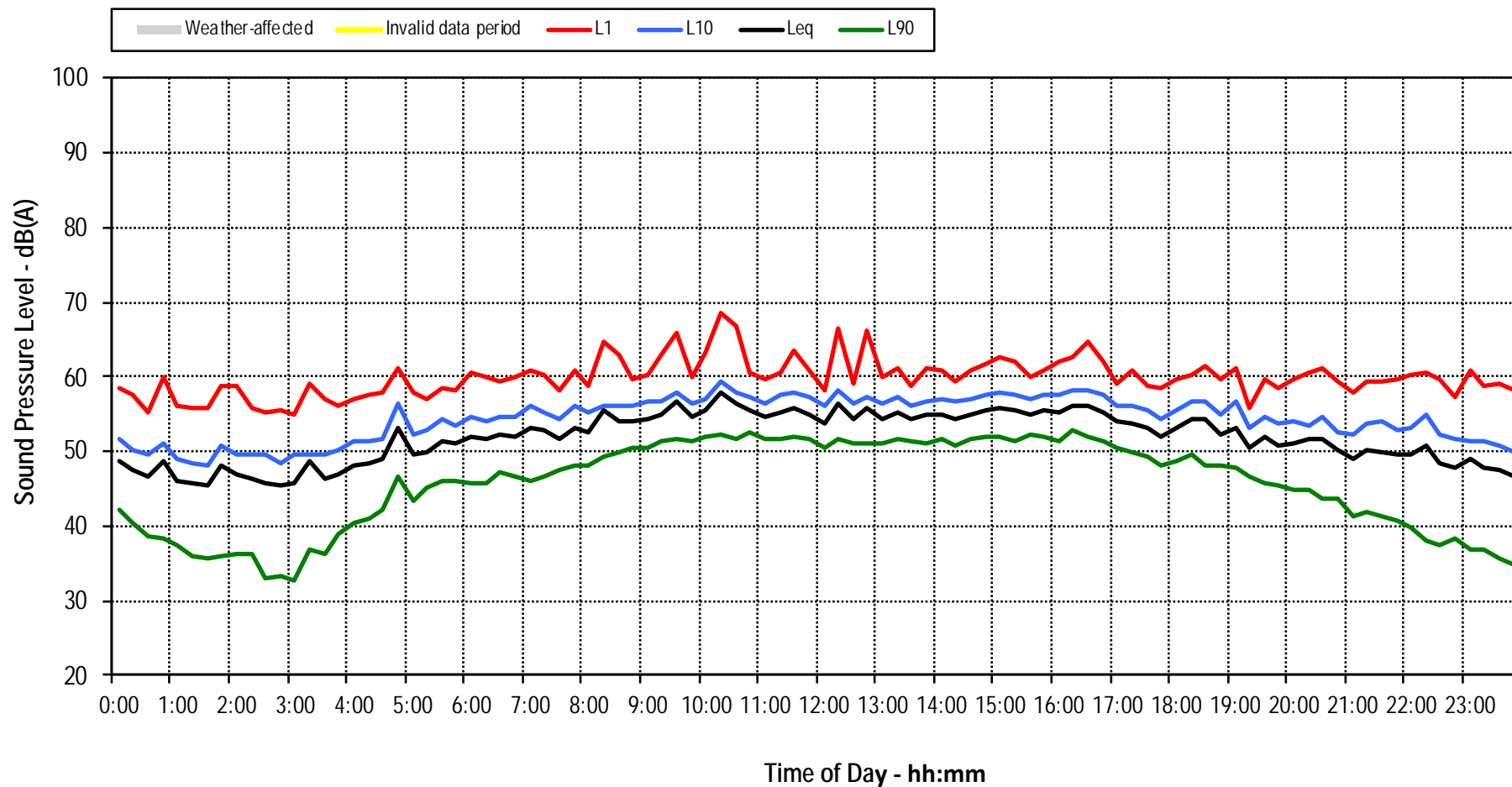
Location 1 - Proposed Carpark Site / 1 Perry Street Residential Boundary - Friday 09 October 2020



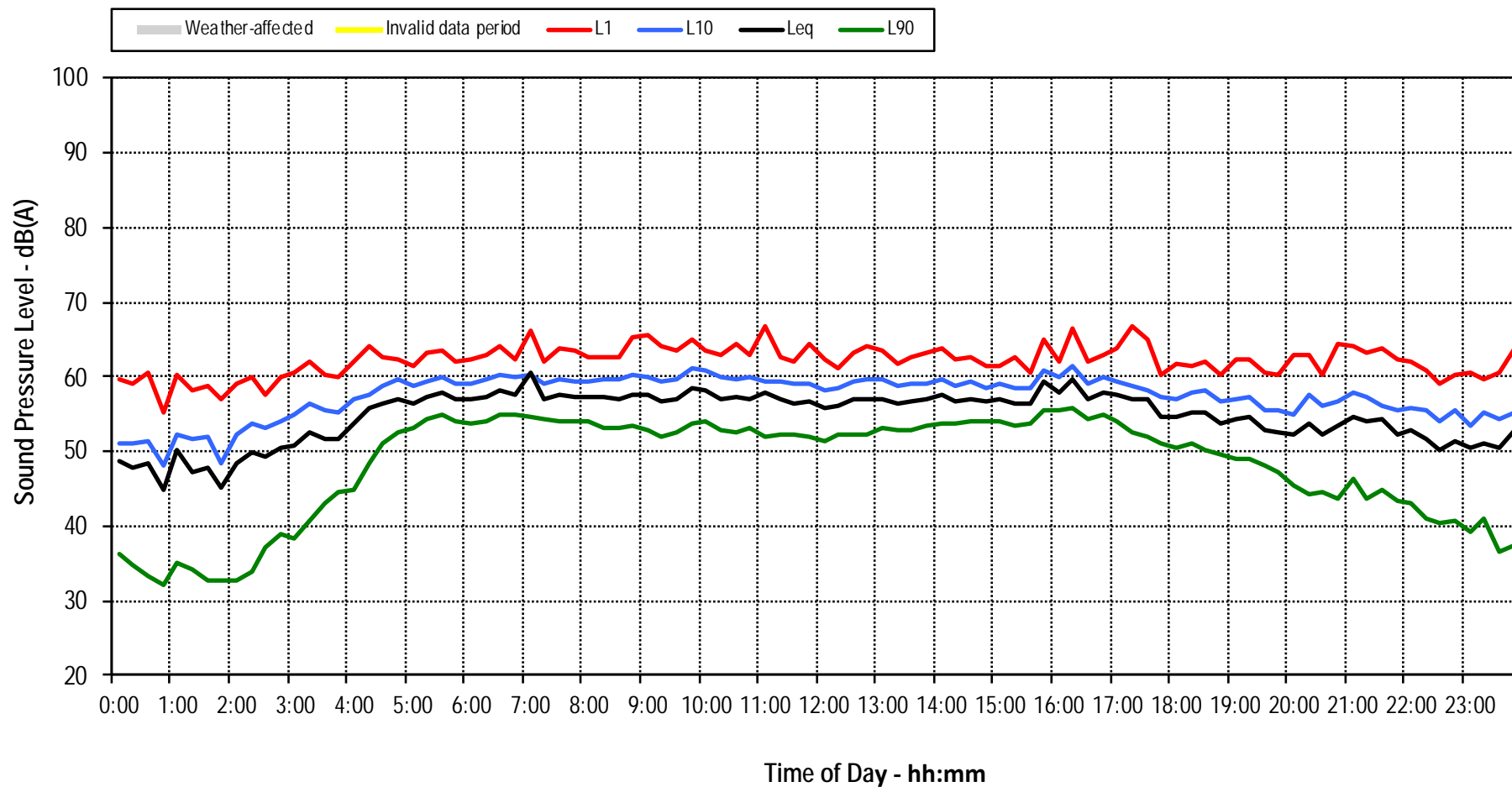
Location 1 - Proposed Carpark Site / 1 Perry Street Residential Boundary - Saturday 10 October 2020



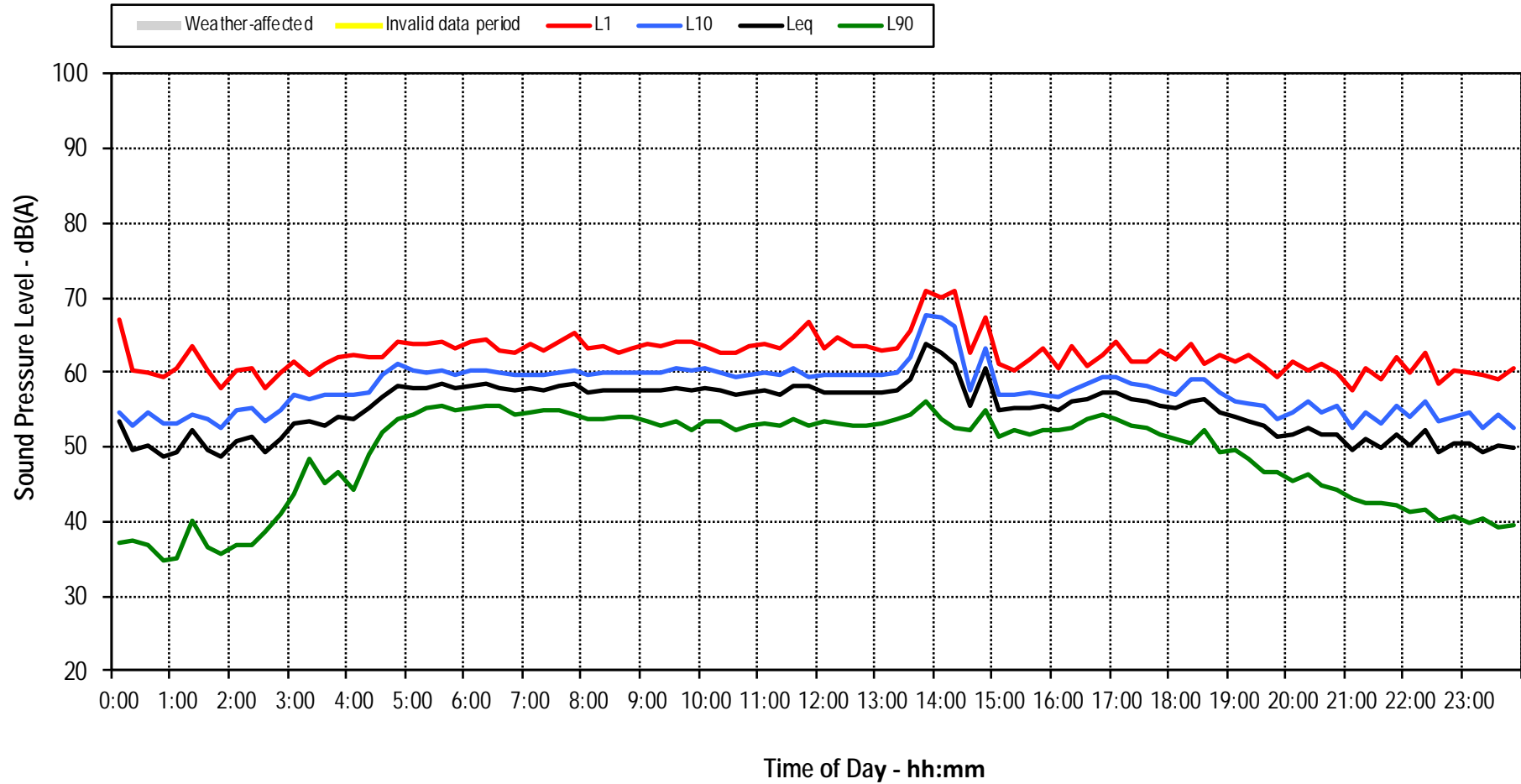
Location 1 - Proposed Carpark Site / 1 Perry Street Residential Boundary - Sunday 11 October 2020



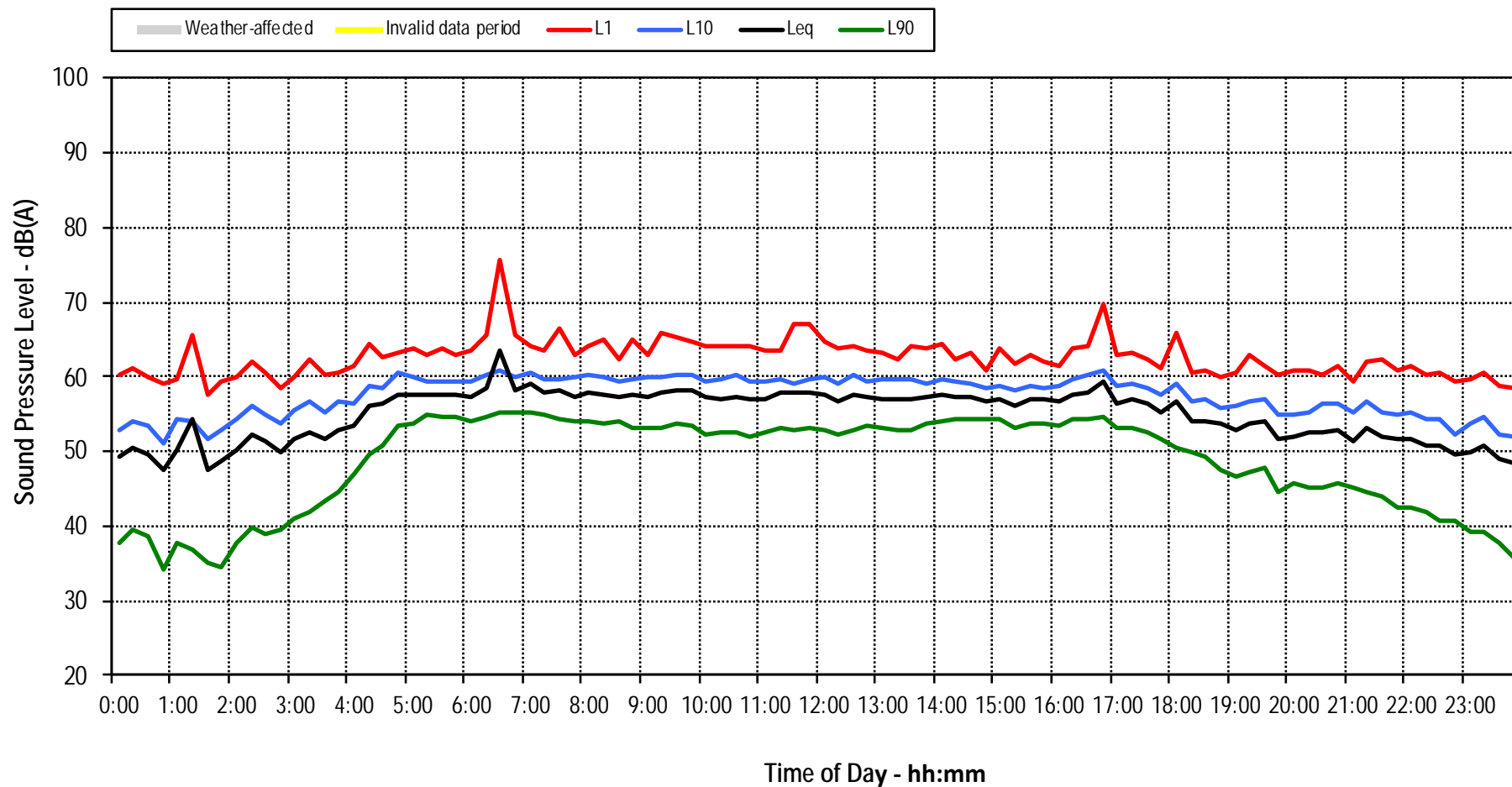
Location 1 - Proposed Carpark Site / 1 Perry Street Residential Boundary - Monday 12 October 2020



Location 1 - Proposed Carpark Site / 1 Perry Street Residential Boundary - Tuesday 13 October 2020

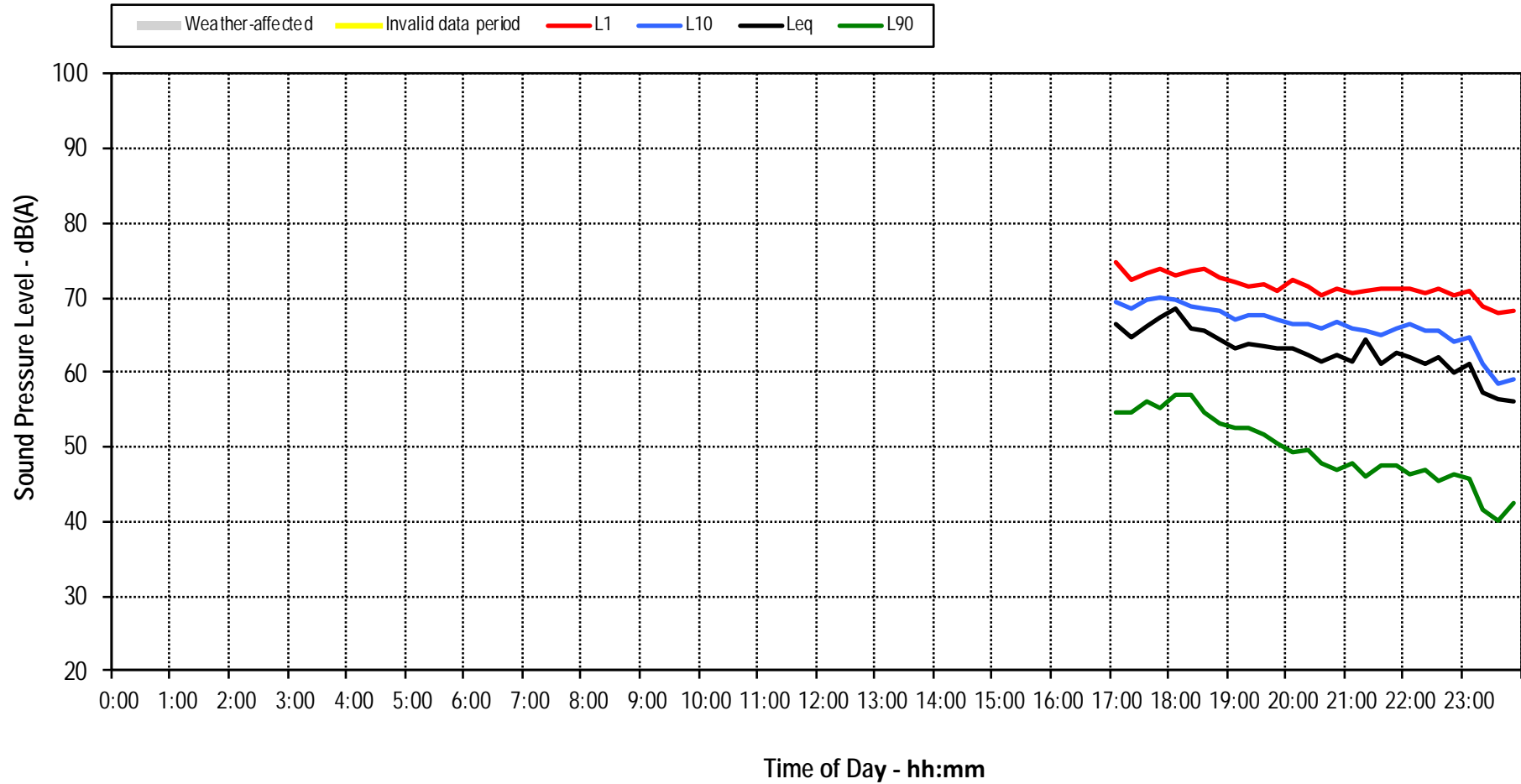


Location 1 - Proposed Carpark Site / 1 Perry Street Residential Boundary - Wednesday 14 October 2020

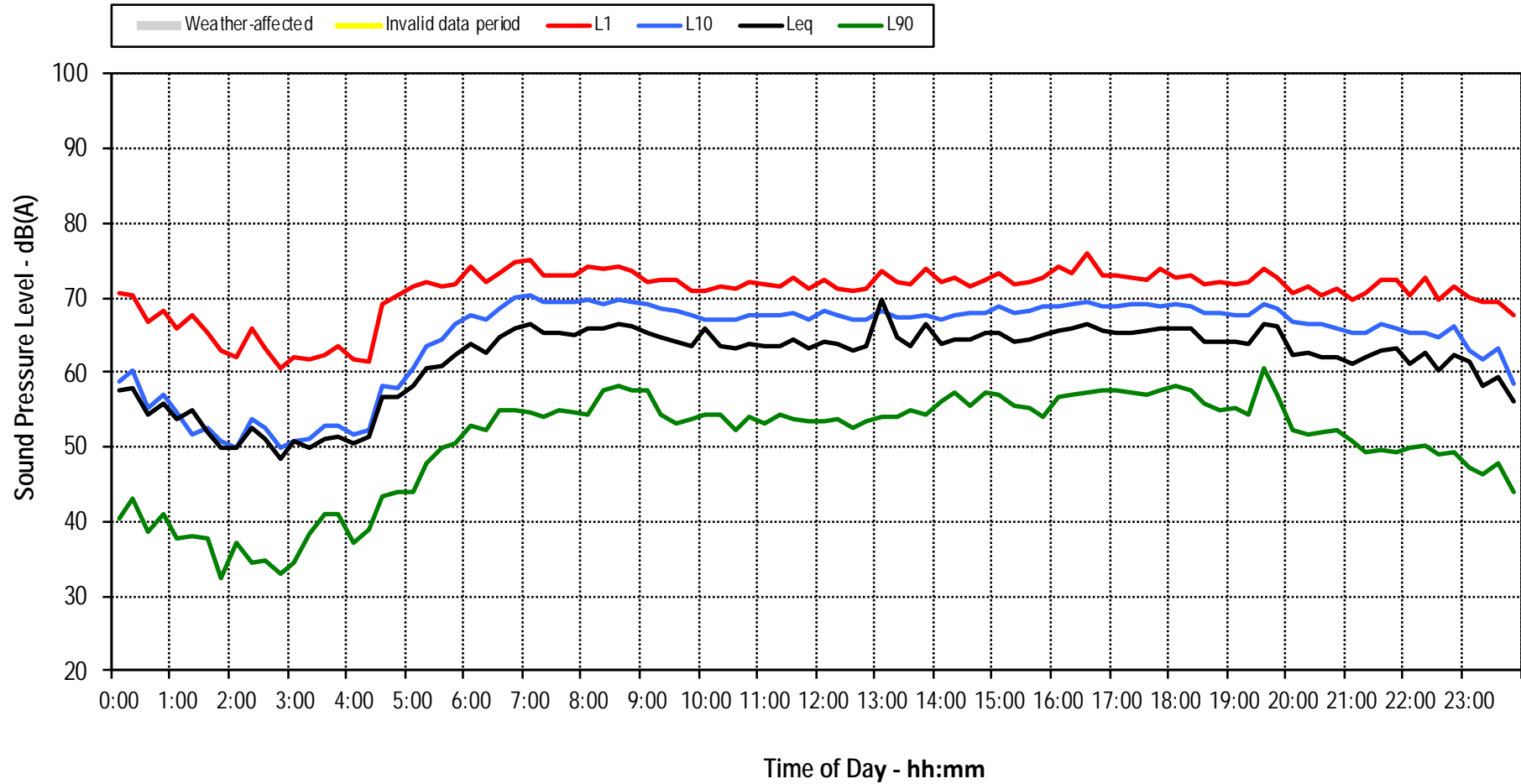


Location L2

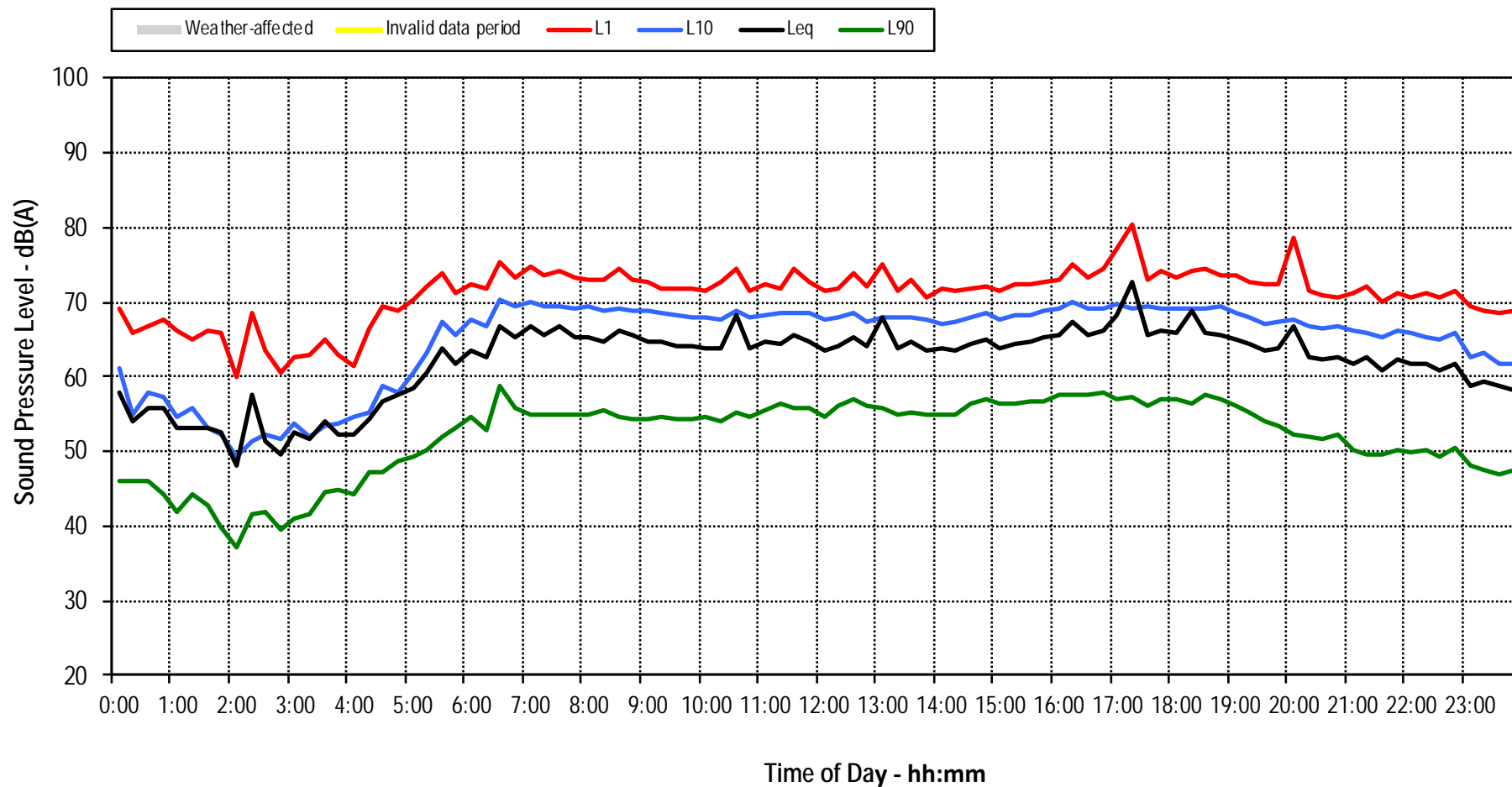
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Wednesday 07 October 2020



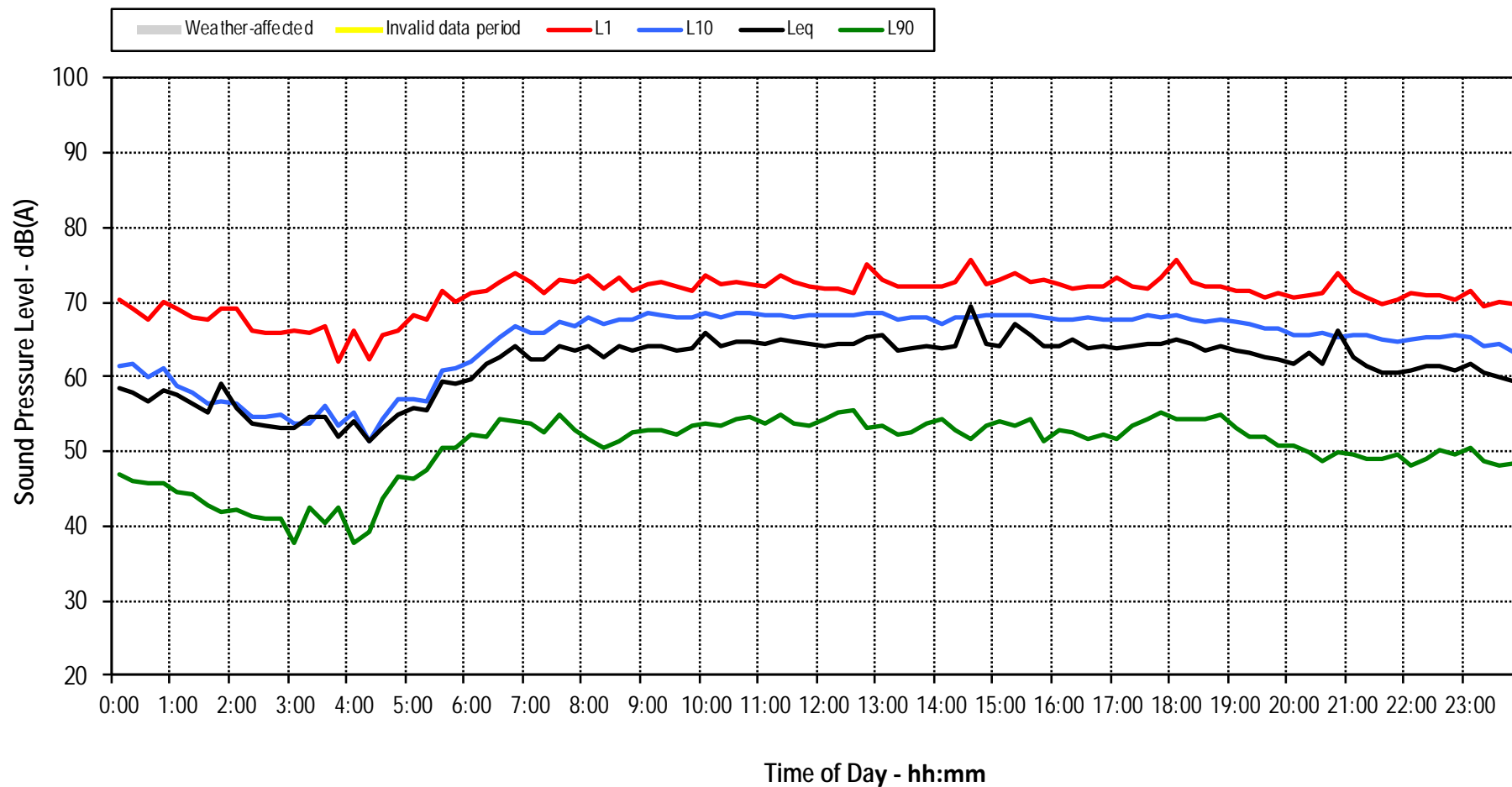
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Thursday 08 October 2020



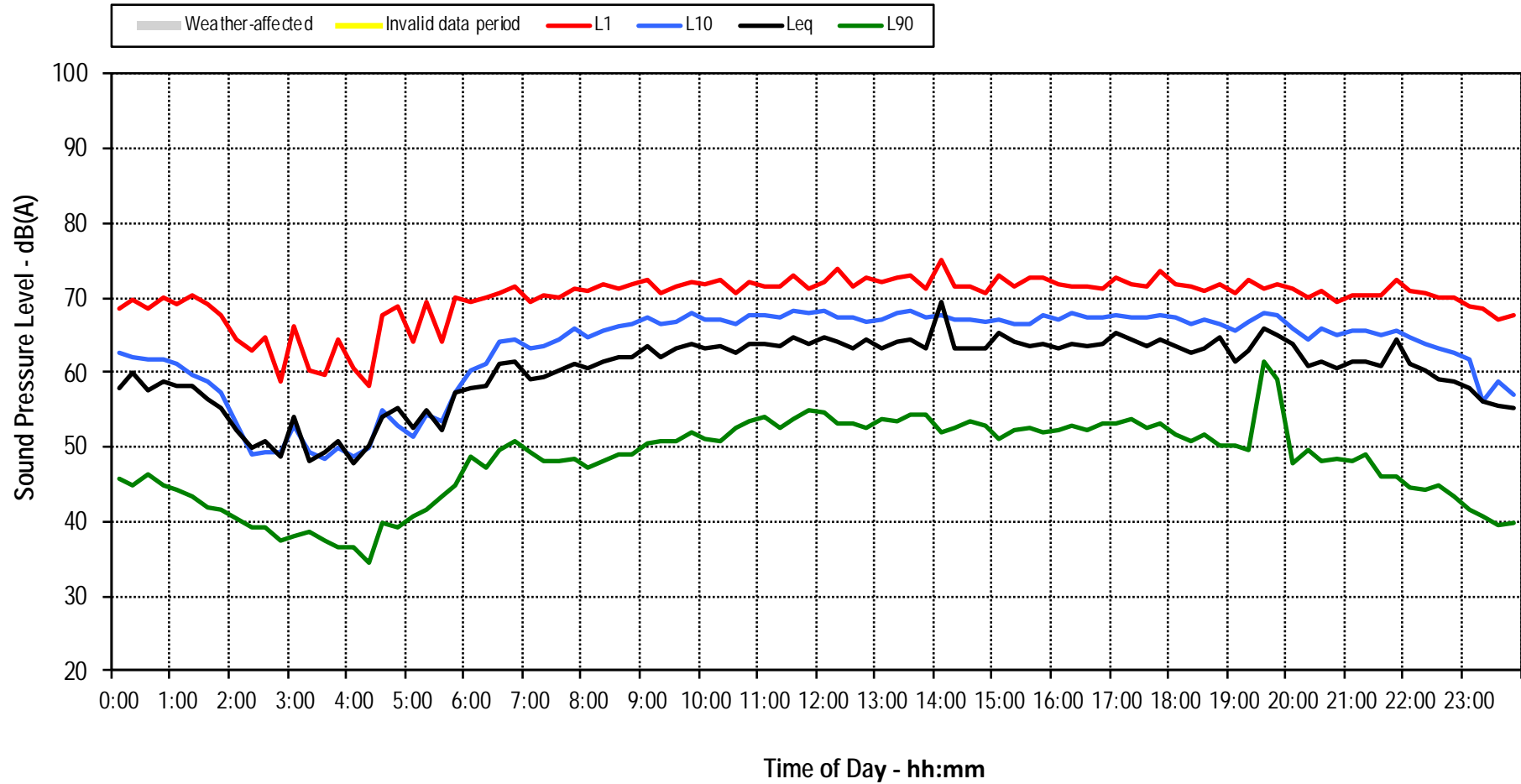
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Friday 09 October 2020



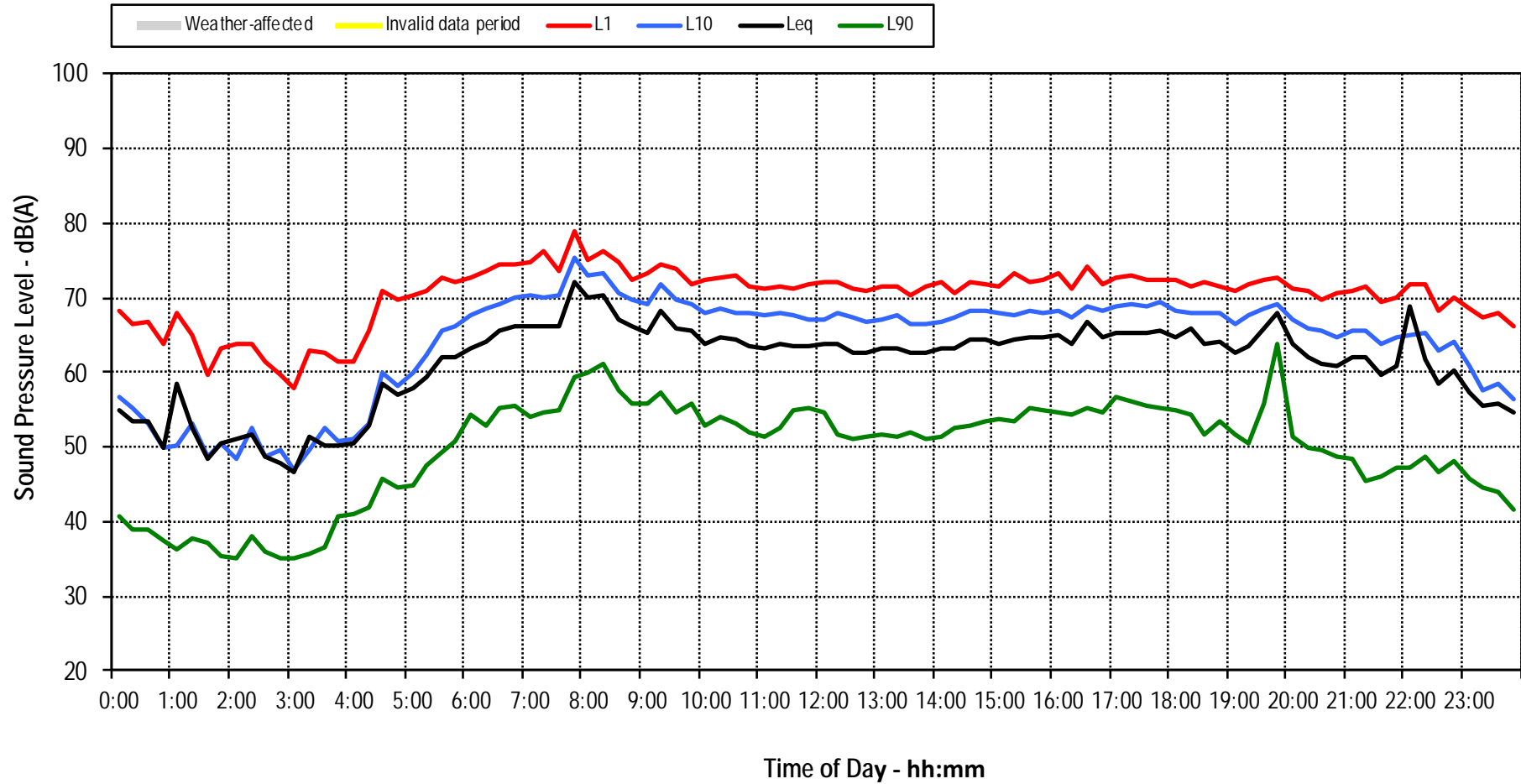
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Saturday 10 October 2020



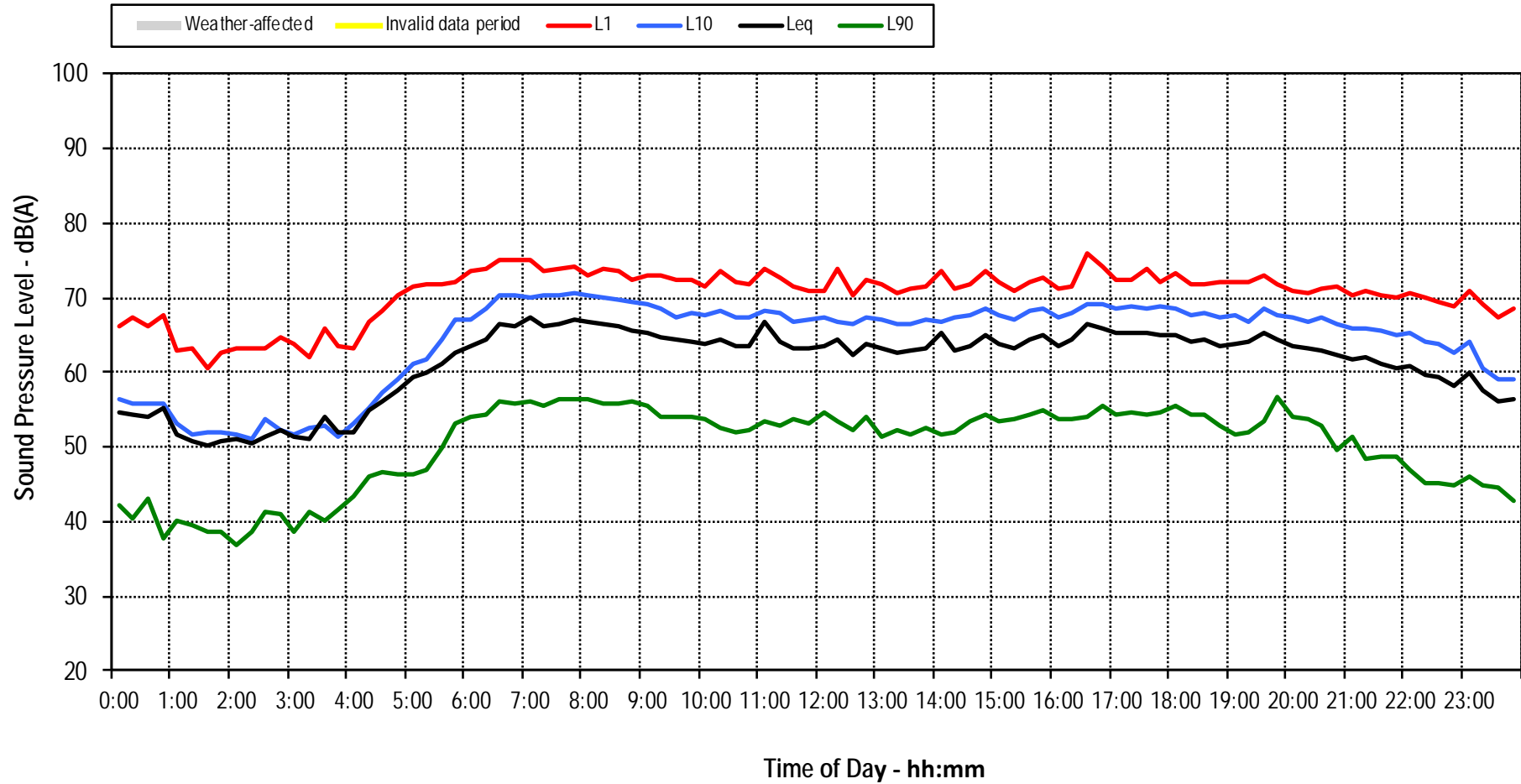
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Sunday 11 October 2020



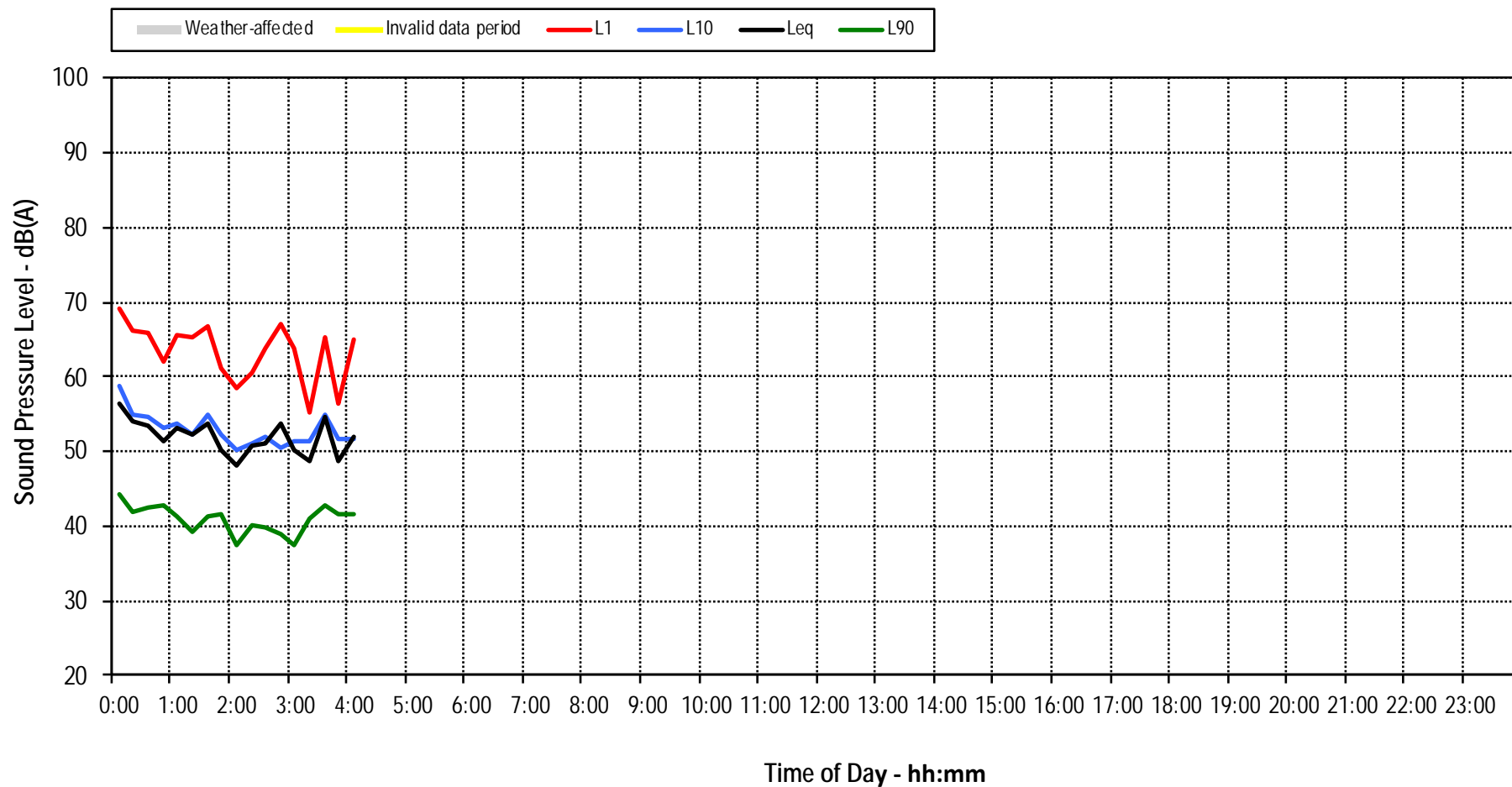
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Monday 12 October 2020



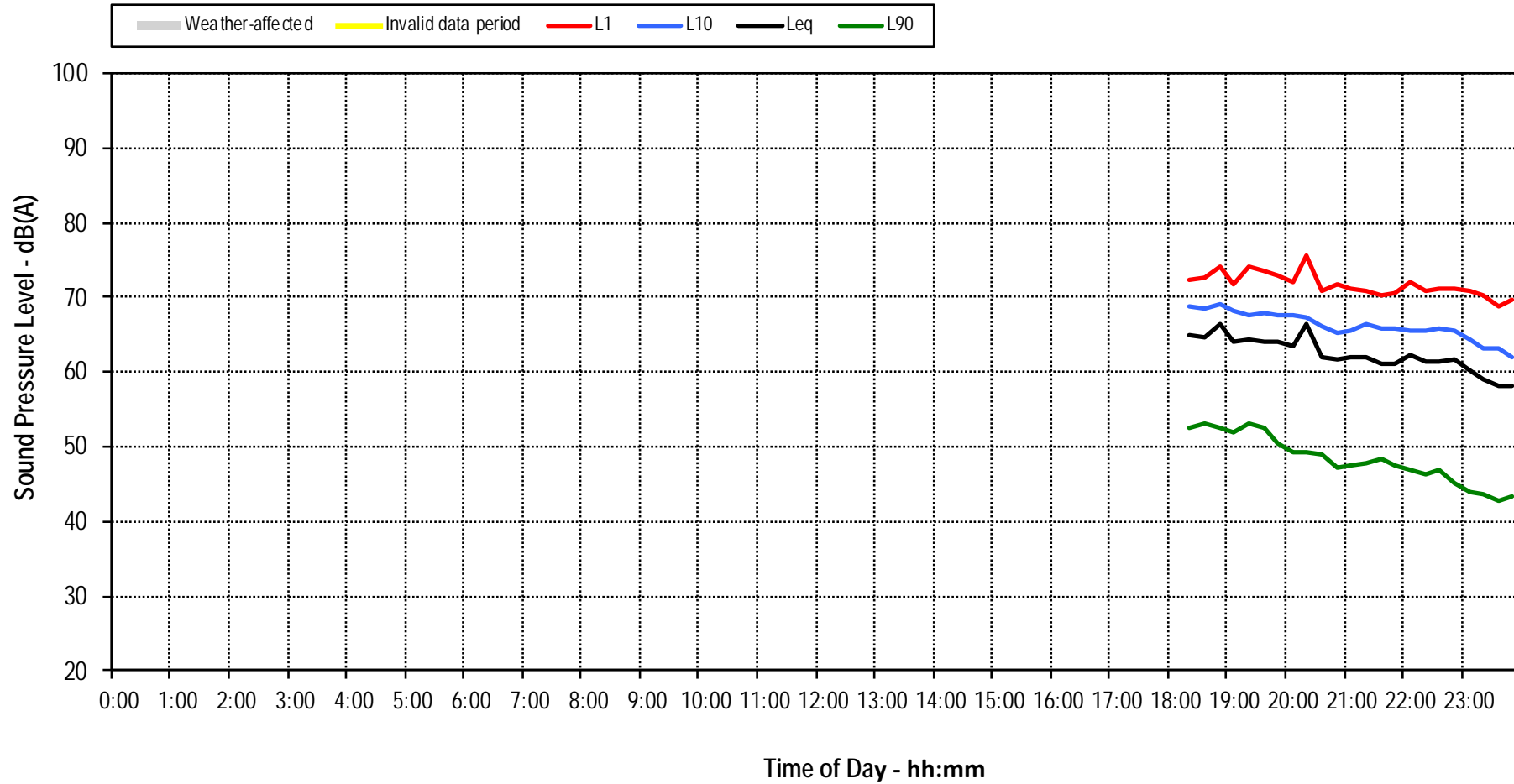
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Tuesday 13 October 2020



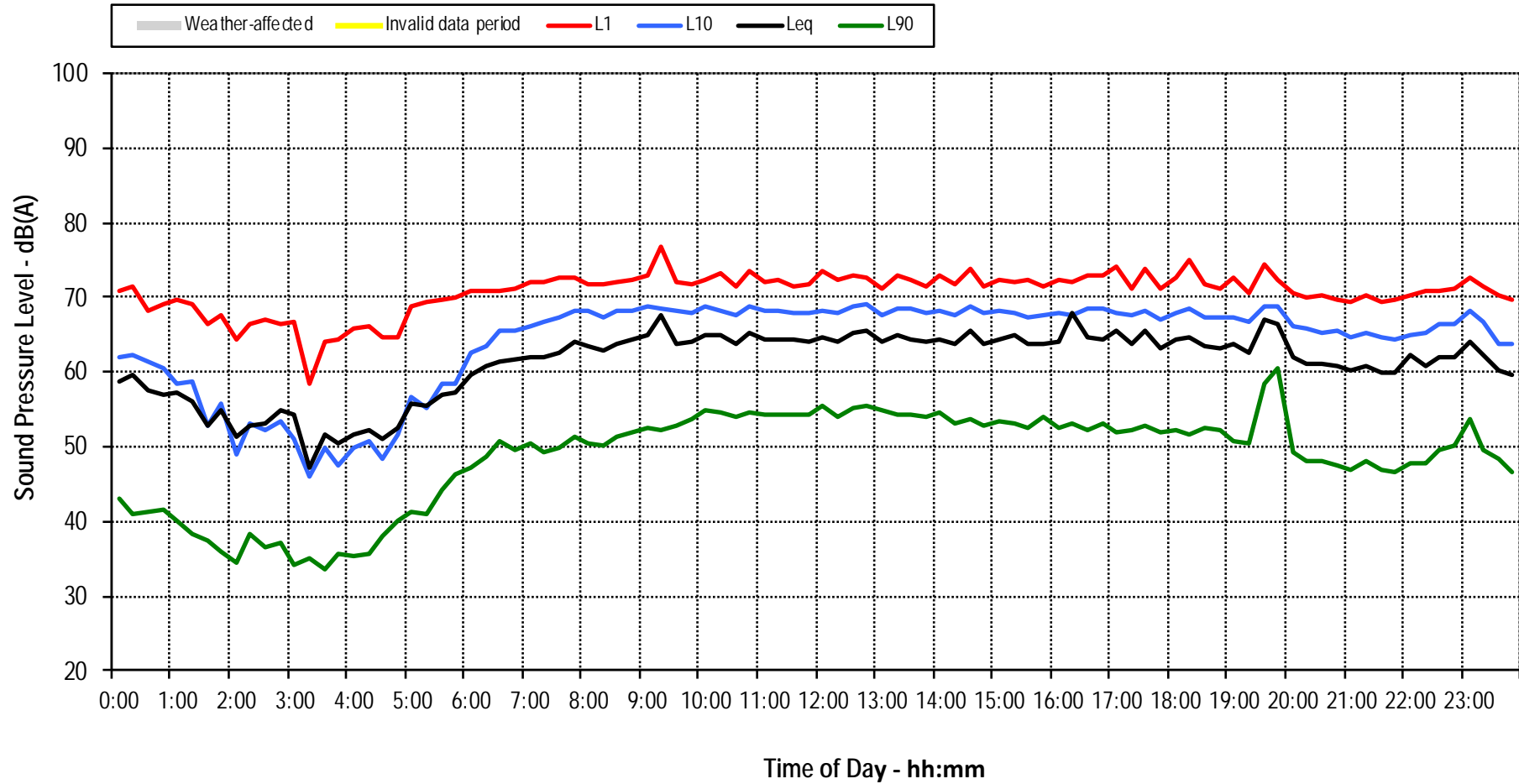
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Wednesday 14 October 2020



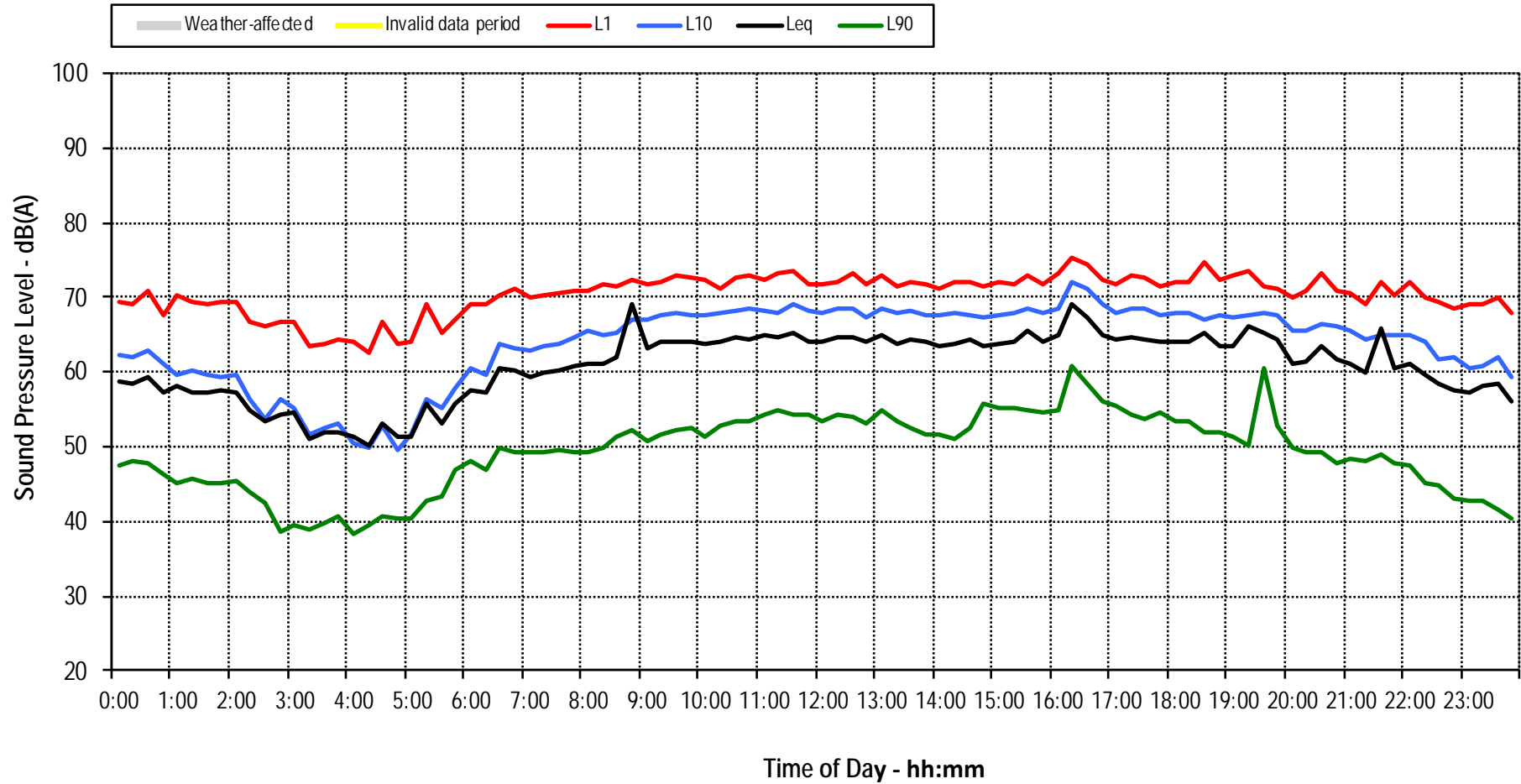
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Friday 16 October 2020



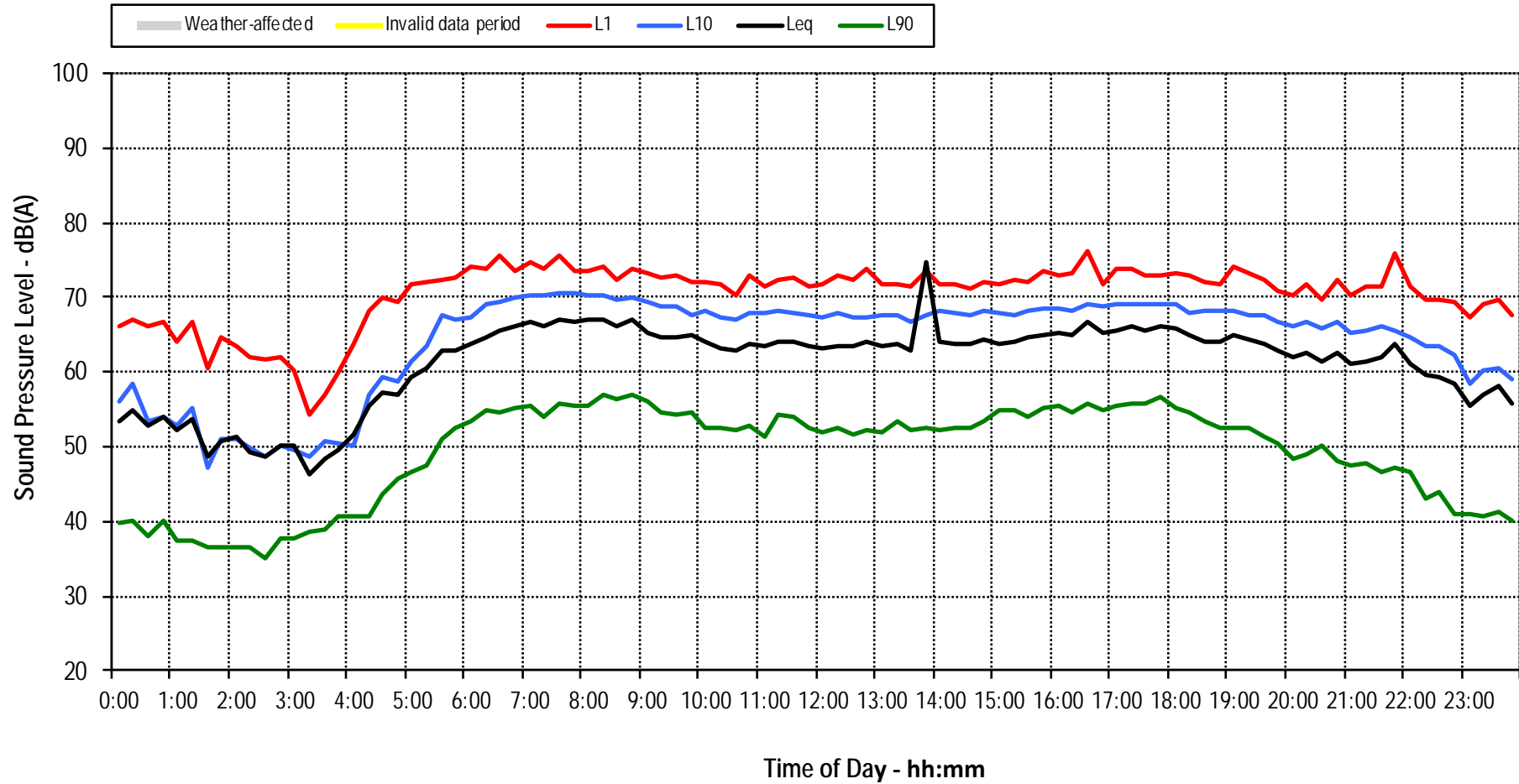
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Saturday 17 October 2020



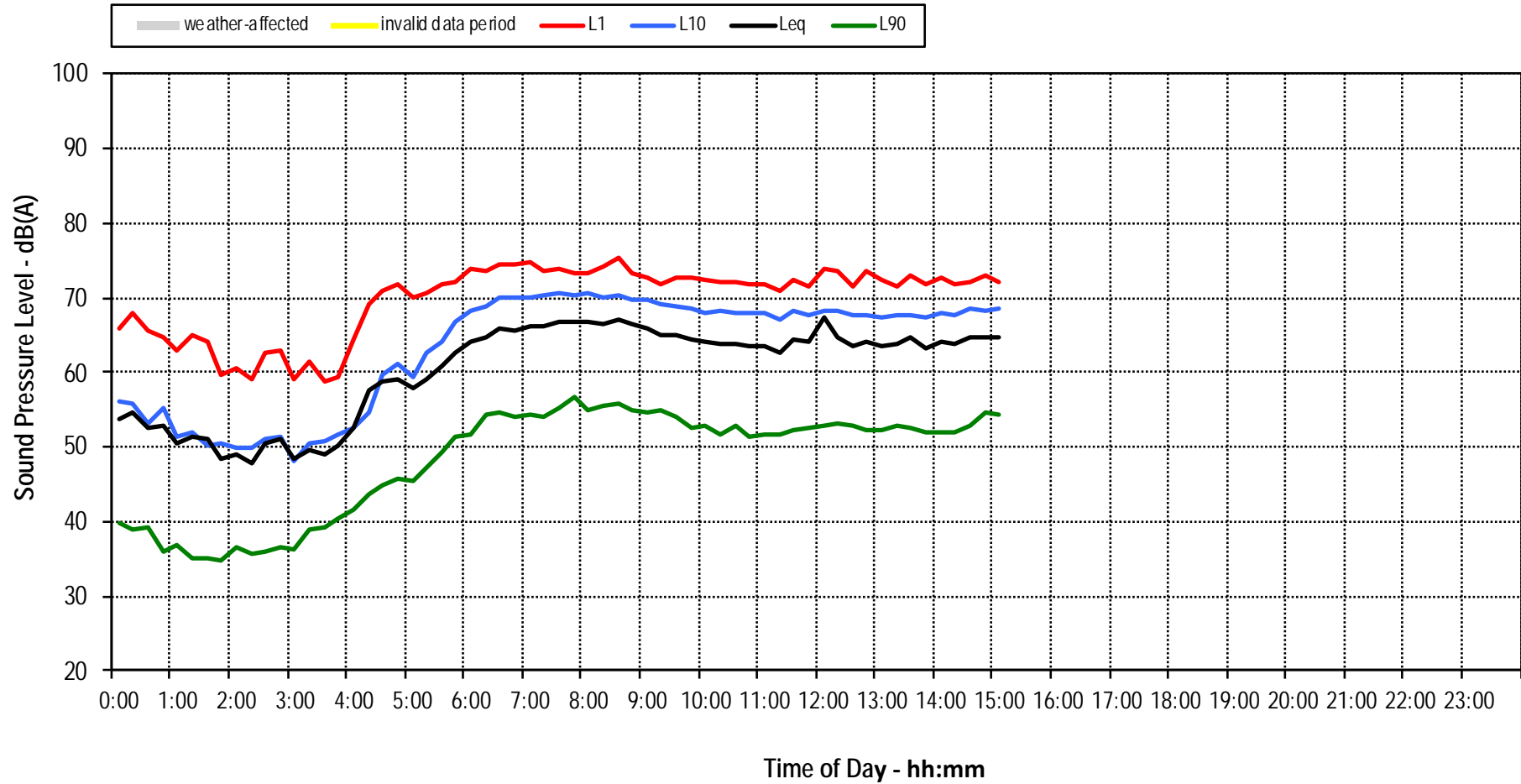
Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Sunday 18 October 2020



Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Monday 19 October 2020



Location 2 - Existing Commuter Carpark / 53 Barclay Road Residential Boundary - Tuesday 20 October 2020



Appendix B – 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.

B.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. Data affected by adverse weather conditions was removed for the analysis procedure. These data are shadowed at Appendix A graphs.

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.

Table B1 : Long-term background and ambient noise levels based on NSW NPI around the site

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	52	43	36	57	52	52
Logger Location 2	52	48	37	66	64	58

B.2 Determination of project intrusiveness noise level

The intrusiveness noise level is defined as:

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

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

Perry Street NCA (based on Logger Location L1)

- Day Intrusiveness criterion of - 52 + 5 = **57 dB(A)**
- Evening Intrusiveness criterion of - 43 + 5 = **48 dB(A)**
- Night Intrusiveness criterion of - 36 + 5 = **41 dB(A)**

Barclay Road East and West NCA (based on Logger Location 2)

- Day Intrusiveness criterion of - 52 + 5 = **57 dB(A)**
- Evening Intrusiveness criterion of - 48 + 5 = **53 dB(A)**
- Night Intrusiveness criterion of - 37 + 5 = **42 dB(A)**

The Intrusiveness noise levels are only applied to residential receivers.

B.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:

$$\text{Project ANL} = \text{Recommended ANL} \text{ minus } 5 \text{ dB(A)} \text{ (Equation 2)}$$

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.

Table B3 : Recommended L_{Aeq} noise levels from industrial noise sources at residential and non-residential receivers

<i>Receiver³</i>	<i>Time of Day</i>	<i>L_{Aeq}, dB(A)</i>
		<i>Recommended ANL</i>
<i>Residential (Suburban)</i>	Day	55
	Evening	45
	Night	40
<i>School classroom - internal</i>	Noisiest 1-hr period when in use	35
<i>Active Recreation Area</i>	When in Use	55
<i>Commercial Premises</i>	When in Use	65
<i>Industrial Premises</i>	When in Use	70

³ 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:

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

○ **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,

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

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.

Table B4: Determination of Project Amenity Noise Levels for residential and commercial receivers

Receiver - External	Time of Day	Recommended ANL	Adjustment	Project ANL ⁴
Residential (Perry Street Noise Catchment)	Day	55	Equation 2	53
	Evening	45	Equation 2	53
	Night	40	Equation 3	40
Residential (Barclay Road East and West Noise Catchment)	Day	55	Equation 3	54
	Evening	45	Equation 3	52
	Night	40	Equation 3	46
School classroom - internal	When in use	35	Equation 2	33
Active Recreation Area	When in use	55	Equation 2	53
Commercial Premises	When in use	65	Equation 2	63
Industrial Premises	When in use	70	Equation 2	68

⁴ 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 $L_{Aeq,period} + 3dB(A)$.

B.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 (Perry Street Noise Catchment)	Day	57	53
	Evening	48	53
	Night	41	40
Residential (Barclay Road East and West Noise Catchment)	Day	57	54
	Evening	53	52
	Night	42	46
School classroom - internal	When in use	-	33 (Internal)
Active Recreation Area	When in use	-	53
Commercial Premises	When in use	-	63
Industrial Premises	When in use	-	68

Table B5 : Determination of Project Noise Trigger Levels for the site