REPORT

16-20 OLD CASTLE HILL ROAD

CASTLE HILL, NSW

NOISE AND VIBRATION IMPACT ASSESSMENT
RWDI # 2409879
17 December 2025

SUBMITTED TO

Urban Property Group
Suite 110, Level 1
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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

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

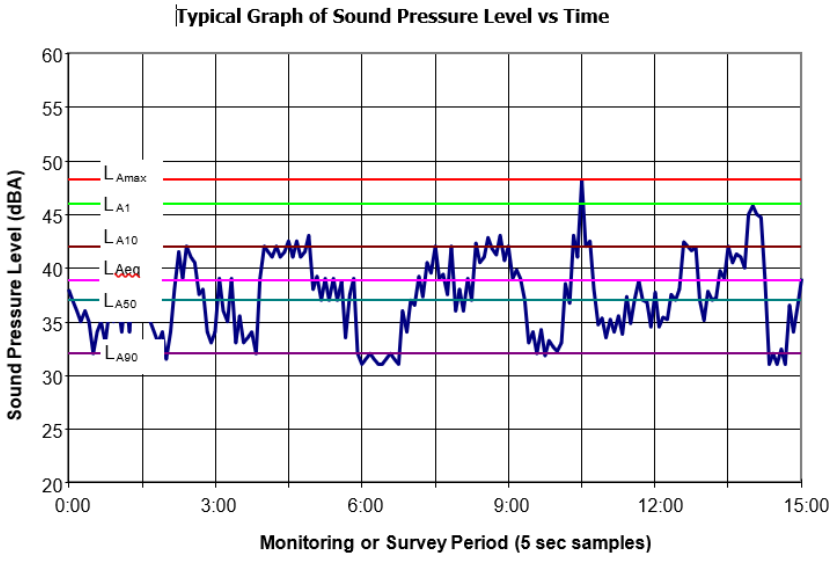
L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

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

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.



EXECUTIVE SUMMARY

This Noise and Vibration Impact Assessment has been prepared by RWDI to accompany a State Significant Development Application (SSDA) for a 40-storey residential apartment building development, located at 16-20 Old Castle Hill Road, Castle Hill within the Hills Shire Council Local Government Area (LGA). This report has been prepared to address the secretary's environmental assessment Requirements (SEARs) issued for the project (SSD-85238209).

This report concludes that the proposed development is suitable and warrants approval, provided that the recommendations for the building envelope shown in **Section 4.1** are implemented, to control noise intrusion from the surrounding major roads. Operational noise emissions from the development to external receivers are anticipated to comply with relevant criteria as discussed in **Section 5.1**.

Noise intrusion to the development's residences from noise sources within the development including mechanical services, vehicle movements, and communal spaces, have been nominally considered in **Section 0**, but should be further developed as the design progresses. The recommendations in **Section 4.1** do not include consideration of internal noise sources.

The construction noise and vibration assessment discussed in **Section 6** includes both the early works and main works. The assessment found the potential for exceedances to both noise management levels and the highly noise affected level at some receivers during all stages, and the potential for vibration intensive equipment to operate within safe working distances, depending on the equipment selected. It is therefore recommended that a CNVMP be developed for the site and that all reasonable and feasible measures be implemented to minimise construction noise and vibration impacts.

As discussed in **Section 7**, the existing traffic noise levels along Garthowen Crescent already exceed recommended criteria. Increases to noise levels are predicted to be less than 2 dB and compliant with criteria.

A cumulative impact assessment has been conducted in **Section 8**, and identified one approved development in the vicinity of the site with the potential to be significant. Noise emissions from this development are not anticipated to significantly change the existing noise characteristics of the area, and impacts from the subject site to the future receiver were found to be comparable to those at the existing receivers at that location. No change to the overall conclusions of this report was deemed warranted.

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1 INTRODUCTION

This report supports a State Significant Development Application and Concurrent Rezoning (SSDA) being lodged with the Department of Planning, Housing and Infrastructure (DPHI) for a residential development including affordable housing at 16-20 Old Castle Hill Road, Castle Hill (the site). The proponent for the SSDA is UPG Castle Corner Pty Ltd (UPG).

State Environmental Planning Policy (Planning Systems) 2022 (Planning Systems SEPP) identifies development which is declared to be State Significant. The site was declared SSD pursuant to State Significant Declaration Order 2025 (No 7) (the Order) issued on 13 May 2025.

A separate 'Early Works' SSDA seeks approval for site establishment, tree removal, bulk excavation, infrastructure services augmentation and ancillary site works. This 'Main Works' SSDA and Concurrent Rezoning seeks approval for the built form aspects of the residential flat building.

The proposal aims to:

- Facilitate transport-oriented development within an area of high amenity, promoting increases to both market and affordable housing supply proximate to public transport, open space, and employment.
- Respond to the housing challenges facing NSW through boosting the delivery of housing in an area of growth.
- Align with the NSW Government's strategic ambitions to deliver 23,300 homes in The Hills by 2029.
- Deliver affordable housing in accordance with the in-fill affordable housing provisions of *State Environmental Planning Policy (Housing) 2021*.
- Deliver a built form that relates to the surrounding context and respects the character of its environs.

1.1 The Site

The site is situated at 16-20 Old Castle Hill Road, Castle Hill, within The Hills Local Government Area (LGA). It is well located, being approximately 250m from Castle Hill Metro Station which provides services to Rouse Hill, Macquarie Park, Chatswood and the Sydney CBD. It is equally proximate to Castle Towers shopping centre, a major regional retail hub. The site has ready access to public open space being less than 100m from Arthur Whitling Park and Eric Fenton Reserve.

The site is located at the corner of Old Castle Hill Road and McMullen Avenue comprising an area of 3,180.4m^2. It comprises 4 lots in an irregular configuration, legally described as:

- Lot 10 in DP 881332
- Lot 11 in DP 881332
- Lot 20 in DP 222257
- Lot 1 in DP 204335

An aerial image of the site is shown below in **Figure 1-1.**

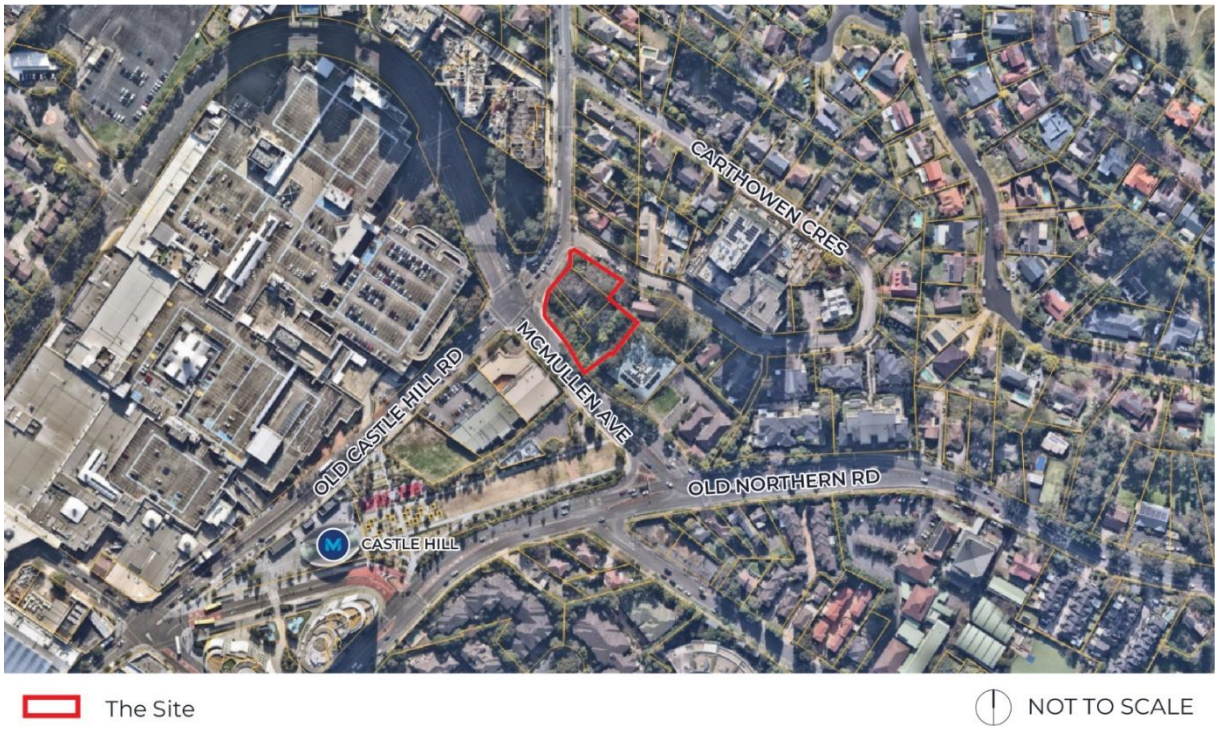


Figure 1-1 Site Aerial Map (Source: Nearmap, edits by Colliers Urban Planning)

The site currently contains development comprising two detached residential dwellings located on 18 and 20 Castle Hill Road. There is currently no development on 16 Castle Hill Road. The site as a whole is covered in dense vegetation and has a steep slope upwards from the north-west to the south-east.

1.2 The Proposed Development

A high-level summary of the proposed development is described below, with further details provided within the Environmental Impact Assessment and Rezoning Report (EIS).

The SSD-86460458 (Early Works) seeks approval for:

- Early works including:
  - Demolition and bulk excavation and activities;
  - Infrastructure services coordination and deviation;
  - Erosion and sediment control; and
  - Removal of trees.

The SSD-85238209 (Main Works) seeks approval for:

- The construction and operation of a 40-storey residential flat building, comprising the following:
  - Market and affordable housing units;
  - Basement parking; and
  - Communal open space;
- Associated landscaping and public domain works.

1.3 SEARs

This Noise and Vibration Impact Assessment report addresses the following Secretary's Environmental Assessment Requirements (SEARs) for both SSD-86460458 and SSD-85238209 set out in **Table 1-1** below.

Table 1-1 Secretary's Environmental Assessment Requirements (SEARs)

SEARs Request	Response / Location in Report
The EIS must: ***10. Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.***	Noise and vibration emissions associated with the construction and operation of the proposed development have been assessed against the relevant EPA and state guidelines, with noise and vibration mitigation recommendations provided to ensure that the acoustic amenity of sensitive receivers in the vicinity of the site is preserved. This report includes an assessment of operational noise impacts associated with the development in **Section 5.1**. Where required, in-principle noise mitigation recommendations have been presented to facilitate compliance with the relevant EPA Noise Policy for Industry. A preliminary assessment of construction noise and vibration impacts from the development has been presented in **Section 6**, with noise and vibration mitigation strategies presented in **Section 6.5** to ensure that impacts are managed in accordance with the EPA's Interim Construction Noise Guideline.

1.4 Assessment Objectives

This report presents RWDI's assessment and results from the on-site environmental noise survey and provides our recommendations for compliance of the development with relevant acoustic requirements.

The objectives of this noise and vibration assessment are listed below.

- Assess the impact of road traffic noise on the proposed development and provide recommendations for the sound isolation performance of the building envelope to achieve the internal noise requirements. Internal noise criteria for the development have been established with reference to the requirements of The Hills Development Control Plan (DCP) 2012, State Environmental Planning Policy (Infrastructure) 2021 and Australian/New Zealand Standard AS/NZS 2017:2016.
- Establish noise emission criteria for the development based on the requirements of the NSW EPA Noise Policy for Industry 2017 (NPfI).
- Assess noise impacts to sensitive receivers associated with use of communal spaces and additional traffic noise generation from the site.

The following documents have been referenced to establish noise and vibration criteria for the proposed development:

- NSW Noise Policy for Industry (NPfI), NSW EPA, 2017;
- NSW Department of Planning Development Near Rail Corridors and Busy Roads (Interim Guideline), 2008
- NSW Road Noise Policy (RNP), DECCW, 2011; and
- The Hills Shire Development Control Plan (DCP) 2012
- Australian/New Zealand Standard AS/NZS 2017:2016: Acoustics - Recommended design sound levels and reverberation times for building interiors
- EPA's Interim Construction Noise Guideline (ICNG), 2009;
- Transport for NSW's (TfNSW) *Construction Noise and Vibration Strategy* (CNVS);

Our assessment and recommendations are based on the architectural drawings set supplied by Studio SC, dated 4th November 2025.

1.5 Summary of Mitigation Measures

The following recommendations and mitigation measures summarized in **Table 1-2** have been identified in order to achieve compliance with relevant standards and criteria.

At this stage of development, no specific operational design mitigation measures are required for compliance with relevant criteria at external receivers. Provision for standard mitigation measures to mechanical services (discussed in **Section 5.1.1**) is predicted to be sufficient.

The following mitigation measures are recommended to manage amenity at internal receivers:

- Façade constructions as discussed in **Section 4.1**
- Provision for standard mitigation measures to mechanical services (discussed in **Section 5.2.2**)
- Addition of a roof to the L30 outdoor communal area, for the protection of noise amenity for overlooking residences (discussed in **Section 5.2.3**)
- Vibration Isolation of the swimming pool (discussed in **Section 5.2.3.3**)
- Potential upgrades to partition constructions separating communal spaces from sole-occupancy units (SOUs) (discussed in **Section 5.2.3** and **Section 5.2.4**)

Standard reasonable and feasible mitigation measures should be applied during construction.

Table 1-2 Summary of recommendations and mitigation measures

Project Stage D / C / O	Mitigation Measure	Report Section
Design	Minimum glazing R_w as per Table 4-1, to control ingress of noise	4.1.1
Design	Provision for alternative ventilation strategies (e.g. mechanical ventilation) to the most noise affected apartments	4.1.4
Design	Provision for standard mitigation measures to mechanical services	5.1.1 and 5.2.2
Design	Addition of a roof to the L30 outdoor communal area, to reduce noise impacts to overlooking residences	5.2.3

Project Stage D / C / O	Mitigation Measure	Report Section
Design	Vibration Isolation of the L30 swimming pool	5.2.3.3
Design	Review of partition construction for partitions separating communal spaces from SOUs	5.2.3 and 5.2.4
Construction	The appointed contractor should submit a CNVMP. All reasonable and feasible mitigation measures should be applied.	6.5 and 6.6
Operation	Restrict hours of access to loading dock to 7am–6pm Monday–Saturday;	5.1.1.4
Operation	Develop a plan of management for communal spaces	5.2.3 and 5.2.4
Operation	Impacts to amenity at existing receivers due to traffic noise are anticipated to be negligible	7
Operation	Cumulative impacts considering other neighbouring developments do not significantly change the conclusions of this report	8

2 SITE SURROUNDS AND NOISE ENVIRONMENT

2.1 Noise Sensitive Receivers

A summary description of existing receivers that are most affected by noise from the proposed development is provided in **Table 2-1**. These receivers are identified in an aerial imagery of the site in **Figure 2-1** below.

It should be noted that there is currently a development application proposed to The Hills Shire Council for the demolition of existing structure and construction of a residential flat building development, located at several lots along Garthowen Crescent and Old Castle Hill Road. Sensitive receivers R05 – R07 are proposed to be demolished as part of the future development, however, will be included as part of this assessment as they may remain for both construction and operational stages of this project.

Impacts to the approved future receivers is considered in **Section 8**.

Table 2-1 Noise Receivers identified to be Most Affected by Site

Receiver ID	Receiver Type	Land Zoning	Receiver Description	Direction from Site
R01	Residential	R4	3 Garthowen Crescent, Castle Hill	Southeast
R02	Residential	R4	7 Garthowen Crescent, Castle Hill	Southeast
R03	Residential	R4	7A Garthowen Crescent, Castle Hill	Southeast
R04	Residential	R4	51-53 Old Castle Hill Road, Castle Hill (Skyview Apartments)	Northwest
R05	Residential	R1	24 Old Castle Hill Road, Castle Hill	North
R06	Residential	R1	26 Old Castle Hill Road, Castle Hill	North
R07	Residential	R1	26A Old Castle Hill Road, Castle Hill	North
R08	Residential	R4	6-12 & 16-20 Garthowen Crescent, Castle Hill (Apartments)	Northeast
C01	Commercial	R1	8 McMullen Avenue, Castle Hill (Contour Clinics)	Southeast
C02	Community Use[1]	R4	2-6 McMullen Avenue, Castle Hill (Castle Hill Senior Citizens Club)	Southeast
C03	Commercial	R1	8-12 Old Castle Hill Road, Castle Hill	Southwest
C04	Commercial	MU1	Castle Towers	Southwest
RE01	Passive Recreation	RE1	Eric Fenton Reserve	Northwest
RE02	Passive Recreation	RE1	Arthur Witling Park Reserve	Southwest

Note 1: Assessed against criteria for commercial buildings

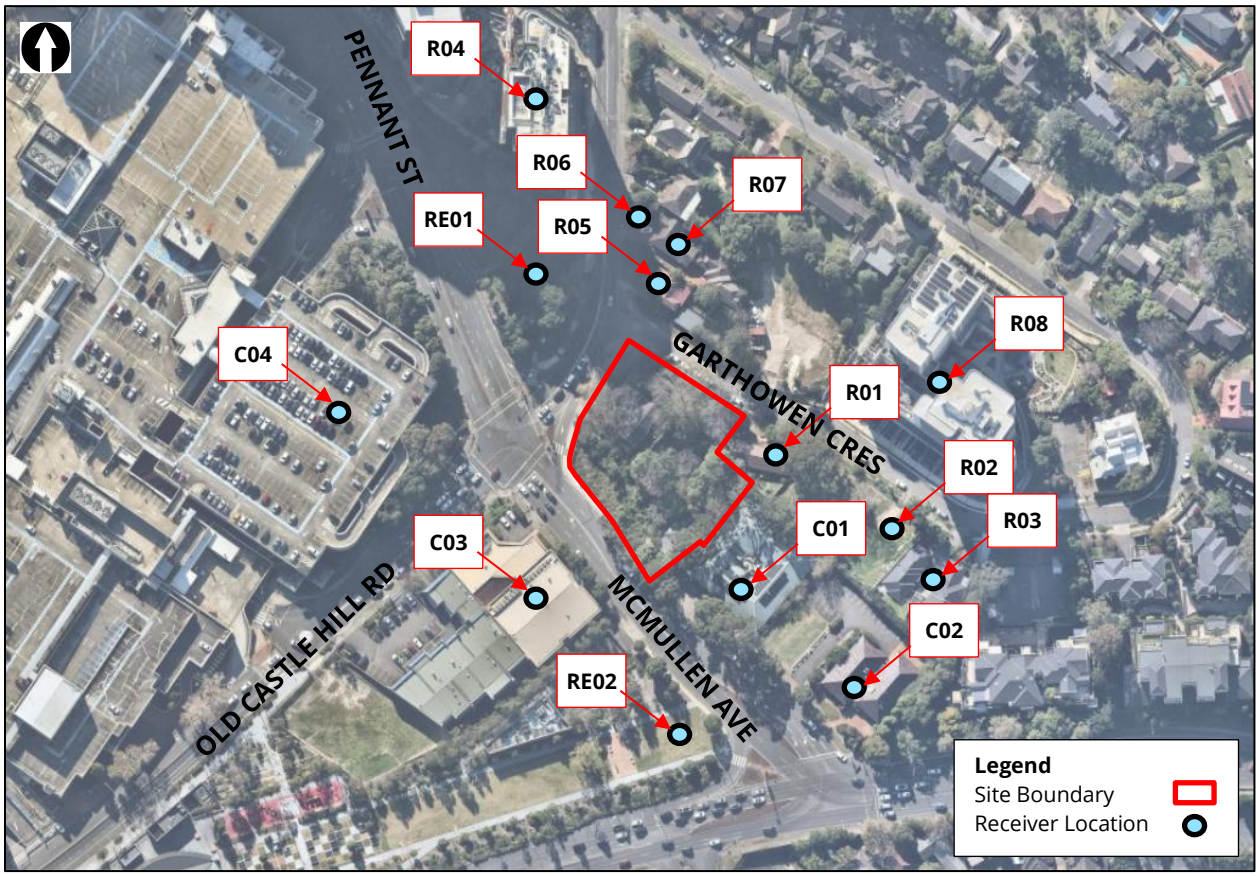


Figure 2-1 Site and Receivers

In order to characterise the existing noise environment of the project location, RWDI personnel attended site to conduct unattended noise measurements Surrounding as described in the sub-sections below.

2.2 Unattended Noise Monitoring

Notable external noise sources in the vicinity of the proposed development are traffic noise emissions from Old Castle Hill Road and McMullen Ave. Traffic on Garthowen Crescent is a secondary source of noise.

Three unattended noise loggers were installed between Monday 12 May and Friday 22 May 2025 at the following locations to measure the ambient and background noise levels:

- Monitoring Position 1 (MP1): in the yard of 20 Old Castle Hill Road. The noise environment at this location was dominated by road traffic noise emanating from Old Castle Hill Road.
- Monitoring Position 2 (MP2): in the yard adjacent to the western boundary of 3 Garthowen Crescent. The noise environment at this location was dominated by general road traffic noise.
- Monitoring Position 3 (MP3): in the yard of 20 Old Castle Hill Road, with direct line of site to Old Castle Hill Road. The noise environment at this location was dominated by road traffic noise emanating from McMullen Avenue and Old Castle Hill Road.

Locations of unattended noise measurement locations are presented in **Figure 2-2** below.

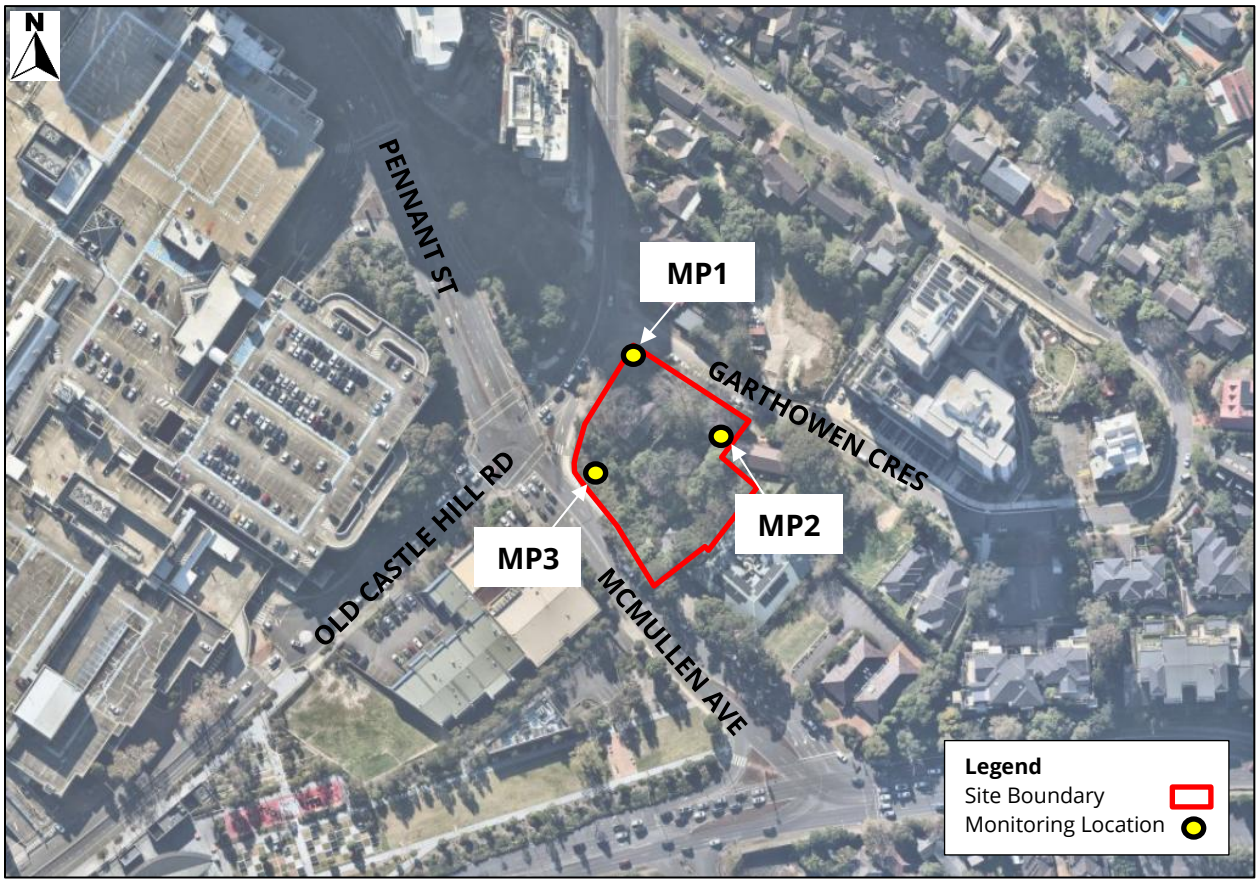


Figure 2-2 Noise Monitoring Locations

Table 2-2 summarises the instrumentation used for the survey.

Table 2-2 Noise Monitoring Equipment

Instrumentation	Manufacturer	Model	Serial Number
Sound Level Meter	Rion	NL-53	00440944
	Rion	NL-53	00440350
	Rion	NL-53	00440351
Sound Calibrator	Brüel & Kjær	4231	2326413

Each sound level meter was fitted with a microphone windshield. The unattended noise measurements were conducted using noise monitors which were programmed to measure A-weighted, statistical noise levels stored at 15-minute intervals on fast response mode. Calibration of each logger was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Noise monitoring was completed in accordance with Australian Standard AS 1055-2018 *"Acoustics - Description and measurement of environmental noise*". All acoustic instrumentation utilised complies with AS IEC 61672.1-2004 *"Electroacoustics - Sound level meters – Specifications".*

2.3 Existing Noise Levels

Unattended noise monitoring was conducted between Monday 12 May and Friday 22 May 2025 at three locations. The measured data was processed according to the general procedure described in the NPfI.

Table 2-3 and **Table 2-4** summarise the measured noise levels at the unattended noise monitoring locations. Data affected by adverse meteorological conditions or extraneous noise was removed from the data prior to processing. Full noise monitoring plots are provided in **Appendix A.**

Table 2-3 Unattended Noise Monitoring Results – Background (L_{A90}) Noise Levels

Monitor Position	Time Period [1]	RBL (dB)
MP1	Day	57
	Evening	49
	Night	33
MP2	Day	52
	Evening	45
	Night	30
MP3	Day	57
	Evening	49
	Night	30

Note 1: Monday to Saturday — Daytime (7am – 6pm), Evening (6pm – 10pm), Night (10pm – 7am)
Sunday and Public Holidays — Daytime (8am – 6pm), Evening (6pm – 10pm), Night (10pm – 8am)

Table 2-4 Unattended Noise Monitoring Results – Ambient (L_{Aeq}) Noise Levels

Monitor Position	Time Period [1]	Ambient Noise Levels (dB)
MP1	Day	64 $L_{Aeq, 15hr}$
	Night	58 $L_{Aeq, 9hr}$
MP2	Day	58 $L_{Aeq, 15hr}$
	Night	52 $L_{Aeq, 9hr}$
MP3	Day	63 $L_{Aeq, 15hr}$
	Night	58 $L_{Aeq, 9hr}$

Note 1: Monday to Saturday — Daytime (7am – 6pm), Evening (6pm – 10pm), Night (10pm – 7am)
Sunday and Public Holidays — Daytime (8am – 6pm), Evening (6pm – 10pm), Night (10pm – 8am)

3 NOISE AND VIBRATION CRITERIA

The following sub-sections detail the acoustic criteria that are applicable to the proposed development.

3.1 Noise Intrusion Criteria

3.1.1 The Hills – Development Control Plan 2012

The proposed development is located within The Hills Shire Council area. As the development is to be assessed under the State Significant Development pathway, compliance with local Council requirements is not strictly required. Nonetheless the controls of The Hills DCP (2012) are presented below.

The Hills DCP 2012 states the following with respect to noise:

5.10 Noise

5. The provisions of the State Environmental Planning Policy (Infrastructure) 2007 and Development Near Rail Corridors and Busy Roads Interim Guideline must be taken into consideration to minimise impact of busy roads and railway corridors on residential and other sensitive development.

6. Development applications are to demonstrate how buildings comply with the noise criteria specified in Table 3 (reproduced in **Table 3-1**).

Table 3-1 The Hills DCP 2012 – Internal Noise Criteria

Internal Space	Recommended Noise Criteria	Maximum Noise Criteria
Living areas **Working areas**	40 dBA	45 dBA
Sleeping areas	35 dBA	40 dBA

3.1.2 NSW Department of Planning's Development Near Rail Corridors and Busy Roads (Interim Guideline) 2021

McMullen Ave is identified by Transport for NSW as a road on which the requirements of the 2021 Infrastructure SEPP are mandatory. Section 3.5 of the NSW Department of Planning's Development Near Rail Corridors and Busy Roads - Interim Guideline (SEPP) states:

The following provides an overall summary of the assessment procedure to meet the requirements of clauses 87 and 102 of the Infrastructure SEPP. The procedure covers noise at developments for both Road and Rail.

- *If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
  - *in any bedroom in the building: 35dB(A) at any time 10pm-7am*
  - *anywhere else in the building (other than a garage, kitchen, bathroom or hallway): 40dB(A) at any time.*

3.1.3 AS/NZS 2107:2016 – Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors

The AS/NZS 2107:2016 - *Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors* provides recommended design sound levels for different spaces depending on their intended use. These internal noise recommendations apply to steady or quasi-steady state noise source, including road traffic.

The noise criteria for this development are presented in **Table 3-2** and are based on applicable design sound levels from AS/NZS 2107:2016.

Table 3-2 AS/NZS 2107:2016 Internal Noise Levels Criteria

Type of Occupancy	Time of Day	Internal Noise Criteria $L_{Aeq,period}$ dBA
Apartment Sleeping Areas	Night (10 pm – 7 am)	35
Apartment Living Areas	Day (7 am – 10 pm)	45
Indoor Communal Spaces	When in Use	45
Retail Tenancies	When in Use	<50
General Office Areas (e.g., Building Manager Room)	When in Use	45

3.1.4 Summary of Internal Noise Criteria

Table 3-3 below provides a summary of the internal noise criteria applicable to this assessment.

Table 3-3 Summary of Internal Noise Level Recommendations

Type of Occupancy	Time of Day	Internal Noise Criteria $L_{Aeq,period}$ dBA
Apartment Sleeping Areas	Day (7 am – 10 pm)	40
	Night (10 pm – 7 am)	35
Apartment Living Areas	Any time	40
Indoor Communal Spaces	When in Use	45
Retail Tenancies	When in Use	<50
General Office Areas (e.g., Building Manager Room)	When in Use	45

3.2 Noise Emission Criteria

3.2.1 NSW EPA Noise Policy for Industry 2017

The NSW EPA *Noise Policy for Industry* 2017 provides a framework for assessing environmental noise impacts from industrial premises and industrial development proposals in New South Wales. Although this policy is aimed at addressing industrial noise, it is also used as an appropriate reference document for government authorities for assessing noise from premises it regulates. The noise criteria set by this policy can be generally applied to noise from mechanical plant and equipment and vehicle movements on site.

The NPfI recommends the development of project noise trigger levels, which provide a benchmark for assessing a proposal or site. The project noise trigger levels should not be interpreted as mandatory noise criteria but rather as noise levels that, if exceeded, would indicate a potential noise impact on the community.

The project noise trigger level is the lower value of the project intrusiveness noise level and the project amenity noise level. The project intrusiveness noise level assesses the likelihood of noise being intrusive above the ambient noise level and is applied to residential receivers only. The project amenity noise level ensures the total industrial noise from all sources in the area does not rise above a maximum acceptable level.

3.2.1.1 Project Intrusiveness Noise Levels

The intrusiveness noise level is the noise level 5 dBA above the background noise level for each time period (daytime, evening or nighttime) of interest at a residential receiver. The background noise level is derived from the measured L_{A90} noise levels. The noise logger at Location MP1 was used to determine the project intrusiveness levels for residential receivers to the north of the site, and the noise logger at Location MP2 was used to determine project intrusiveness noise levels for the residential receivers to the east and northeast of the site.

The project intrusiveness noise levels for residential receivers are shown in **Table 3-4.**

Table 3-4 Project Intrusiveness Noise Levels

Type	Receiver ID	Time Period [1]	Intrusiveness Noise Level $L_{Aeq,period}$ dBA
Residential	R01 – R03, R08	Day	57
		Evening	50
		Night	35
	R04 – R07	Day	62
		Evening	54
		Night	38

Note 1: Monday to Saturday — Daytime (7am – 6pm), Evening (6pm – 10pm), Night (10pm – 7am)
Sunday and Public Holidays — Daytime (8am – 6pm), Evening (6pm – 10pm), Night (10pm – 8am)

3.2.1.2 Project Amenity Noise Levels

Project amenity noise levels aim to set a limit on continuing increases in noise levels from all industrial noise sources affecting a variety of receiver types; that is, the ambient noise level in an area from all industrial noise sources remains below recommended amenity noise levels.

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

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

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

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

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

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

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

The project amenity noise levels are calculated from the recommended amenity noise levels presented in **Table 3-5**.

Table 3-5 Recommended Amenity Noise Levels

Receiver	Noise Amenity Area	Time Period [1]	Recommended Amenity Noise Level $L_{Aeq,period}$ dBA
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See Column 4	See Column 4	5dBA above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day.
School classroom-internal	All	Noisiest 1-hour period when in use	35
Hospital ward internal external	All	Noisiest 1-hour	35
Place of worship-internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5dB(A) to recommended noise amenity area

Note 1: Monday to Saturday — Daytime (7am – 6pm), Evening (6pm – 10pm), Night (10pm – 7am)
Sunday and Public Holidays — Daytime (8am – 6pm), Evening (6pm – 10pm), Night (10pm – 8am)

The project amenity trigger level sets limits on the total noise level from all industrial noise sources affecting a receiver. Different amenity noise levels apply for different types of receivers (e.g. residential, commercial, industrial – or for areas specifically reserved for passive recreation) and different areas (e.g. urban, suburban,

rural). The amenity noise level applies to the $L_{Aeq,period}$ during the full day (or evening or night). To ensure that industrial noise levels remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise. This is calculated as the recommended amenity noise level for the receiver type minus 5 dBA. Where noise sources are not continuous for the whole period it is allowable to add 3 dB to convert from a period level to a 15-minute level.

Based on the background noise levels measured during the day and evening periods, residential receivers have been classified as urban as per the NPfI.

The project amenity noise levels are presented in **Table 3-6.**

Table 3-6 Project Amenity Noise Levels

Receiver	Time Period [1]	Recommended Amenity Noise Level $L_{Aeq,period}$ dBA [2]	Project Amenity Noise Level $L_{Aeq,15min}$ dBA
Residential R01 – R08	Day	60	58
	Evening	50	48
	Night	45	43
Commercial C01 – C04	When in use	65	63
Passive Recreation RE01, RE02	When in use	50	48

Note 1: Monday to Saturday — Daytime (7am – 6pm), Evening (6pm – 10pm), Night (10pm – 7am)
Sunday and Public Holidays — Daytime (8am – 6pm), Evening (6pm – 10pm), Night (10pm – 8am)
Note 2: Calculated as an area with high traffic noise levels as per Section 2.4.1 of the NPfI.

3.2.1.3 Project Noise Trigger Levels

The project noise trigger levels are presented in **Table 3-7**.

Table 3-7 NPfI Project Noise Trigger Level Criteria

Receiver	Time Period [1]	Intrusiveness Criteria $L_{Aeq,15min}$ dBA	Amenity Criteria $L_{Aeq,15min}$ dBA	Project Noise Trigger Criteria $L_{Aeq,15min}$ dBA
R01 – R03, R08	Day	**57**	58	57
	Evening	50	**48**	48
	Night	**35**	43	35
R04 – R07	Day	62	**58**	58
	Evening	54	**48**	48
	Night	**38**	43	38
C01 – C04	When in use	-	65	63
RE01, RE02	When in use	-	50	48

Note 1: Monday to Saturday — Daytime (7am – 6pm), Evening (6pm – 10pm), Night (10pm – 7am)
Sunday and Public Holidays — Daytime (8am – 6pm), Evening (6pm – 10pm), Night (10pm – 8am)

3.2.1.4 Sleep Disturbance

Guidance for assessing the potential for sleep disturbance impacts on nearby residences is provided in Section 2.5 of the NPfI, which states:

Where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40 dBA or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{Amax} 52 dBA or the prevailing RBL plus 15 dB, whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.

3.3 Construction Noise & Vibration Criteria

3.3.1 Noise – Interim Construction Noise Guideline (EPA, 2009)

The NSW EPA Interim Construction Noise Guideline (ICNG) requires project-specific Noise Management Levels (NMLs) to be established for noise affected receivers. All construction works are expected to be carried out during the standard daytime construction hours as per the *ICNG* of Monday to Friday 7 am – 6pm and Saturday 8 am – 1pm. Where Out-of-Hours-Works (OOHWs) are required, it is likely they would require separate approval. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

Having investigated all feasible and reasonable work practices, if construction noise levels are still predicted to exceed the NMLs then the potential noise impacts would be managed via site-specific construction noise management plans, to be prepared in the detailed design phase. **Table 3-8** details the ICNG noise management levels.

Table 3-8 Interim Construction Noise Guideline Criteria

Time of Day	NML	How to Apply
Recommended Standard Hours	Noise Affected RBL+10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly Noise Affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences; 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL+5 dBA	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 dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the *ICNG*.

Table 3-9 details the ICNG noise management levels for non-residential receivers, which are applicable when the premises are in use.

Table 3-9 ICNG Criteria at Sensitive Land Uses

Land Use	Management Level[1] $L_{Aeq,15min}$
Commercial - offices, retail outlets	External noise level 70 dB
Passive recreation areas	External noise level 60 dB

Note 1: Applies when properties are being used.

Based on the above, **Table 3-10** presents the applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications.

Table 3-10 Site-Specific Construction Noise Management Levels

Location	Construction Noise Management Level (NMLs) $L_{Aeq,15min}$				Highly Noise Affected Noise Level $L_{Aeq,15min}$
	Day Standard Hours[1]	Day OOH[2]	Evening OOH[2]	Night OOH[2]	
R01	62	57	50	35	75
R02	62	57	50	35	75
R03	62	57	50	35	75
R04	67	62	54	38	75
R05	67	62	54	38	75
R06	67	62	54	38	75
R07	67	62	54	38	75
R08	62	57	50	35	75
C01	6	70	70	70	N/A
C02	70	70	70	70	N/A
C03	70	70	70	70	N/A
C04	70	70	70	70	N/A
RE01	60	60	60	60	N/A
RE02	60	60	60	60	N/A

Note 1: Standard Hours (7am – 6pm Monday to Friday, 8am – 1am Saturday with no work on Sundays or Public Holidays)
Note 2: Day OOH (7am – 6pm), Evening OOH (6pm – 10pm), Night OOH (10pm – 7am)

3.3.2 Vibration – Construction Noise & Vibration Strategy (TfNSW, 2018)

Minimum working distances for typical vibration intensive construction equipment are provided in the Transport for NSW's (TfNSW) Construction Noise and Vibration Strategy (CNVS).

The minimum working distances presented in Appendix D of the CNVS are for both cosmetic damage (from BS 7358) and human comfort (from the NSW EPA Vibration Guideline) and are based on empirical data which suggests that where vibration intensive works are conducted outside the minimum distances, adverse vibration impacts are unlikely.

The recommended minimum working distances for vibration intensive activities from the CNVS are presented in **Table 3-11.**

Table 3-11 Recommended Minimum Working Distances from Vibration Intensive Equipment

Plant Item	Approx. Size / Weight / Model	Minimum Distance	
		Cosmetic Damage (BS 7385)	Human Response (NSW EPA 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 34t 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)	4 m
Piling Rig – Hammer	12 t down force	15 m	50 m
Jackhammer	Handheld	1 m (nominal)	Avoid contact with structure

4 EXTERNAL NOISE INTRUSION ASSESSMENT

The primary source of external noise intrusion on the development once operational is assumed to be road traffic noise. Traffic noise from Old Castle Hill Road and McMullen Avenue generate the greatest noise impact to the development.

The impact of traffic noise on the development, once operational following the "Main works", has been assessed by developing a noise intrusion model. The model determines the internal noise levels within the development based on the following:

- Measured road noise levels presented in **Section 2.3**
- The distance of the noise sources from facades of the development
- The transmission loss performance of the building façade elements (glazing, external walls and roof/ceiling)
- The estimated surface area of each façade element exposed to the external noise based on the architectural drawings
- The absorption characteristics of the internal spaces due to room finishes.

The recommendations for the construction of the building envelope discussed in this section have been designed to meet the internal noise criteria discussed in **Table 3-3**.

4.1 Residential

Based on RWDI's analysis, the indicative weighted sound reduction index (R_w) performance for the building façade elements is presented in the sub-sections below. These recommendations should be reviewed at detailed design stage once room layouts and glazing areas have progressed sufficiently to ensure that the internal noise criteria are achieved (refer to **Section 3.1**).

4.1.1 Glazing and Glazed Doors

The indicative minimum glazing performances for the development are presented in **Table 4-1** below. These recommendations have been developed assuming full height glazing and should be revised once layouts, glazing sizes and apartments finishes are finalised.

Glazing suppliers are to provide acoustic laboratory test reports confirming that the acoustic performance of their window systems (combined performance of the glass and window frame) meets the R_w requirements.

Table 4-1 Recommended Minimum Acoustic Performance for Glazing

Facade	Floor Level	Room Type	Minimum Glazing and Frame
Facing McMullen Avenue and Old Castle Hill Road	Up to Level 10	All	R_w 31
	Above level 10	Living Rooms	R_w 29
	Above level 10	Bedrooms	R_w 31
All Other Façades	All Levels	Living Rooms	R_w 29
		Bedrooms	R_w 31

Retail	Ground Floor	Typical retail	R_w 29

4.1.2 External Walls

Any proposed concrete or masonry external walls will provide adequate acoustic isolation to meet the internal noise requirements. No additional acoustic treatment is expected to be required for these external walls.

Any lightweight external walls should be reviewed at detailed design stage to determine the appropriate construction to meet in the internal noise requirements.

Any penetrations in the external walls (e.g. for services) should be adequately sealed so as not to reduce the acoustic performance of the external walls.

4.1.3 Roof/Ceiling

Any concrete roof will provide adequate acoustic isolation to meet the internal noise requirements. No additional acoustic treatment is expected to be required for the roof/ceiling to mitigate external noise intrusion.

Any lightweight roof constructions should be reviewed at detailed design stage to determine the appropriate construction to meet in the internal noise requirements.

4.1.4 Ventilation

Regarding natural ventilation of the dwelling, the NSW Department of Planning document "Development near Busy Roads and Rail Corridors - Interim Guideline" dictates that:

- "If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia."

With windows open, the allowable internal noise goal is permitted to be 10dBA higher than when the windows are closed. Where façade noise levels exceed this threshold, alternative ventilation systems may be required to meet the requirements of AS1668.1, in order to provide a method of ventilation that does not require residents to open their windows. Examples of alternative methods are as follows:

- Acoustically treated balconies;
- Partially enclosed balconies,
- Acoustic plenums;
- Wintergardens;
- Ventilation louvres
- Mechanical ventilation/air-conditioning system.

Indicatively, the first 10 levels of apartments may need alternative ventilation strategies. Residents may still elect to open their windows for ventilation if they choose to.

Any system that is installed should be acoustically designed such that the acoustic performance of the recommended constructions is not reduced by any element penetrating the wall/ceiling/roof.

4.2 Retail Tenancy

There are no mandatory acoustic requirements applicable external spaces within the development. Noise levels in the outdoor space beside the retail tenancy (shown in **Figure 4-1**) are predicted to be approximately 59-63 dBA during the daytime, across the space. Noise levels above 55 dBA are approximately when people need to raise their voice to be heard in conversation, or move closer together. In order to reduce the noise level within the outdoor space, additional shielding using solid constructions such as fences without airgaps, would need to be introduced.

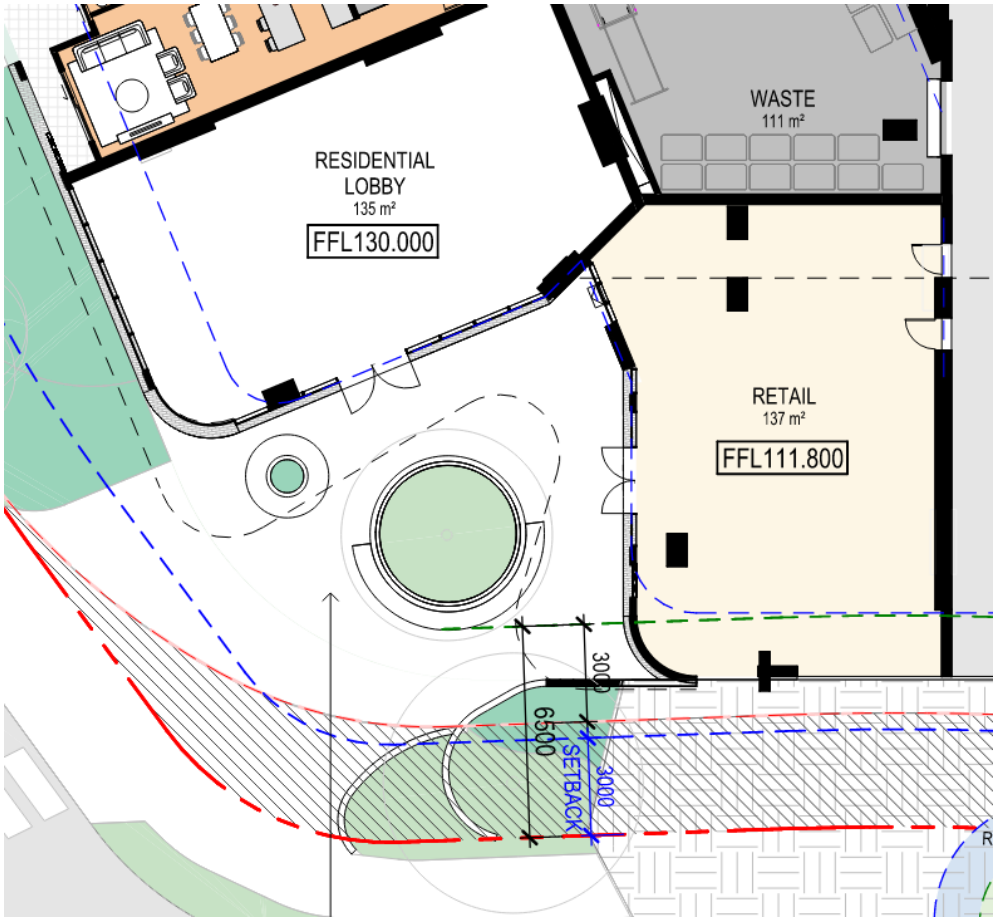


Figure 4-1 Ground Floor Retail Plan

5 OPERATIONAL NOISE ASSESSMENT

Modelling of noise emissions from the development has been undertaken using the ISO 9613 noise prediction algorithm in the CadnaA modelling software.

At relatively large distances from a source, the resultant noise levels at receivers can be influenced by meteorological conditions, particularly temperature inversions and gradient winds. Where these factors are a feature of an area, their effect on resultant noise levels should be taken into account. The NPfI recommends that noise predictions be conducted under these meteorological conditions that are favourable for noise propagation.

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable for noise propagation.

The primary sources of noise generation from the site are as follows:

- Vehicle noise from the use of the proposed driveway leading to basement car parking, accessible from Garthowen Crescent;
- Mechanical plant noise; and
- Speech sources at the outdoor pool/communal space on Level 30.

Our noise modelling methodology and noise predictions of the various noise sources are presented in the sub-sections below.

5.1 Noise Impacts to External Receivers

5.1.1 On-Site Vehicular Noise and Mechanical Plant

5.1.1.1 On-Site Vehicular Noise

RWDI's modelling of noise emissions from vehicle movements along the driveway and within the basement assumed the vehicular noise emissions from a car and truck presented in **Table 5-1.** These noise levels are based on measurements undertaken by RWDI. Modelling of noise emissions from vehicle movements assumes that heavy vehicles accessing the site are no larger than a class 3 size.

Table 5-1 Assumed Vehicular Sound Power Levels

Noise Source	Sound Power Level $L_{w,A}$ (dB)
Car manoeuvring at 10 km/hr	85
Truck manoeuvring at 10 km/hr	99

The RTA's *Guide to Traffic Generating Developments*' traffic generation rate for high-density residential flat buildings in metropolitan sub-regional centres is 0.24 trips per unit during peak hour. To be conservative in our assessment, one trip per three units during peak hour has been adopted in our noise model for the daytime

period, which is higher than RTA's generation rate. Typical trip generation rates are not available for non-peak periods. A maximum generation rate of one trip per six units has been assumed during the evening period, and one trip per nine units during the night period.

Given the adopted traffic generation rates, and the number of units on site (371 units), the following worst case vehicle movements have been assumed per 15 minute period:

- Day: 31
- Evening: 16
- Night: 10

These vehicles are assumed to either enter or exit the parking area via the driveway on Garthowen Crescent. A maximum of one heavy vehicle movement per 15 minutes is assumed between 7am and 10pm, with no heavy vehicle movements outside these hours.

5.1.1.2 Mechanical Plant

A preliminary assessment of mechanical noise emissions has been completed based on nominal assumptions using representative equipment selections. The following sources and assumptions were considered:

- One condenser per four apartments (total 93), located on the rooftop of the tallest tower
- Each condenser was assigned a conservative sound power level of 70 dBA, representative of a Daikin model REYQ12TAY1 condenser
- Up to half of all condensers operate simultaneously during all periods.
- No other mechanical plant items were modelled; it is likely that additional equipment will be present including cooling towers, chillers and car park fans.
- No preliminary mitigation measures were included, such as barriers, absorption, shielding or louvres.

The purpose of this assessment is to demonstrate that the development is capable of complying with NPfI criteria, based on reasonable assumptions. A detailed acoustic review of mechanical plant should be undertaken at detailed design stage once plant selections and locations have been finalised.

5.1.1.3 Predicted Noise Levels

The predicted combined noise levels at the surrounding receivers from vehicle movements and rooftop condensers are presented in **Table 5-2**. The noise levels have been assessed against the project noise trigger levels of the NPfI (refer to **Table 3-7**).

Table 5-2 Predicted Noise Levels from Vehicle Movements and Nominal Mechanical Services

Receivers	Predicted Noise Level $L_{Aeq, 15min}$			PNTLs [1] $L_{Aeq, 15min}$			Complies
	Day	Evening	Night	Day	Evening	Night	
R01	46	45	34	57	48	35	**Yes**
R02	33	33	21	57	48	35	**Yes**
R03	28	28	18	57	48	35	**Yes**
R04	27	26	22	58	48	38	**Yes**
R05	39	38	29	58	48	38	**Yes**
R06	33	32	23	58	48	38	**Yes**
R07	42	41	31	58	48	38	**Yes**
R08	40	39	28	57	48	35	**Yes**
C01	38	37	27	63	63	63	**Yes**
C02	26	25	<20	63	63	63	**Yes**
C03	23	23	<20	63	63	63	**Yes**
C04	<20	<20	<20	63	63	63	**Yes**
RE01	22	22	20	48	48	48	**Yes**
RE02	<20	<20	<20	48	48	48	**Yes**

Note 1: Monday to Saturday — Daytime (7am – 6pm), Evening (6pm – 10pm), Night (10pm – 7am)
Sunday and Public Holidays — Daytime (8am – 6pm), Evening (6pm – 10pm), Night (10pm – 8am)

Our analysis indicates that cumulative noise emissions from vehicle movements and mechanical plant can comply with the NPfI project noise trigger criteria.

5.1.1.4 Recommendations

The following recommendations are provided for on-site vehicular noise based on the assessment of noise emissions presented in the previous section:

- Use of the loading dock should generally be restricted to between 7 am and 6 pm Monday to Saturday, with no deliveries on Sundays or public holidays.
- Drivers should see signs at the loading dock reminding them to turn off their engines while idling, unless the engine is needed for essential tasks.
- To minimise noise generated by vehicles driving over loose items on the ground, any speed bumps, drainage grates or expansion joint covering plates should be firmly fixed such that they do not generate any rattling noises when driven over by vehicles.

Based on the preliminary assessment, the development is considered capable of complying with the requirements of Council and the NPfI using typical acoustic mitigation measures applicable to mechanical services, such as:

- Locating mechanical equipment as far as practicable from noise sensitive receivers;

- Using in-duct treatments such as internally lined ductwork or silencers;
- Building barriers or enclosures around equipment;
- Using acoustic louvers.

5.1.2 Outdoor Communal Spaces

5.1.2.1 Noise Modelling Procedure

The total capacity of all internal and external communal spaces within the development is approximately 110 people. Modelling of noise emissions from speech has been conducted for the only outdoor communal space, the pool area located on Level 30. Modelling has been undertaken based on the following assumptions:

- The sound power level (SWL) of one person talking in a raised voice is 77 dBA
- Up to 50 people using the outdoor communal space, in proportion with the area of the space compared to the total area of all communal spaces
- 1 in 2 people (25 people) speaking in a raised voice at any given time
- No amplified music

5.1.2.2 Predicted Noise Levels

The predicted noise levels at the surrounding receivers from vehicle movements are presented in **Table 5-3.** The noise levels have been compared to the day and evening project noise trigger levels of the NPfI (refer to **Table 3-7**), noting that noise from speech sources is not strictly within the scope of the NPfI.

Table 5-3 Predicted Noise Levels from Outdoor Speech Sources

Receivers	Predicted Noise Level $L_{Aeq, 15min}$	PNTL $L_{Aeq, 15min}$		Complies
		Day	Evening	
R01	23	57	48	**Yes**
R02	25	57	48	**Yes**
R03	23	57	48	**Yes**
R04	<20	58	48	**Yes**
R05	<20	58	48	**Yes**
R06	<20	58	48	**Yes**
R07	21	58	48	**Yes**
R08	35	57	48	**Yes**
C01	25	63	63	**Yes**
C02	25	63	63	**Yes**
C03	25	63	63	**Yes**
C04	25	63	63	**Yes**
RE01	<20	48	48	**Yes**
RE02	22	48	48	**Yes**

Noise levels from speech sources on level 30 are likely to be quieter than the daytime and evening background noise level at all receivers, based on the ground level background noise levels shown in **Table 2-3**. The acoustic impact to external receivers is anticipated to be negligible.

Noise impacts from the smaller capacity and indoor communal spaces are predicted to be adequately mitigated through management measures, including closure of any operable windows if required.

5.1.3 Ground Floor Retail

If the retail tenancy on the ground floor has the potential to create noise disturbance, this should be detailed within a standalone assessment prepared for the tenancy.

5.2 Noise Impacts on Sensitive Spaces Within Development

5.2.1 On Site Vehicular Sources

Based on the assumed traffic volumes accessing the underground carpark and loading dock, vehicle noise emissions have a low risk of adverse acoustic impacts to the façades of nearby SOUs.

5.2.2 Mechanical Services

Based on the preliminary assessment discussed in **Section 5.1.1**, noise levels at facades within the development are predicted to comply with requirements, using only standard mitigation measures that are commonly employed to control noise emissions from mechanical equipment, such as:

- Locating mechanical equipment as far as practicable from noise sensitive receivers;
- Using in-duct treatments such as internally lined ductwork or silencers;
- Building barriers or enclosures around equipment;
- Using acoustic louvers.

5.2.3 Outdoor Communal Space and Swimming Pool

Level 30 is proposed to include an outdoor communal space and swimming pool for use by residents of the building. The surrounding spaces with the potential to be affected by noise or vibration in this space are as follows:

- Level 30 Indoor communal space (immediately adjacent)
- Level 30 Easternmost apartment (distance to nearest façade approximately 3m)
- Level 29 apartments and plant room (immediately beneath)
- Level 31 apartments (overlooking)

5.2.3.1 Airborne Noise Impacts

Noise levels from use of the outdoor communal space have a risk of annoyance to surrounding residences, primarily through means of airborne noise spill from the communal area to surrounding windows and balconies. Based on the assumptions outlined in **Section 5.1.2**, the worst-case façade noise levels may be up to 62 dBA at the immediately overlooking apartment on Level 31, including at the balcony.

To control noise levels to an acceptable level, it is recommended that the outdoor communal area be wholly or partially covered with a solid roof, the extent of which would be determined during detailed design stage. The

roof would need to block line of sight from the pool to the overlooking receivers and be made of a solid, continuous construction without gaps, including at the building façade. Soffit lining could be considered to reduce the build-up of reverberant noise if necessary.

Upgrades to glazing could be considered for control of internal noise levels at nearby apartments, and in the communal space if desired.

Additionally, it is recommended to develop a plan of management for the outdoor terrace, to balance the use of the communal space with the amenity of surrounding apartments. The following managements measures could be considered within a plan of management:

- Permitted hours of access
- Restrictions of group size
- Restriction of permitted activities during certain hours (e.g. lap swimming only)
- Use of amplified music
- Signage reminding users to be mindful of nearby residents
- Management procedure for complaints
- Any other measures deemed suitable

5.2.3.2 Noise Transmission through Horizontal or Vertical Partitions

The NCC requirements for airborne noise through floors separating SOUs from public spaces (refer to **Section 9**) apply to the slab separating the outdoor communal space from any sleeping areas below. The pool must also be vibration isolated (refer to **Section 5.2.3.3**).

There are no mandatory requirements in the NCC for airborne sound insulation between the outdoor pool area and indoor communal area. The majority of the façade of this space is currently shown as glazed, which will limit the degree of acoustic separation which can be achieved unless double glazing is considered.

5.2.3.3 Vibration Isolation of Swimming Pool

Pool activities such as diving into the pool or bobbing in the pool generate vibration in the pool shell which can then transmit to the building structure. If this vibration transmission between the pool shell and the building is not adequately mitigated, it can result in unacceptable levels of structure-borne noise being generated in nearby sensitive spaces within the development.

To prevent this, the pool shell (horizontal and vertical floors/walls) should be vibration isolated from the building structure using a resilient isolation support system. The detailed requirements of this isolation should be determined at detailed design stage.

5.2.4 Indoor Communal Areas

Level 1 and Level 30 are proposed to contain indoor communal areas for use by residents of the building. The horizontally adjacent spaces to these areas will be a corridor and a sole occupancy unit (SOU) on Level 1, and the outdoor pool area, corridor and one SOU on Level 30. SOUs are located directly above the indoor communal areas on both levels, and directly below the indoor communal area on Level 30. No information is available at this stage concerning the expected uses of the spaces.

There are no NCC requirements for noise transmission between public areas. In the absence of this, we recommend that the walls and floor separating these spaces be designed to achieve a minimum R_w 50 performance. These assumptions should be confirmed at detailed design stage.

If the spaces are to be used as free social spaces by the residents of the building, consideration should be given to managing noise impacts to surrounding SOUs. Management measures could include restrictions on the following, but not limited to:

- Permitted group size
- Permitted time of use
- Use of amplified music

If either communal space is to be used as a gym, requirements for vibration isolation of the floor should also be reviewed at detailed design stage, in order to control transmission of structure-borne vibration into surrounding areas.

6 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

6.1 Proposed Construction Activities

6.1.1 Proposed Works

This report provides a preliminary assessment of the potential construction noise and vibration impacts associated with the proposed development. The construction noise and vibration assessment has considered the following construction stages in-principle:

- Early works:
  - Demolition
  - Excavation
- Main works:
  - Piling
  - Construction

6.1.2 Construction Hours

Where possible, works should be completed during the standard daytime construction hours of Monday to Friday 7.00am to 6.00pm and Saturday 8.00am to 1.00pm. Where Out-of-Hours Works (OOHWs) are required (for emergency works/delivery, etc) it is likely that they would require separate approval.

6.2 Construction Noise Modelling

Noise modelling of the construction noise emissions was undertaken using the ISO 9613 noise prediction algorithm in the Cadna/A modelling software.

The noise model was constructed from a combination of aerial photography, existing ground topography, design ground topography and proposed design. The local terrain, receiver buildings and structures have been digitised in the noise model to develop a three-dimensional representation of the construction works and surrounding environment.

6.3 Construction Equipment Noise Sources

Sound power levels for the typical operation of construction equipment applied in the modelling are listed in **Table 6-1** and have been based on measurements conducted by RWDI and Appendix C of the CNVS. To assess construction noise levels against the NMLs, the noise levels have been converted to equivalent $L_{Aeq,15min}$ noise emissions based on the expected period of operation of the individual pieces of construction plant.

Table 6-1 Construction Noise Sources

Stage		Equipment	Operating minutes in 15-min period	Qty	Sound Power Level $L_{w,A}$ (dB)	
					Per Item	Per Stage
Early Works	Demolition	Excavator (30 t)	15	2	110	**114**
		Truck & Dog (30 t)	15	1	108	
	Excavation	Dozer (D10)	15	2	116	**122**
		Truck & Dog (30 t)	15	2	108	
		Excavator (40 t)	15	2	115	
Main Works	Piling	Piling Rig	15	1	116	**117**
		Concrete Truck	15	1	109	
		Concrete Pump	15	1	109	
	Construction	Concrete Truck / Agitator	15	2	106	**117**
		Concrete Pump	15	1	109	
		Truck (20 t)	15	1	103	
		Mobile Crane	15	1	113	
		Hand Tools	15	5	105	
		Elevated Work Platform	15	2	97	

Consistent with the requirements of the ICNG, and to inform the scheduling of construction activity and management of noise during the detailed design phase, the construction noise impacts are based on an expected typical worst-case scenario. The ICNG recommends that the realistic worst-case or conservative noise levels from the source should be predicted for assessment locations representing the most noise-exposed residences or other sensitive land uses. For each receiver area the noise levels are predicted at the most noise-exposed location, which would usually be the closest receiver.

For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted at the most-exposed receiver as the noise levels presented in this report are based on a realistic worst-case assessment.

6.4 Predicted Construction Noise Impacts

Preliminary noise impacts have been quantitatively assessed of construction activities for receivers surrounding the site. The activities considered are described in **Table 6-1**.

The typical $L_{Aeq,15min}$ noise levels at the surrounding noise receivers are provided in **Table 6-2.** Each of the construction activities are representative of the 'noisiest' construction periods where there may be

simultaneous operation of noise intensive construction plant on site. Values shown in **BOLD** have the potential to exceed the NMLs for that receiver. Values shown in **BOLD** have the potential to exceed the Highly Noise Affected Level for that receiver.

Table 6-2 Predicted Construction Noise Impacts

Stage	Receivers	Predicted Noise Level $L_{Aeq,15min}$ dBA	Noise Affected Noise Management Levels (NMLs)				Highly Noise Affected Level $L_{Aeq,15min}$ dBA
			Day [1] Standard	Day OOH [2]	Eve OOH [2]	Night OOH [2]	
Demolition	R01	**76**	62	57	50	35	75
	R02	**66**	62	57	50	35	
	R03	62	62	57	50	35	
	R04	64	67	62	54	38	
	R05	**75**	67	62	54	38	
	R06	63	67	62	54	38	
	R07	**71**	67	62	54	38	
	R08	**68**	62	57	50	35	
	C01	**81**	70	70	70	70	NA
	C02	59	70	70	70	70	
	C03	**75**	70	70	70	70	
	C04	67	70	70	70	70	
	RE01	**70**	60	60	60	60	
	RE02	**65**	60	60	60	60	
Excavation	R01	**87**	62	57	50	35	75
	R02	**76**	62	57	50	35	
	R03	**70**	62	57	50	35	
	R04	**68**	67	62	54	38	
	R05	**80**	67	62	54	38	
	R06	**71**	67	62	54	38	
	R07	**77**	67	62	54	38	
	R08	**74**	62	57	50	35	
	C01	**92**	70	70	70	70	NA
	C02	**62**	70	70	70	70	
	C03	**79**	70	70	70	70	
	C04	**72**	70	70	70	70	
	RE01	**77**	60	60	60	60	
	RE02	**70**	60	60	60	60	

Stage	Receivers	Predicted Noise Level $L_{Aeq,15min}$ dBA	Noise Affected Noise Management Levels (NMLs)				Highly Noise Affected Level $L_{Aeq,15min}$ dBA
			Day [1] Standard	Day OOH [2]	Eve OOH [2]	Night OOH [2]	
Piling/Construction	R01	**79**	62	57	50	35	75
	R02	**69**	62	57	50	35	
	R03	**65**	62	57	50	35	
	R04	67	67	62	54	38	
	R05	**78**	67	62	54	38	
	R06	66	67	62	54	38	
	R07	**74**	67	62	54	38	
	R08	**71**	62	57	50	35	
	C01	**84**	70	70	70	70	NA
	C02	62	70	70	70	70	
	C03	**78**	70	70	70	70	
	C04	70	70	70	70	70	
	RE01	**73**	60	60	60	60	
	RE02	**68**	60	60	60	60	

Note 1: Standard Hours (7am – 6pm Monday to Friday, 8am – 1pm Saturday with no work on Sundays or Public Holidays)
Note 2: Day OOH (7am – 6pm), Evening OOH (6pm – 10pm), Night OOH (10pm – 7am)

Exceedances of the noise affected NMLs are expected at the majority of receivers during all stages due to the proximity of the site. There is the potential for exceedances to the highly noise affected level at R01 during demolition, R01, R02, R05, R07, and R08 during excavation, and R01 and R05 during piling and construction.

Measures to manage construction noise emissions are discussed in **Section 6.5**.

6.5 Construction Noise Mitigation

As discussed in **Section 6.4**, noise levels from construction activities during standard hours are predicted to exceed the NMLs of the ICNG at all receivers surrounding the site. Therefore, in accordance with the ICNG, all reasonable and feasible measures should be applied to manage construction noise emissions from the site. In particular, the following is recommended:

A detailed Construction Noise and Vibration Management Plan (CNVMP) should be prepared and should include, but not be limited to the following:

- Identification of nearby residences and other sensitive land uses;
- Description of approved hours of work;
- Description and identification of construction activities, including work areas, equipment and duration;
- Description of what work practices (generic and specific) will be applied to minimise noise;
- Consider the selection of plant and processes with reduced noise emissions;
- A complaints handling process;

- Noise monitoring procedures;
- Overview of community consultation required for identified high impact works;
- Overview of community consultation process and assessment required for identified additional works outside of standard construction hours; and
- Induction and training will be provided to relevant staff and sub-contractors outlining their responsibilities regarding noise.

Examples of typical construction noise mitigation measures are provided in **Table 6-3,** along with the likely reduction in noise levels. Where reasonable and feasible, these measures should be employed during the construction of the development.

Table 6-3 Indicative Construction Noise Mitigation Measures

Mitigation Measure	Anticipated Noise Reduction, dBA
Administrative Controls	
Operate during approved hours	N/A
Undertake regular noise monitoring to determine the impact of operating plant on sensitive receivers	N/A
Appropriate training of onsite staff	N/A
Undertake community consultation and respond to complaints in accordance with established project procedures	N/A
Turning off machinery when not in use	0-5
Respite periods for pile drivers and rock breakers (if applicable)	N/A
Conducting regular maintenance of plant to ensure that they are operating as efficiently and quietly as practicable	N/A
Engineering Controls	
Portable temporary screens	5-10
Screen or enclosure for stationary equipment	10-15
Maximising the offset distance between noisy plant items and sensitive receivers	3-6
Avoiding using noisy plant simultaneously and / or close together, adjacent to sensitive receivers	2-3
Orienting equipment away from sensitive receivers	3-5
Carrying out loading and unloading away from sensitive receivers	3-5
Using dampened tips on rock breakers	3-6
Using noise source controls, such as the use of residential class mufflers, to reduce noise from all plant and equipment including bulldozers, cranes, graders, excavators and trucks	5-10

Mitigation Measure	Anticipated Noise Reduction, dBA
Selecting site access points and roads as far as reasonably practicable away from sensitive receivers	3-6
Using spotters, closed circuit television monitors, "smart" reversing alarms, or "squawker" type reversing alarms in place of traditional reversing alarms	2-5
Employ non-noise-generating structures such as site offices, storage sheds, stockpiles and tanks as noise barriers	5-10

6.6 Predicted Construction Vibration Impacts

The nearest neighbouring building to the site boundary is approximately 3 metres to the southeast of the site, though it is noted that the setback to the nearest building within site is approximately 8 metres.

Based on the CNVS's recommended minimum working distances for vibration sensitive equipment (refer to **Section 3.3.2**), the vibration intensive activities that could potentially occur at distances less than the recommended minimum working distances from the sensitive receivers with respect to cosmetic building damage and human comfort are listed in **Table 6-4**.

Table 6-4 Vibration Intensive Equipment that Could Operate at Distances Less Than the Minimum Recommended Distances of Sensitive Receivers

Equipment Potentially Operating Less Than the Recommended Minimum Distances to Sensitive Receivers	
Cosmetic Damage (BS 7385)	**Human Response (NSW EPA Guideline)**
Vibratory Roller (any weight) Medium or Large Hydraulic Hammer > 900 kg Vibratory Pile Driver (sheet piles) Hammer Piling Rig	Vibratory Roller (any weight) (any weight) Vibratory Pile Driver (sheet piles) Hammer Piling Rig Bored Piling Rig

Should these pieces of plant be operated less than the minimum recommended distances of the CNVS of a sensitive receiver, or if there are any other vibration intensive plant items that the Contractor has concerns for causing disruption at neighbouring development, it is recommended that a preliminary vibration survey (typically attended vibration measurements) be undertaken of each vibration generating piece of plant.

This vibration survey will determine whether there will be any exceedances of the relevant construction vibration criteria. If exceedances are observed, vibration mitigation and management strategies can be developed to minimise vibration impacts as far as practicable, and ideally to be compliant with the vibration criteria.

The vibration management strategy may also include the installation of unattended vibration monitors at sensitive receivers to notify the contractor of any exceedances of the vibration criteria. Any such vibration management strategy should be developed as part of a CNVMP.

6.7 Construction Traffic Noise Assessment

Given the existing traffic volumes on Old Castle Hill Road and McMullen Avenue, it is unlikely that traffic generated during construction works will result in any appreciable change to the levels of road traffic noise currently experienced at surrounding receivers along the construction traffic route.

7 ROAD TRAFFIC NOISE GENERATION

Guidance for the assessment of traffic noise generated on public roads by new developments is set out in the EPA's Road Noise Policy 2011 (RNP).

Table 3 of the RNP is reproduced in **Table 7-1** and presents the relevant baseline criteria for traffic noise impacts from various road categories on residential uses.

Table 7-1 Road Traffic Noise Assessment Baseline Criteria for Residential Land Uses

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from **new** local road corridors 5. Existing residences affected by noise from **redevelopment** of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq, (1\ hour)}$ 55 (external)	$L_{Aeq, (1\ hour)}$ 50 (external)

Where existing road traffic noise exceeds the relevant base line criteria stipulated in **Table 7-1,** the RNP requires additional analysis to evaluate whether traffic noise levels at residences would increase by more than 2dBA as a result of increased flows associated with the development. If the increase in overall traffic noise levels is less than 2dBA, this would typically be considered as a barely perceptible increase in noise level and is unlikely to result in any adverse impacts on residential receivers.

The site will be accessed via Garthowen Crescent; an existing local road. Based on the noise monitoring at MP2 presented in **Table 2-4**, the recommended criteria for local roads are already exceeded during both the daytime and night-time. The peak hour traffic generation of the site is conservatively anticipated to be approximately 125 vehicles during the day, and 40 during the night.

Based on these volumes and the existing measured noise level, the increase in noise level to existing receivers along Garthowen Street is predicted to be less than 2 dB, and impacts to amenity due to traffic noise are anticipated to be negligible.

8 CUMULATIVE IMPACT ASSESSMENT

A cumulative impact assessment has been prepared in accordance with the NSW Department of Planning, Industry and Environment's Cumulative Impact Assessment Guidelines for State Significant Projects (March 2023). Consideration has been given to other significant developments in the immediate vicinity that may influence the acoustic environment for sensitive receivers associated with this application.

Future potential developments identified in the surrounding area are 51 Old Castle Hill Road, Castle Hill, "Garthowen West" located directly to the north of the site, and the hotel tower/commercial tower located at 6-14 Castle Street, Castle Hill.

Based on the assumption that the operation of the function/entertainment spaces located on the ground floor of Garthowen West are fully internal, and windows and doors are to be closed, low impact is expected to our site.

Based on the type of development and distance to the site, the additional impact of these sites is anticipated to be low. No additional mitigation measures are recommended at this stage.

8.1 Cumulative Impact Assessment

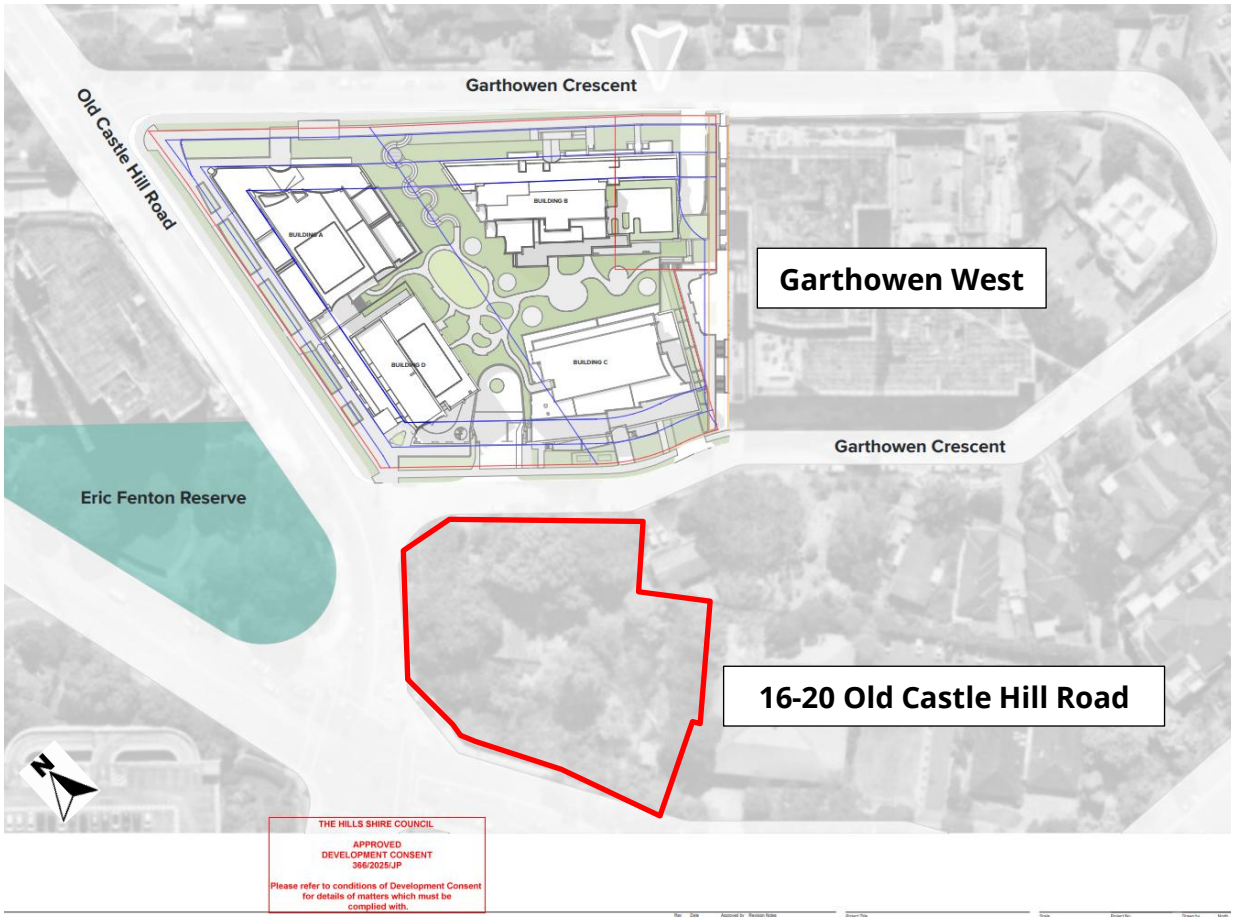
A cumulative impact assessment has been prepared in accordance with the NSW Department of Planning, Industry and Environment's Cumulative Impact Assessment Guidelines for State Significant Projects (March 2023). The purpose of this assessment is to consider whether other existing, approved, or proposed developments in the vicinity could materially influence the acoustic environment for sensitive receivers associated with this application, or be impacted by the proposed development.

8.2 Identification of Relevant Projects

A review of planning registers, council development applications, and publicly available information has been undertaken to identify significant projects within the immediate and broader area surrounding the site. This includes residential, commercial, industrial, and infrastructure developments that could contribute to cumulative noise or vibration impacts.

The only future site considered to be potentially relevant to this proposal is the residential tower "Garthowen West", to be developed across several lots directly north of the Site. The extent and location of the development are shown in **Figure 8-1**. The tallest of the proposed towers is 214m tall and the development application was approved by the Hills Shire Council on 03/11/2025.

Figure 8-1 Future Development "Garthowen West"



8.3 Qualitative Assessment of Combined Noise Impacts

- **Effect on conclusions as a potential future noise source**

The acoustic report prepared for Garthowen West (*Garthowen West: 22-28 Garthowen Crescent & 24-30 Old Castle Hill Road, Castle Hill Noise Impact Assessment*, prepared by Acoustic Logic dated 3rd September 2024) assessed the following noise sources within the future site:

- Mechanical services noise (in principle)
- Noise from light and heavy vehicles
- 400 PAX indoor function space

Emissions from vehicle use, and in-principle emissions from mechanical services, were predicted to be compliant with NPfI criteria at the northern boundary of the 16-20 Old Castle Hill Road site (referred to as R3 in the Acoustic Logic Report). Emissions from use of the function space, which is assumed to be fully enclosed, were predicted to be <30 dBA at the same location.

Assuming that all mitigation measures required by the Garthowen West Noise Impact Assessment are applied, this development is not anticipated to have an adverse effect on the acoustic environment surrounding the subject site.

- **Effect on conclusions as a potential future receiver**

Noise impacts at the future Garthowen West receivers have been modelled under the same assumptions discussed in **Section 5.1**, and are predicted to be comparable to those predicted at existing receivers R05-R07, despite the increase in height and minor changes in setback distance. It is noted that Garthowen West will not be taller than the subject site. to Compliance with council and NPfI criteria is predicted at all times of day.

8.4 Conclusion

Based on the current review, the cumulative impact of surrounding developments on the acoustic environment of the proposed site is expected to be negligible. The proposed development will not contribute to, nor be adversely affected by, cumulative noise or vibration impacts in the area. No additional mitigation measures are recommended at this stage.

Should new significant projects be proposed in the future, a supplementary cumulative impact assessment may be warranted to ensure ongoing compliance with relevant acoustic criteria.

9 NATIONAL CONSTRUCTION CODE

The bounding walls and floors of the residential components of the development should, at minimum, be designed to meet the acoustic requirements of Part F7 of the *National Construction Code* (NCC) 2022, which are presented below in **Table 9-1.** Where apartments adjoin spaces that generate high levels of noise (e.g. a plant room, cinemas), the separating partition construction may be required to exceed the requirements of the NCC in order to maintain an adequate acoustic amenity for the apartment spaces.

Specific constructions required to meet the requirements of the NCC (or any more stringent requirements to preserve acoustic amenity) will be determined at detailed design stage.

Table 9-1: NCC Acoustic Requirements

Construction	NCC Requirements	
	Laboratory Rating	Verification
Walls between sole occupancy units	$R_W + C_{tr} \geq 50$	$D_{nT,w} + C_{tr} \geq 45$
Walls between a bathroom, sanitary compartment, laundry or kitchen in one sole occupancy unit and a habitable room (other than a kitchen) in an adjoining unit	$R_W + C_{tr} \geq 50$ and Must have a minimum 20mm cavity between two separate leaves[1]	$D_{nT,w} + C_{tr} \geq 45$
Walls between sole occupancy units and a plantroom or lift shaft	$R_W \geq 50$ and Must have a minimum 20mm cavity between two separate leaves[1]	$D_{nT,w} \geq 45$
Walls between sole occupancy units and a stairway, public corridor, public lobby or the like, or parts of a different classification	$R_W \geq 50$	$D_{nT,w} \geq 45$
Door assemblies located in a wall between a sole-occupancy unit and a stairway, public corridor, public lobby or the like	$R_W \geq 30$	$D_{nT,w} \geq 25$
Floors between sole-occupancy units or between a sole-occupancy unit and a plantroom, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification	$R_W + C_{tr} \geq 50$ $L_{n,w} \leq 62$	$D_{nT,w} + C_{tr} \geq 45$ $L_{nT,w} \leq 62$
Soil, waste, water supply and stormwater pipes and ductwork to habitable rooms	$R_W + C_{tr} \geq 40$	N/A
Soil, waste, water supply and stormwater pipes and ductwork to kitchens and other rooms	$R_W + C_{tr} \geq 25$	N/A

Construction	NCC Requirements	
	Laboratory Rating	Verification
Intra-tenancy Walls	There is no statutory requirement for airborne isolation via intra-tenancy walls.	

Note 1: A wall must be of "discontinuous construction" if it separates a sole occupancy unit from a plantroom or lift shaft. Clause F7D4(3) defines "discontinuous construction" as a wall having a minimum 20mm cavity between two separate leaves with no mechanical linkage except at the periphery.

10 CONCLUSION

This report has presented a noise and vibration impact assessment for the proposed residential development to be located at 16-20 Old Castle Hill Road, Castle Hill. This assessment has been prepared to address the noise and vibration clause of the SEARs for the State Significant Development Application (SSDA).

Existing ambient noise levels have been established via long-term unattended noise monitoring as presented in **Section 2**. The noise monitoring data has been processed in accordance with the NPfI to establish the project noise trigger levels at sensitive receivers.

Noise impacts associated with the operation of the development have been assessed with reference to the NPfI and presented in **Section 3**. The results of the assessment indicate in-principle that noise emissions from the site can comply with the relevant acoustic requirements through considered design and the implementation of standard acoustic treatments and noise management controls.

Noise intrusion from road traffic on Old Castle Hill Road and McMullen Avenue has been assessed with reference to the internal noise recommendations of AS2107. Indicative recommendations for the building façade construction have been presented in **Section 4** to achieve the internal noise requirements. These recommendations should be reviewed at the detailed design stage once the room layouts and glazing areas have been finalised.

Noise and vibration impacts from the construction of the development have been assessed in-principle in **Section 0** of the report in accordance with the ICNG. Construction NMLs have been established for sensitive receivers based on the measured RBLs. Representative construction noise levels have been predicted for a range of construction activities. The predicted $L_{Aeq,15min}$ construction noise levels are expected to exceed the established NMLs for receivers at all receivers surrounding the site. It is therefore recommended that a CNVMP be developed for the site and that all reasonable and feasible measures be implemented to minimise construction noise and vibration impacts.

A cumulative impact assessment has been conducted in **Section 8**, and identified one approved development in the vicinity of the site with the potential to be significant. Noise emissions from this development are not anticipated to significantly change the existing noise characteristics of the area, provided that all requirements and recommendations within the SSDA for the site are adhered to. Noise impacts from the subject site to the future receiver were found to be comparable to those at the existing receivers in that location, and no change to the overall conclusions of this report was deemed warranted.

11 STATEMENT OF LIMITATIONS

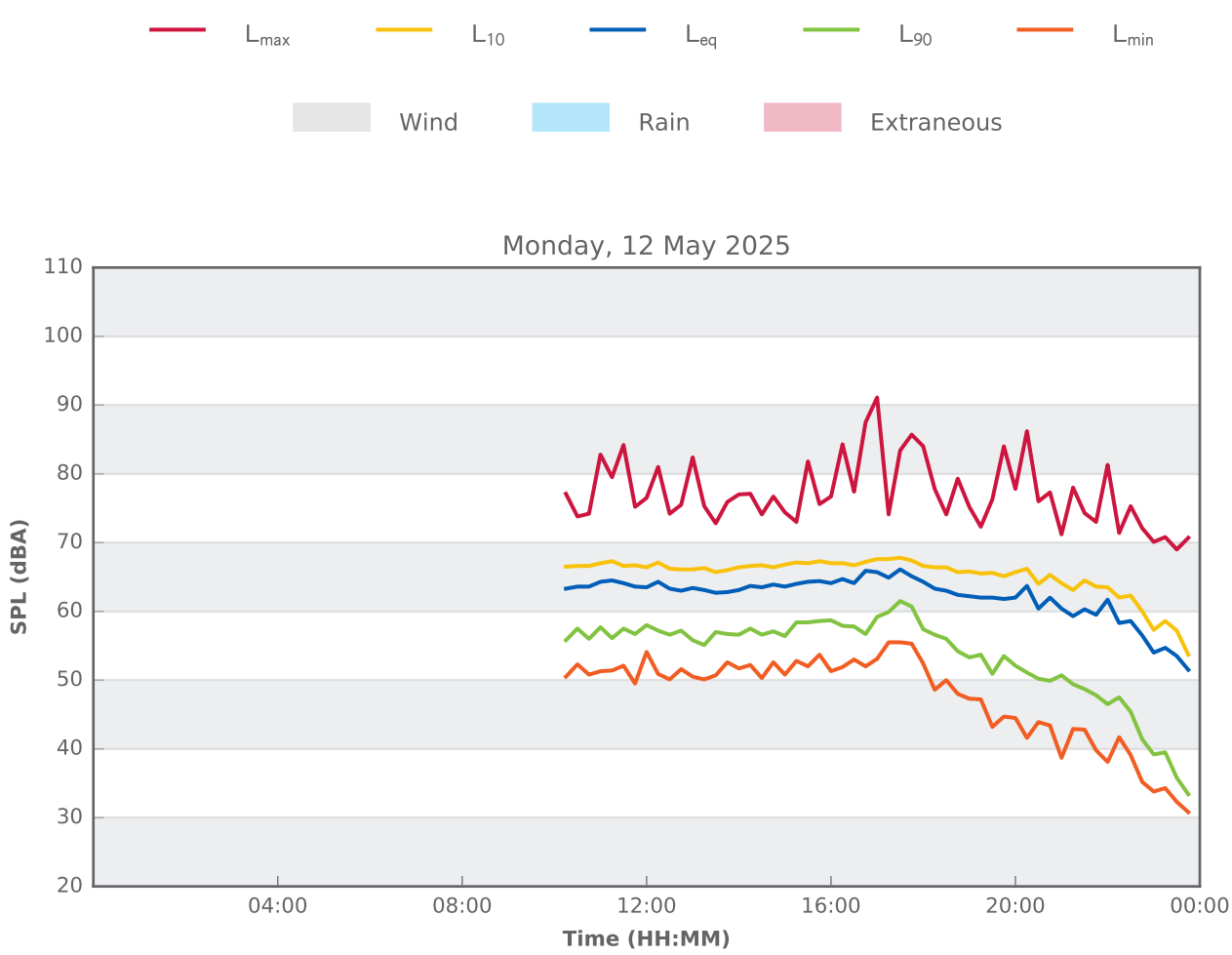
This report entitled Noise and Vibration Impact Assessment was prepared by RWDI Australia Pty Ltd ("RWDI") for Urban Property Group ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

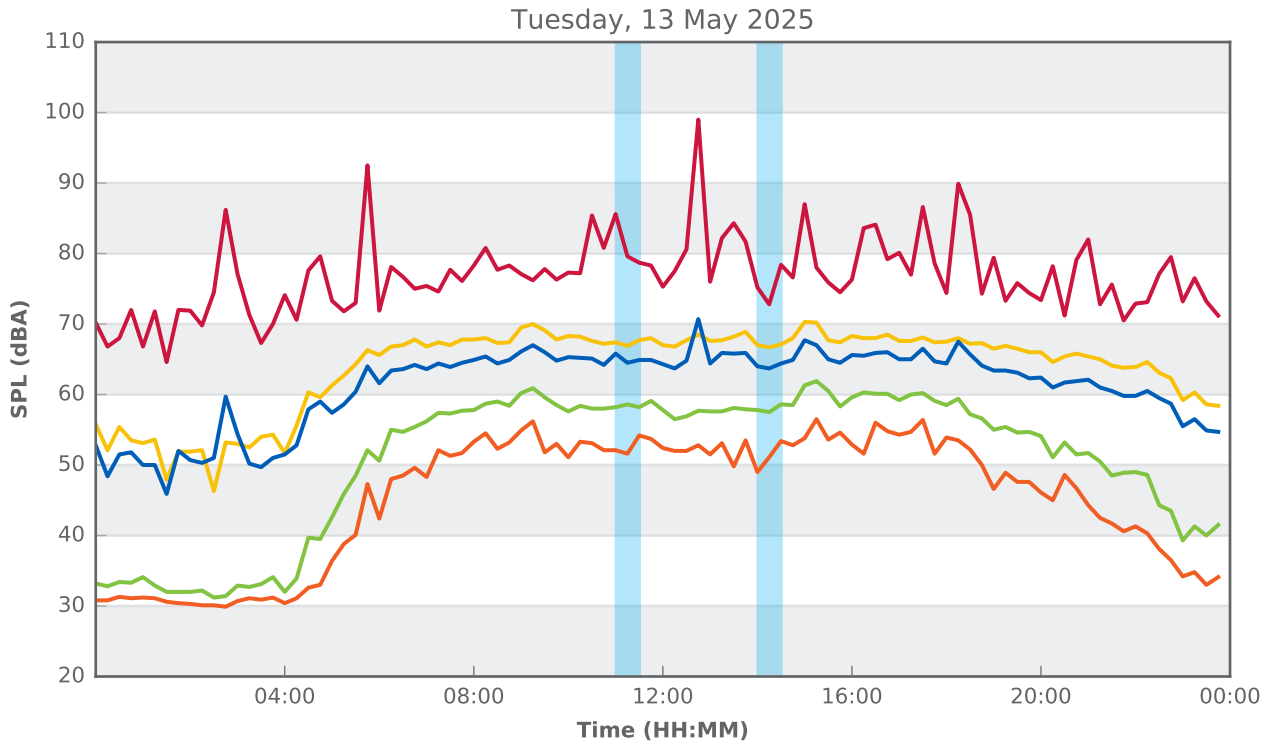
The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilise the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

APPENDIX A

MP1 - Corner of Old Castle Hill Road and Garthowen Crescent





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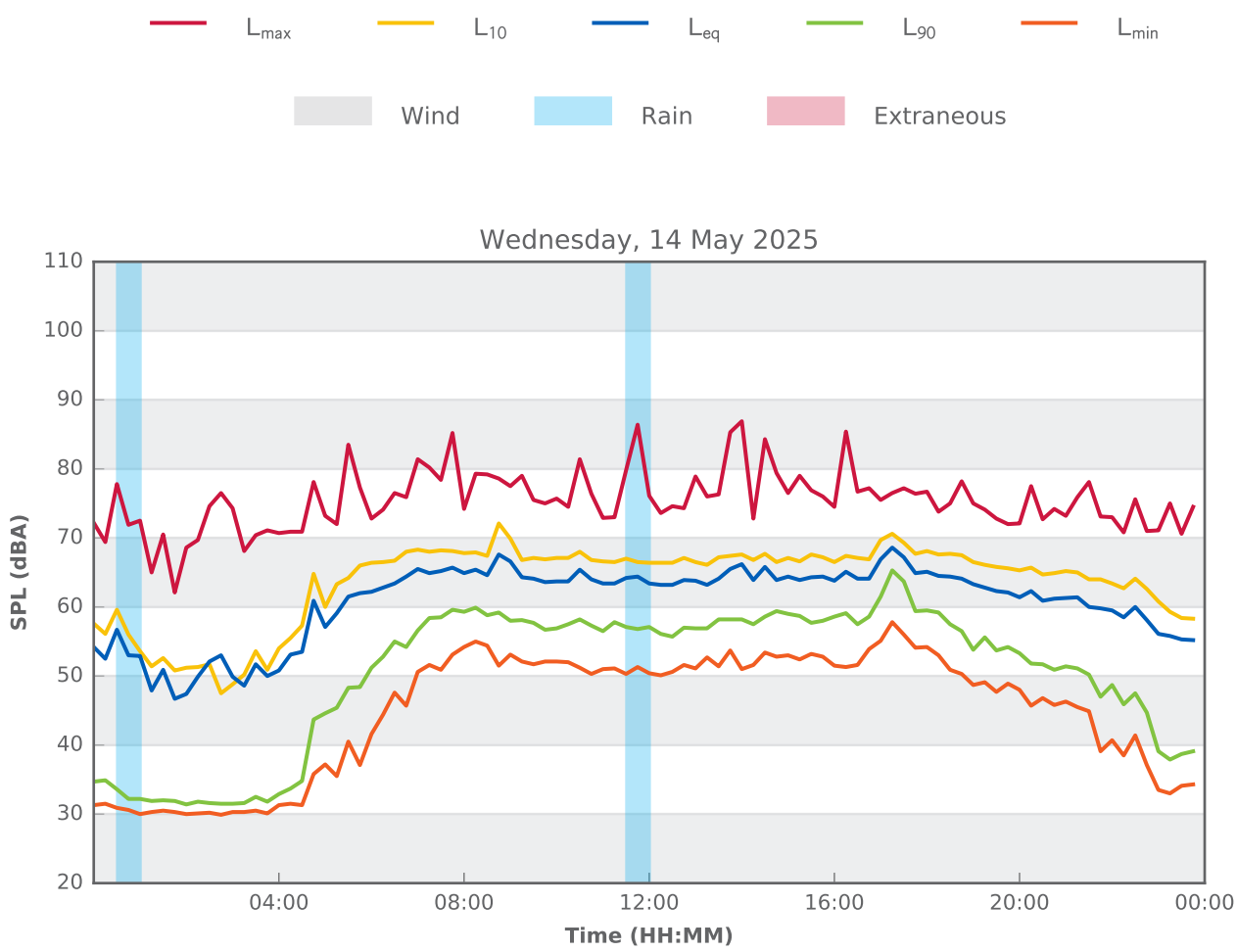

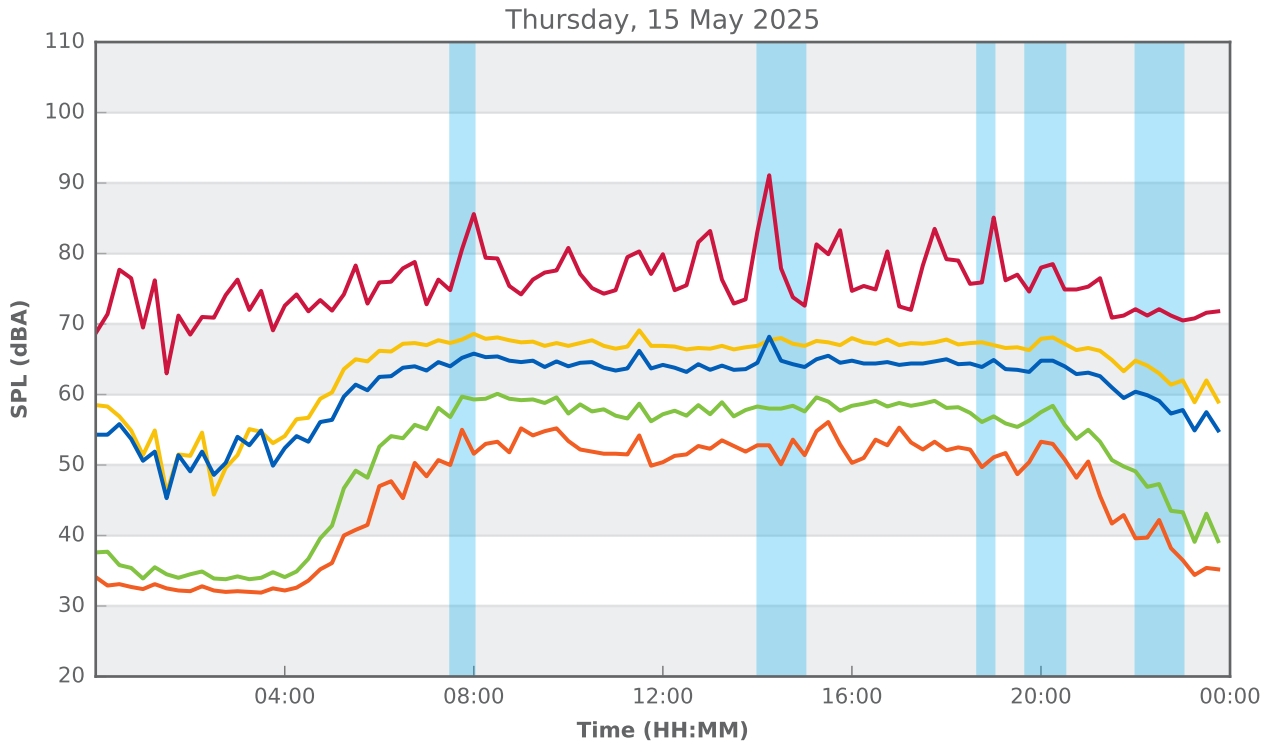

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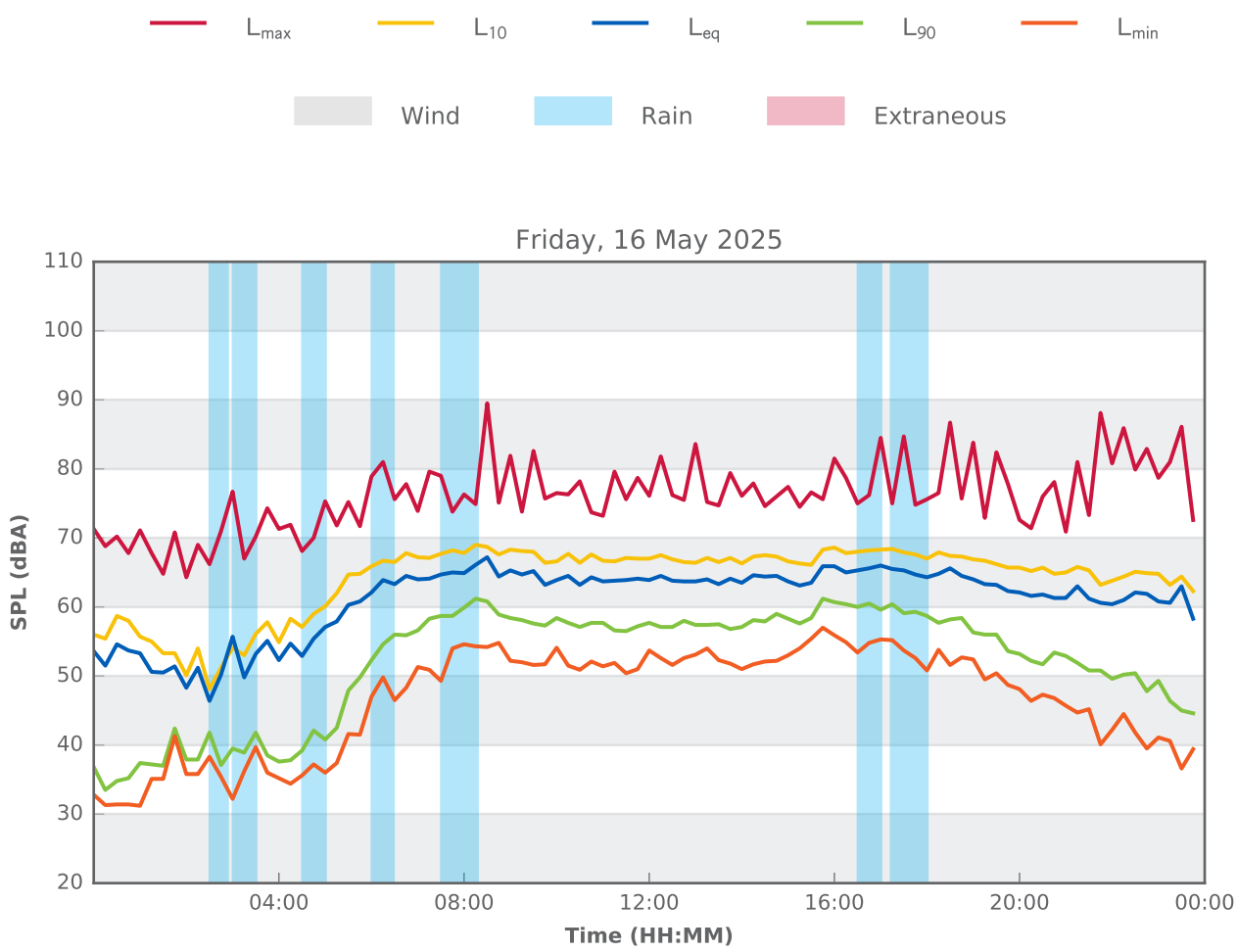

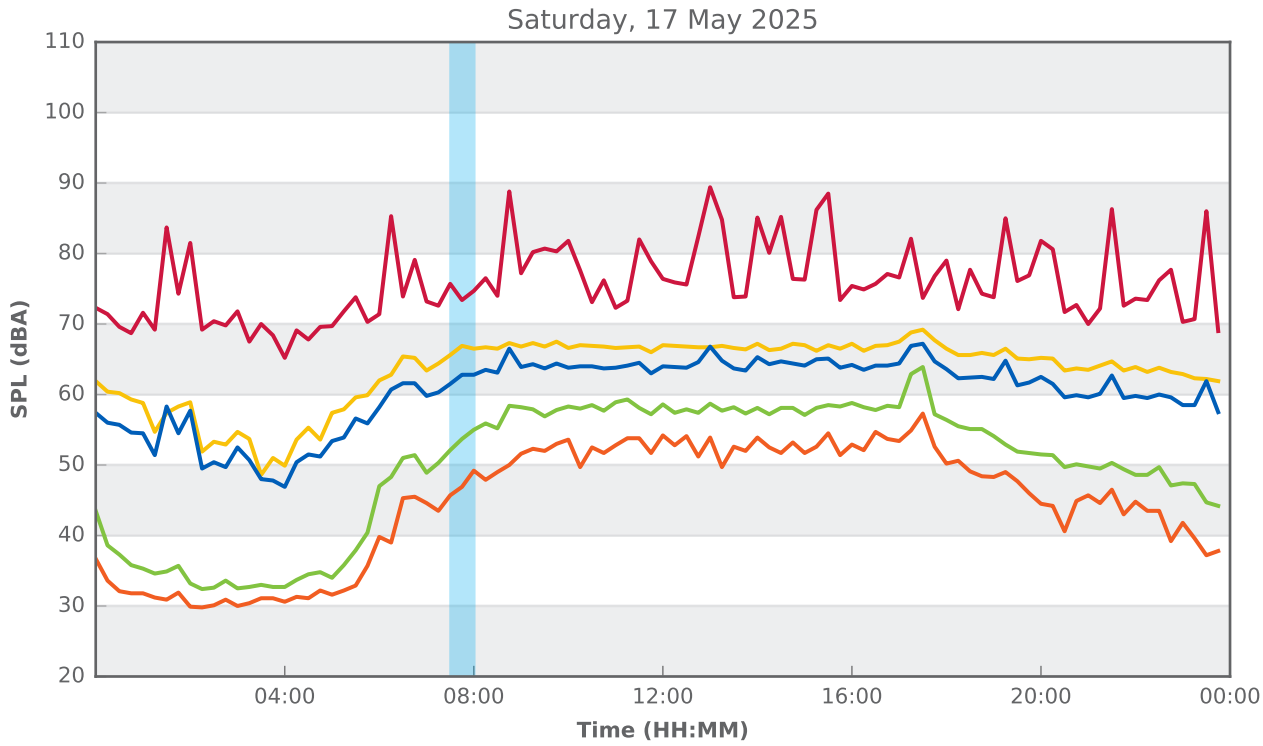

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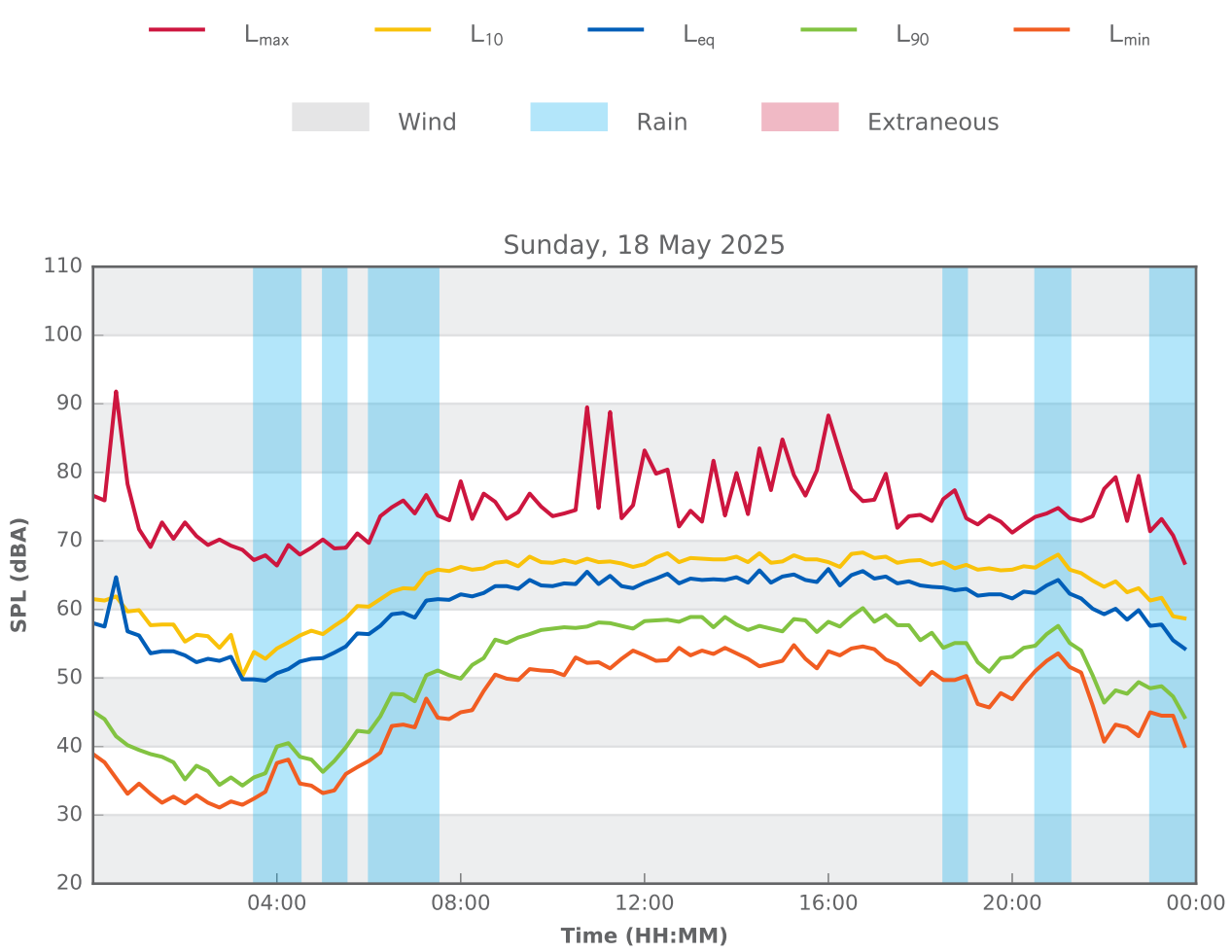

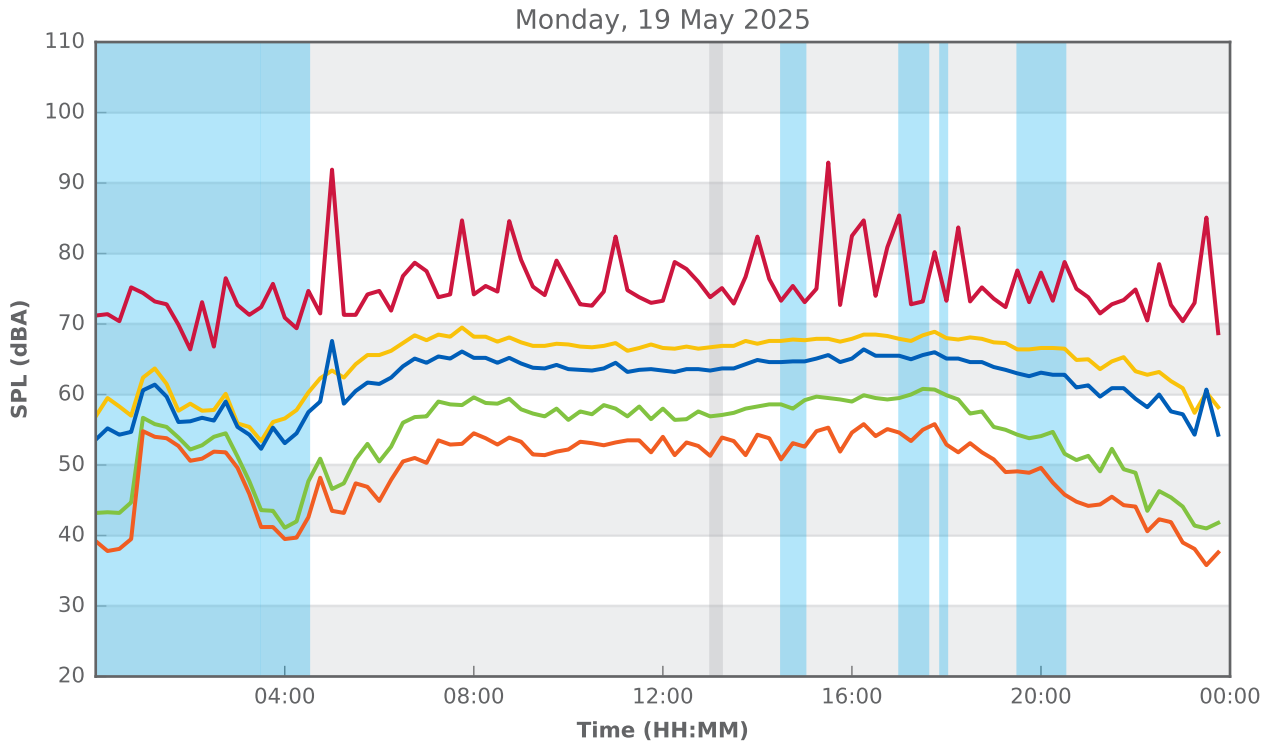

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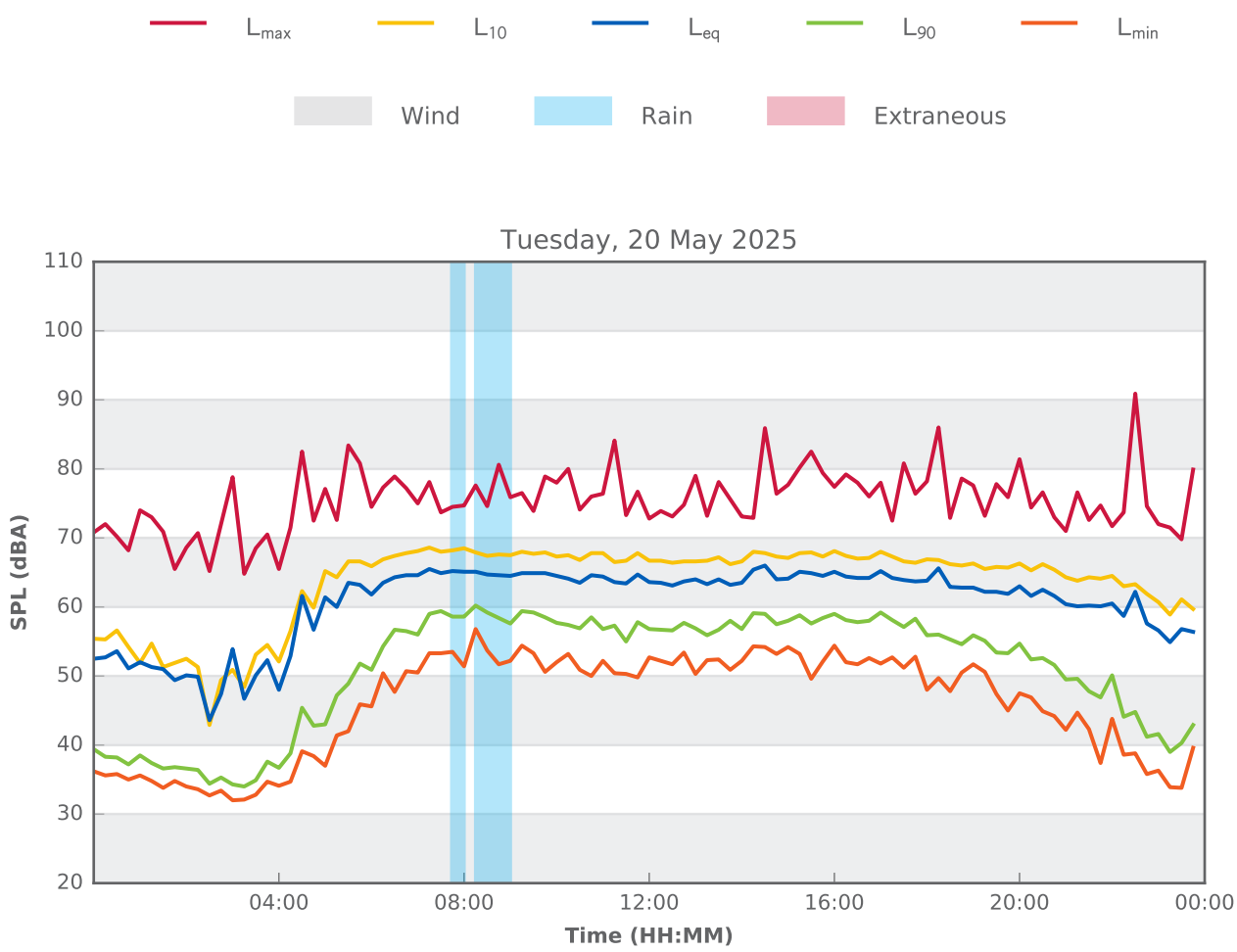

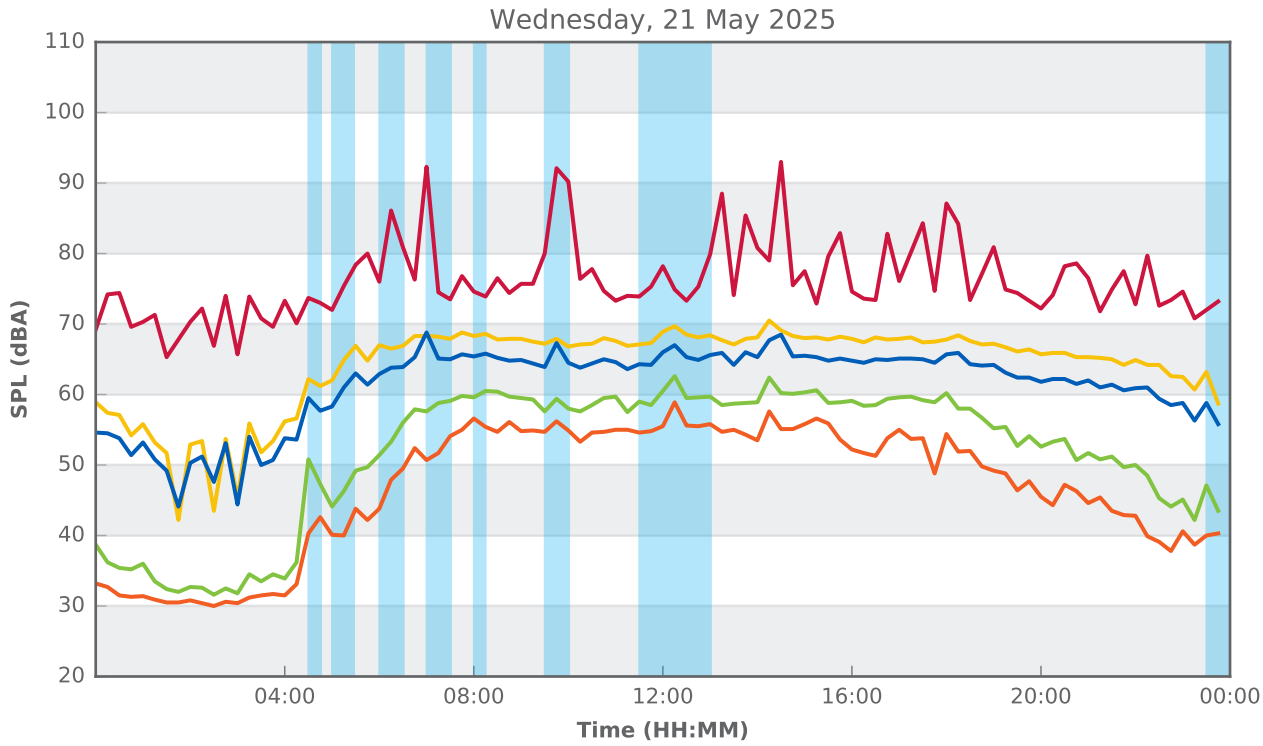

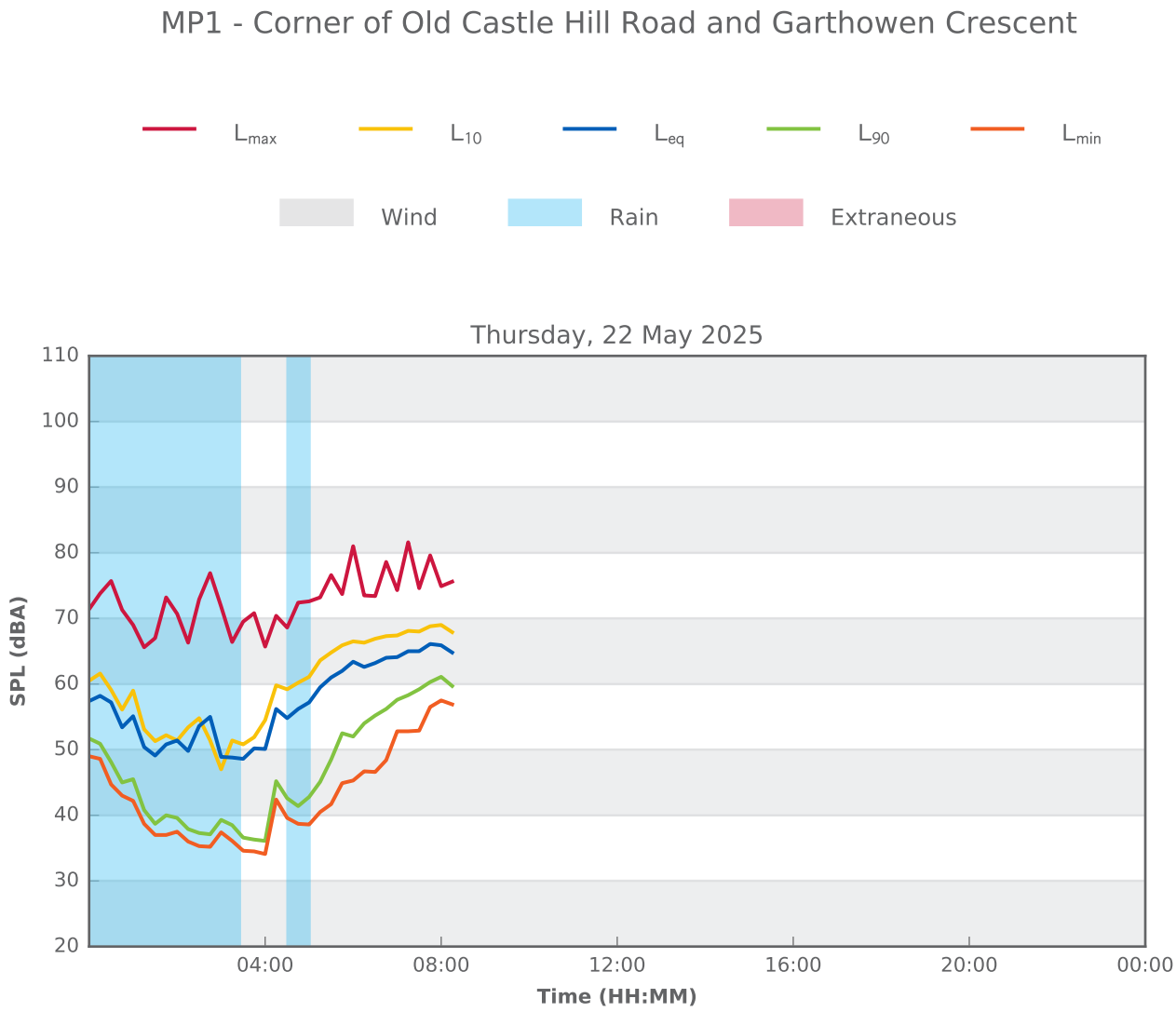
MP1 - Corner of Old Castle Hill Road and Garthowen Crescent
Lmax
L10
Leq
L90
Lmin
Wind
Rain
Extraneous
Thursday, 22 May 2025
110
100
90
80
70
60
50
40
30
20
SPL (dBA)
04:00
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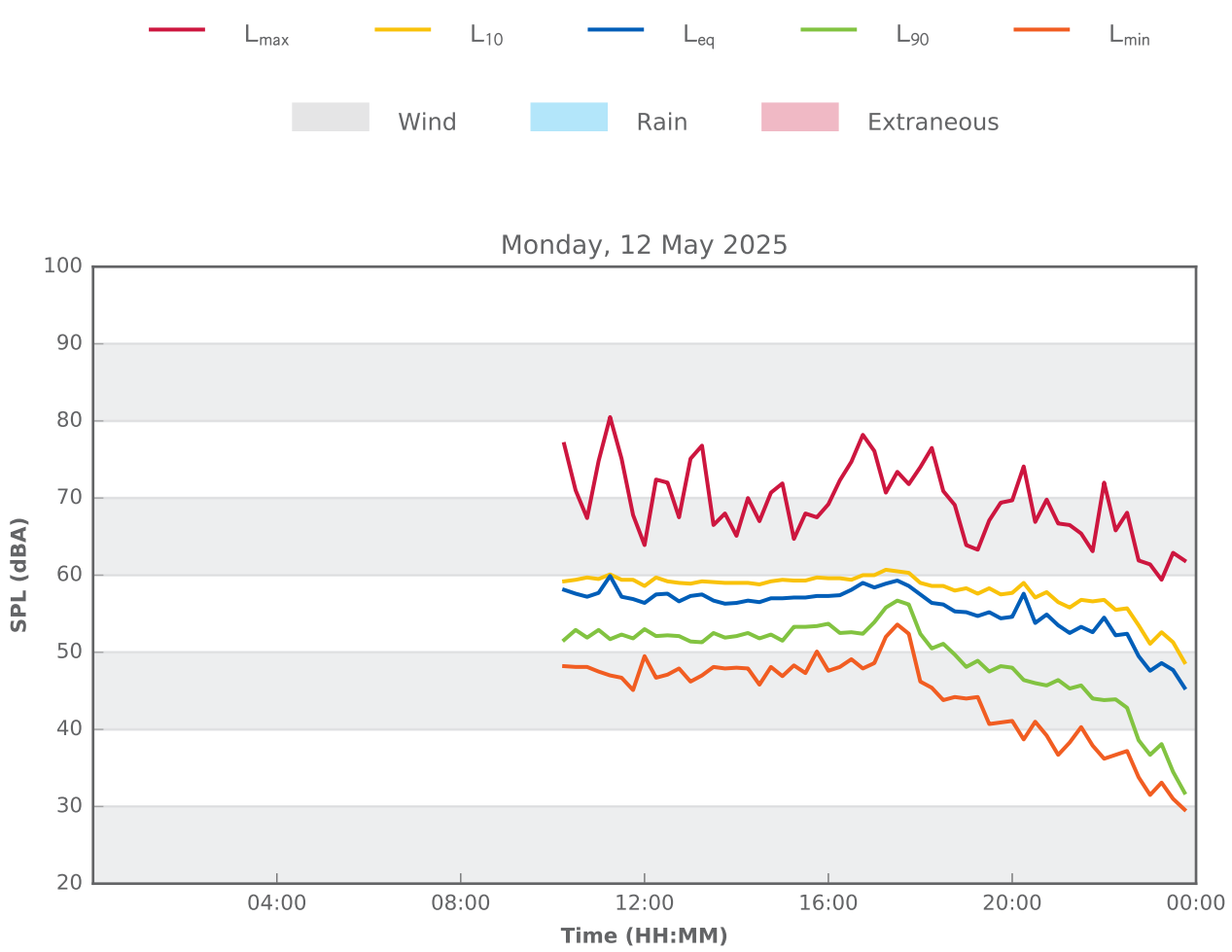
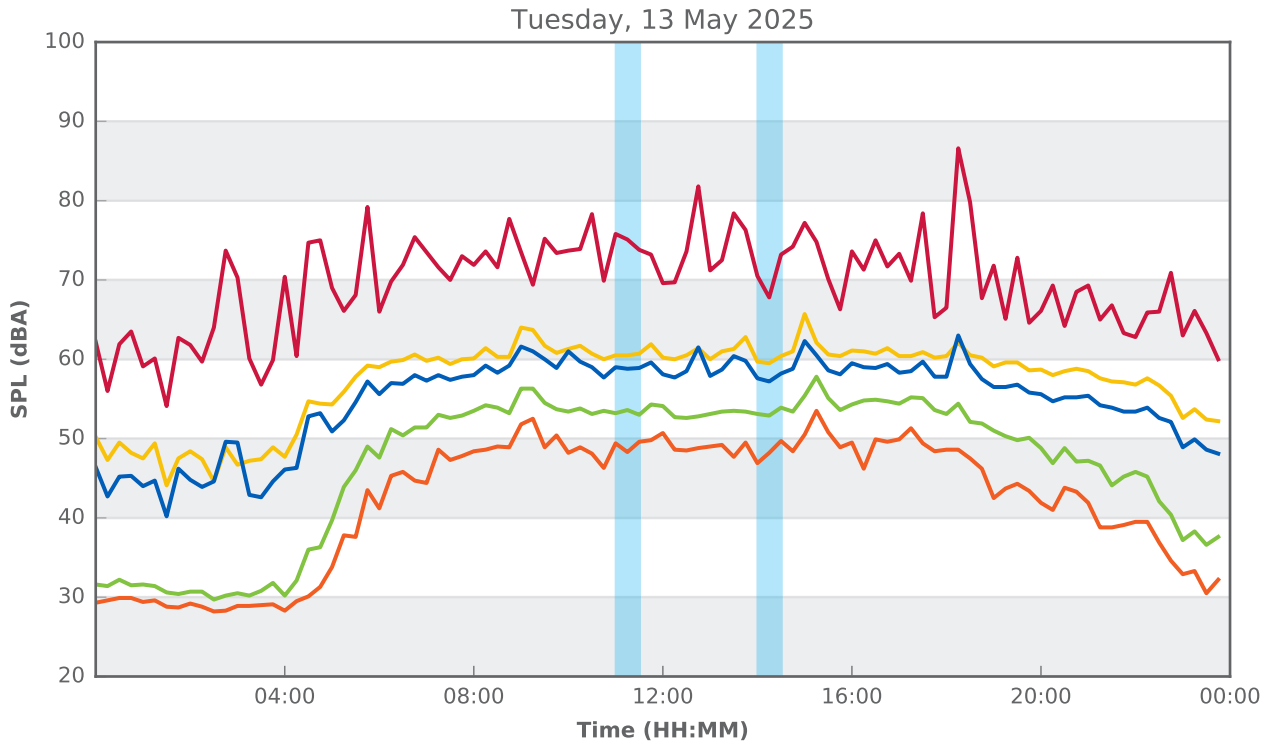
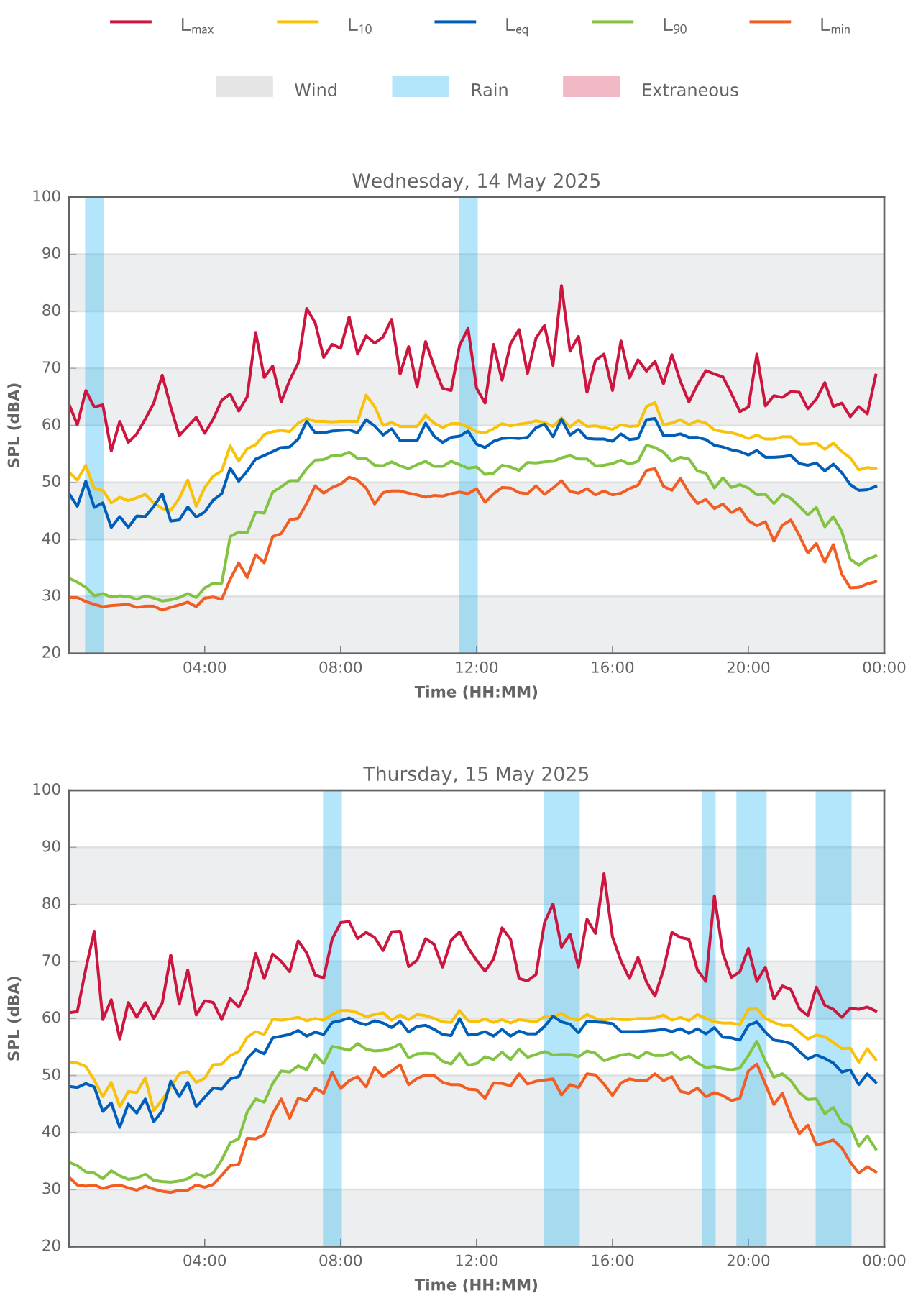
Time (HH:MM)

MP2 - Garthowen Crescent

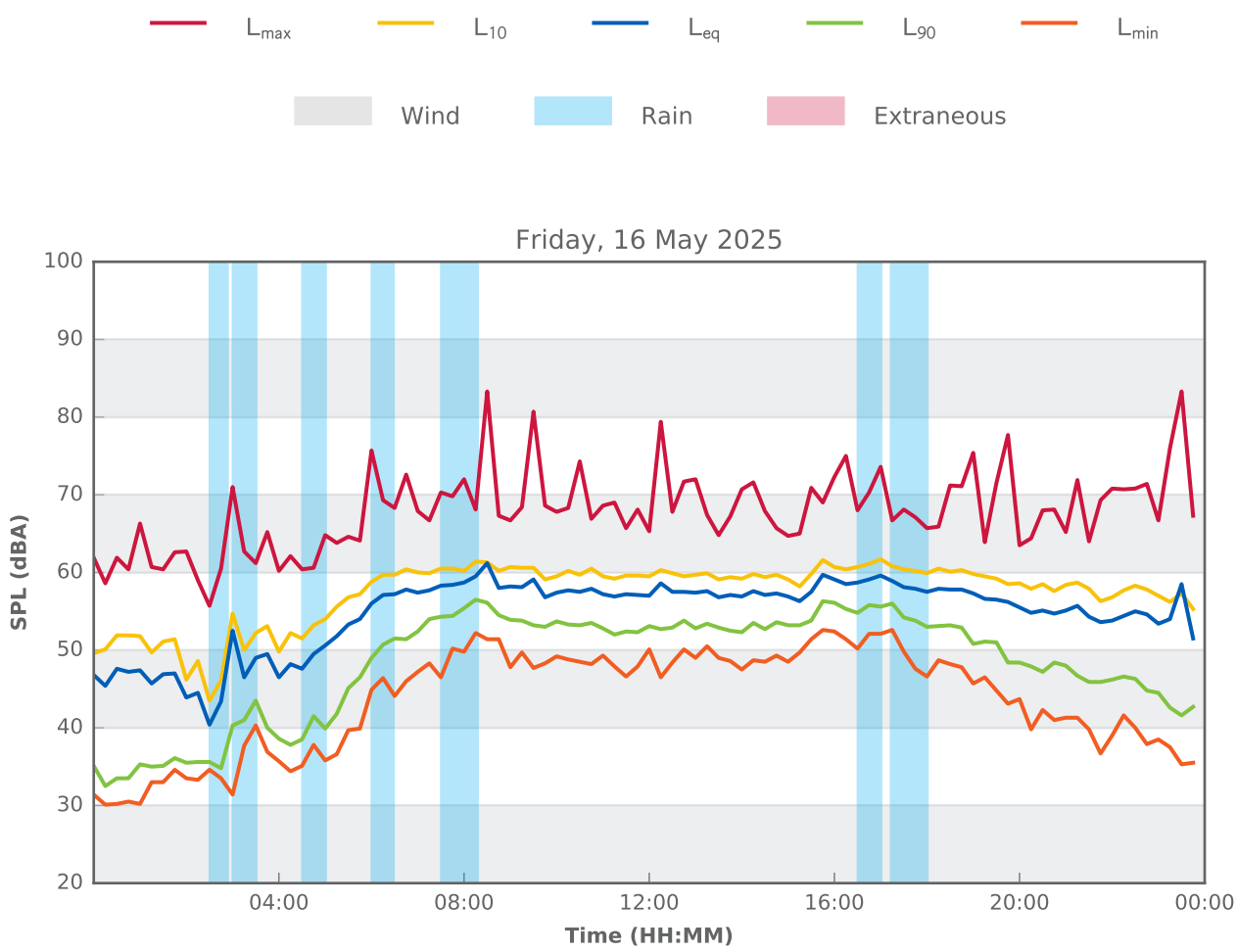


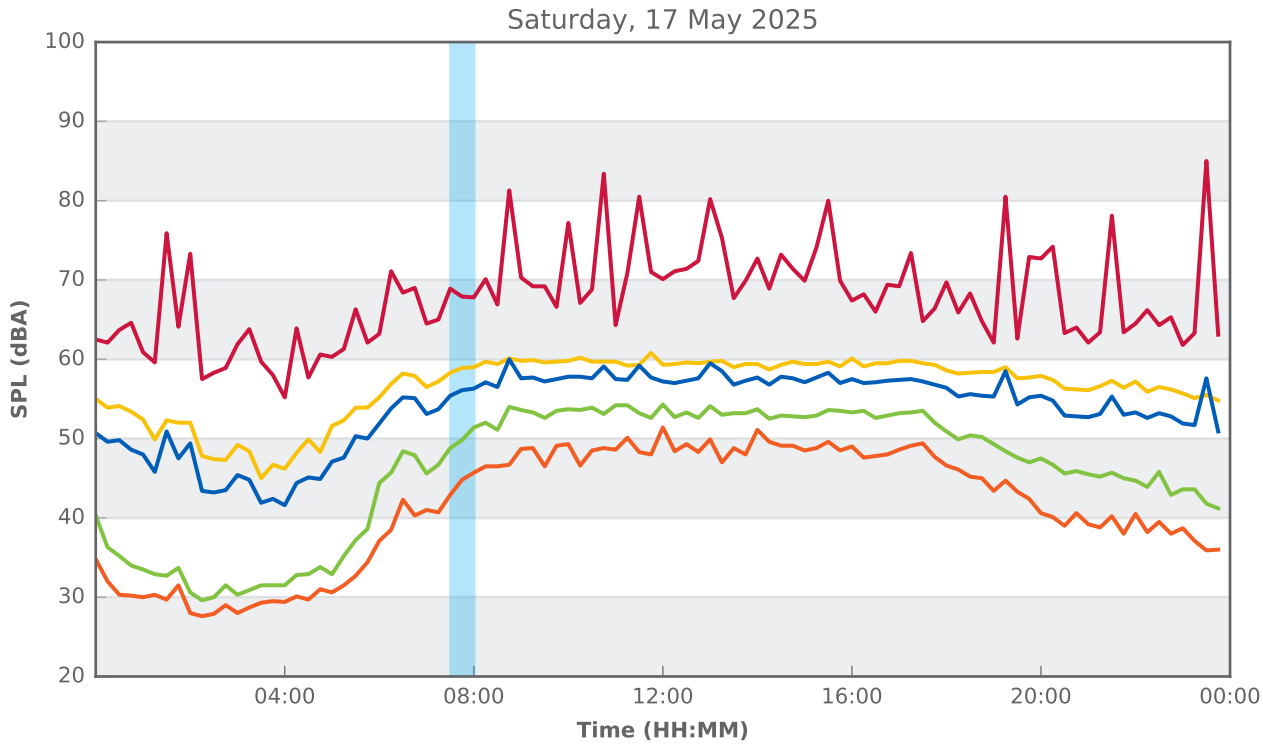


MP2 - Garthowen Crescent



MP2 - Garthowen Crescent






MP2 - Garthowen Crescent
L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Sunday, 18 May 2025
SPL (dBA)
100
90
80
70
60
50
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30
20
04:00
08:00
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16:00
20:00
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Time (HH:MM)
Monday, 19 May 2025
SPL (dBA)
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16:00
20:00
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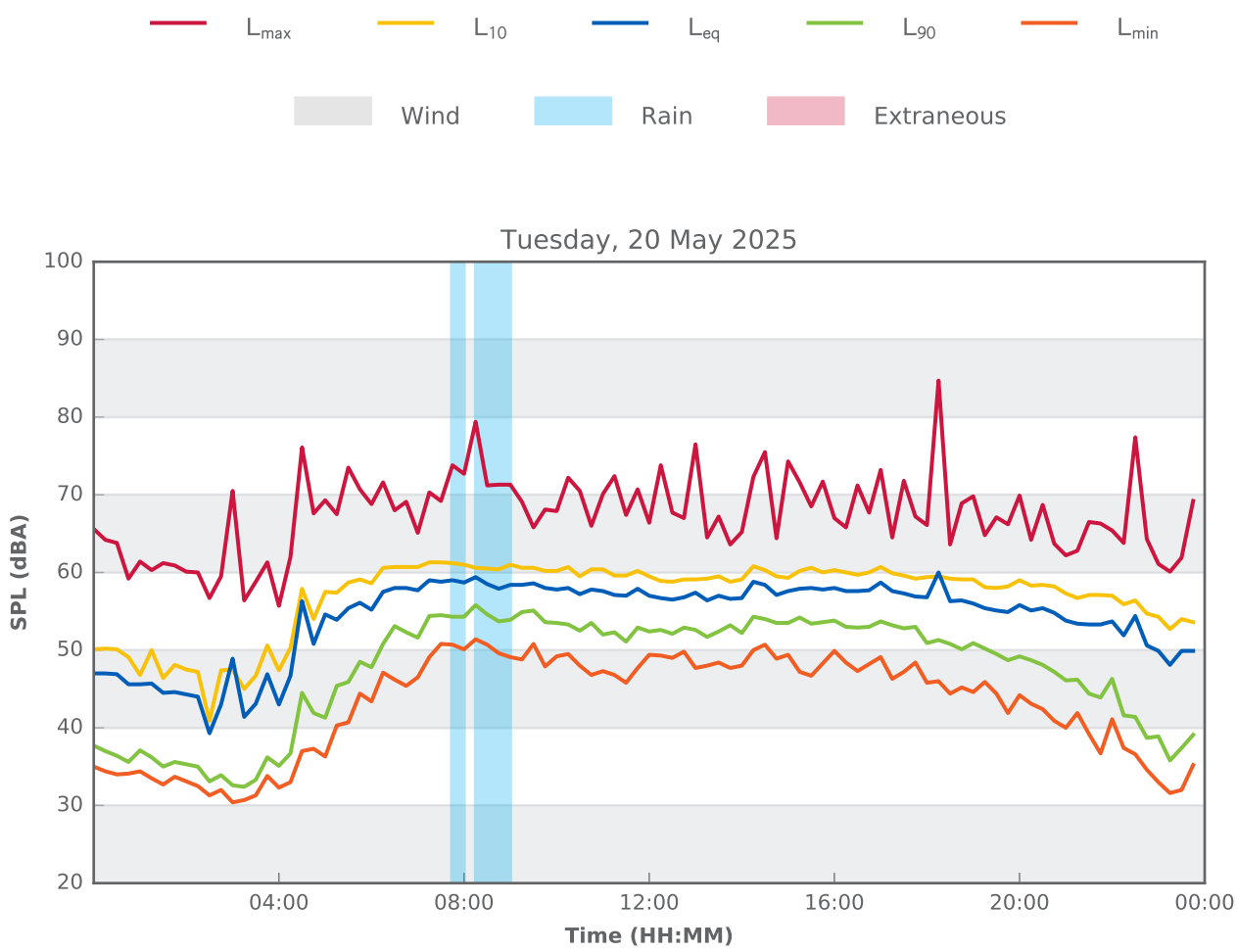
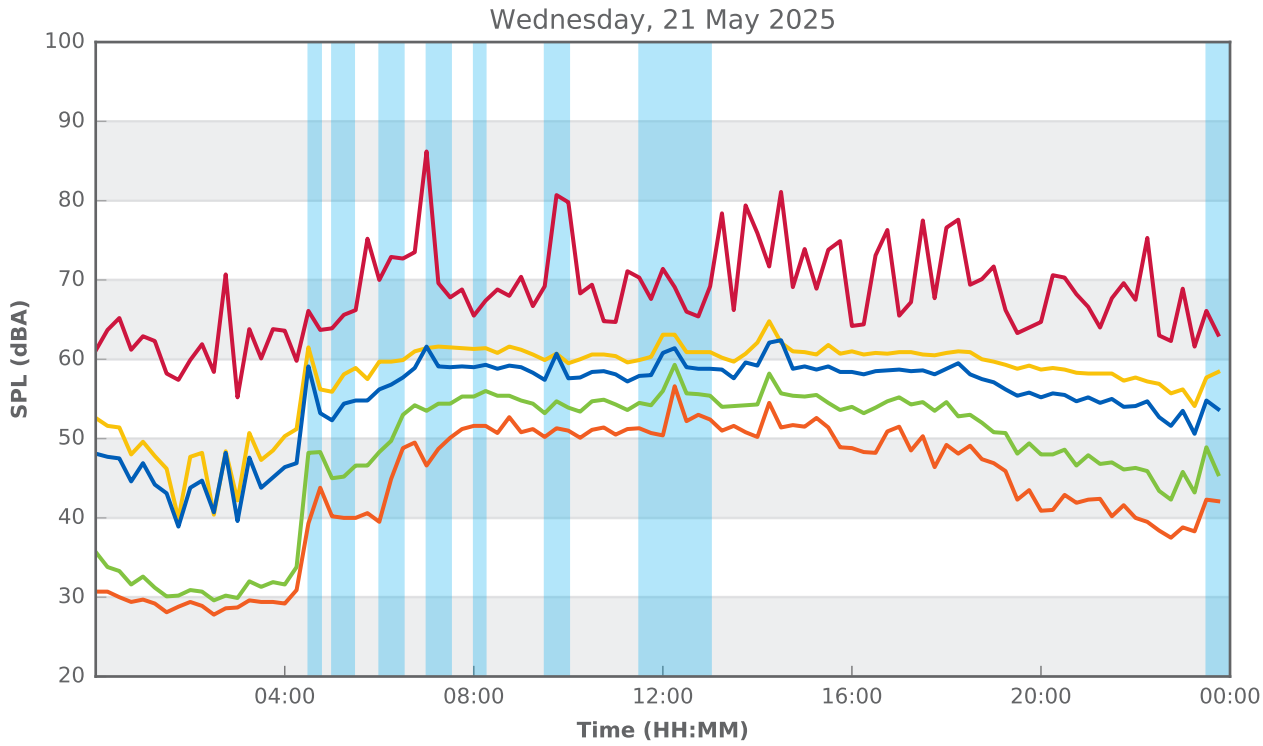
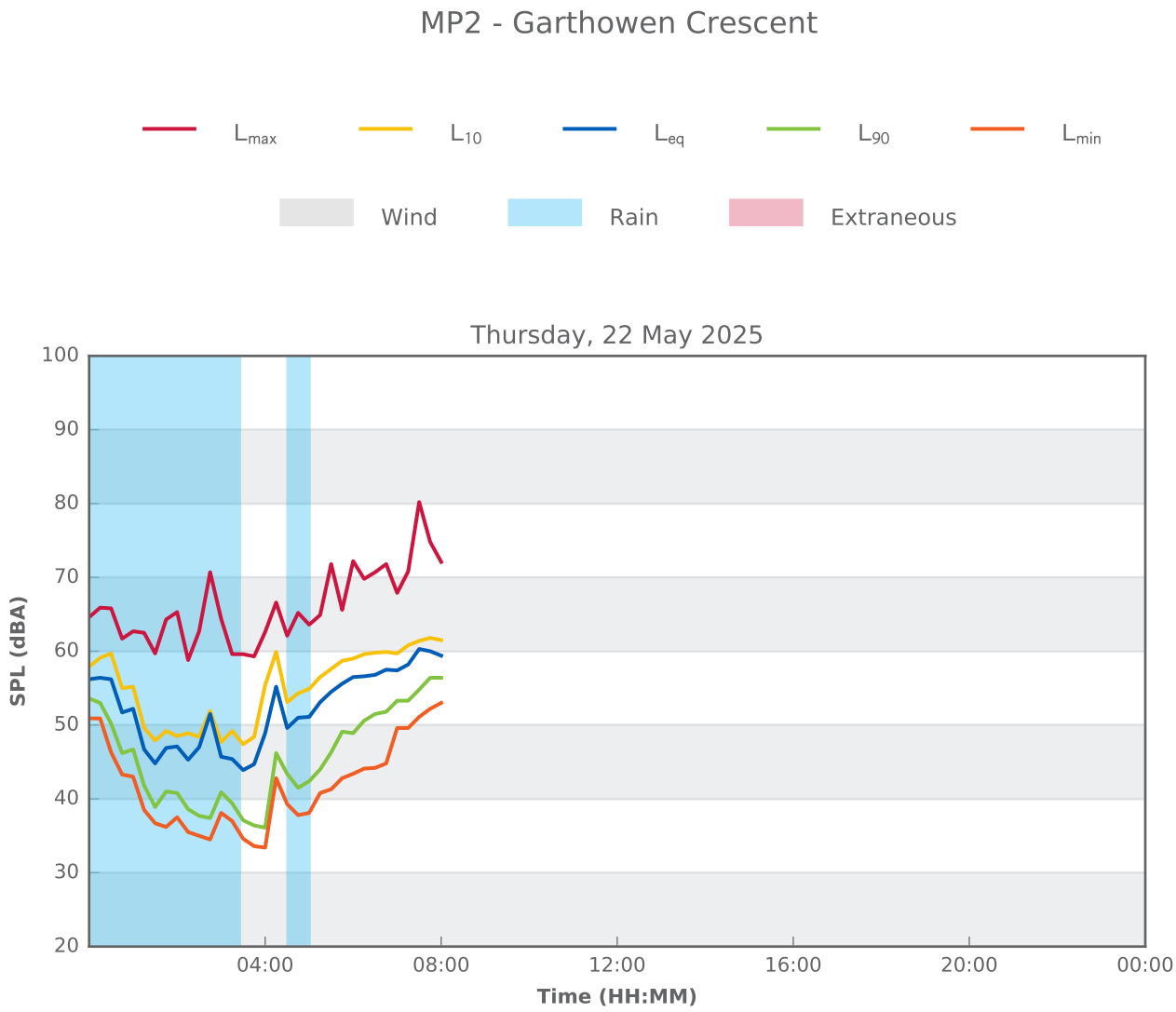
Time (HH:MM)

MP2 - Garthowen Crescent






MP2 - Garthowen Crescent
L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Thursday, 22 May 2025
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SPL (dBA)
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16:00
20:00
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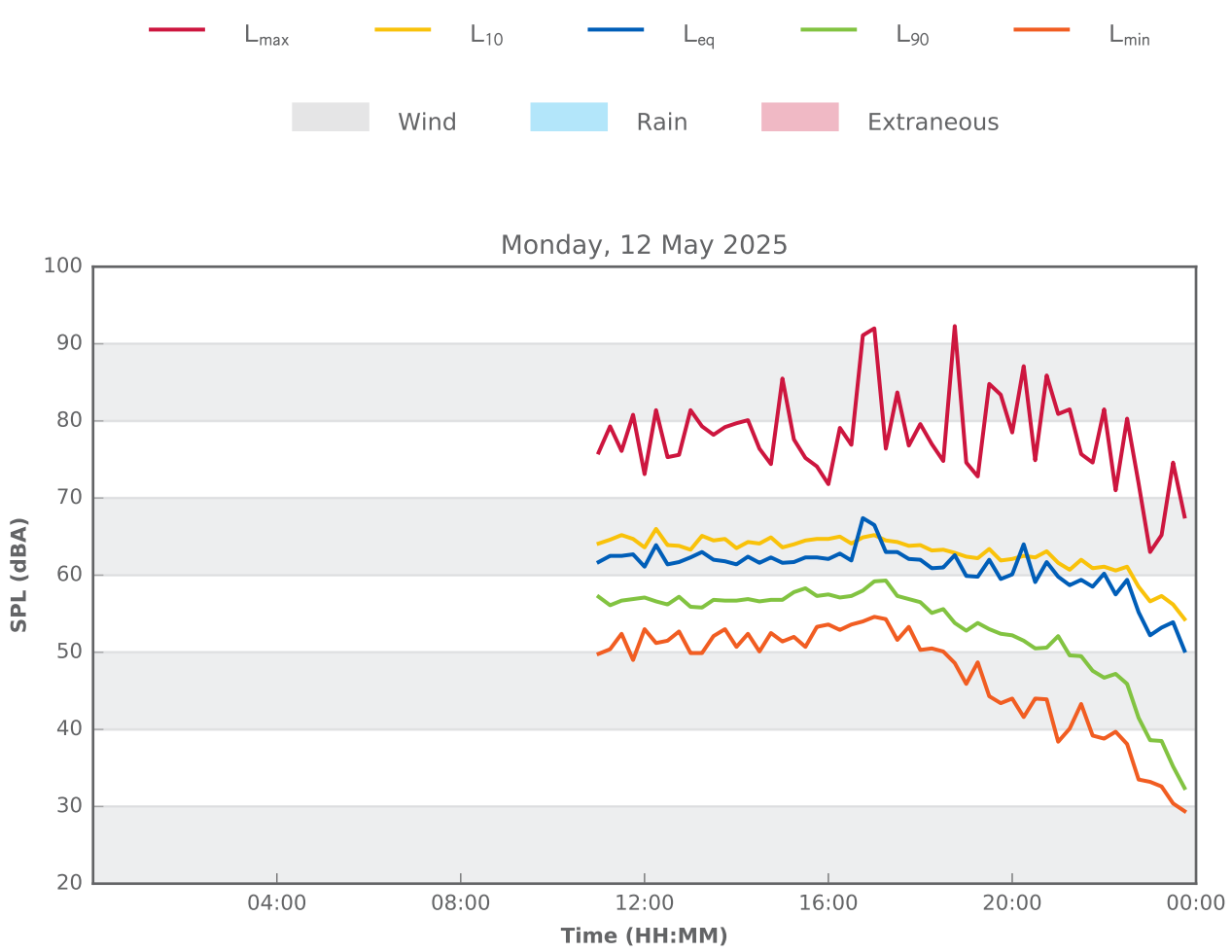
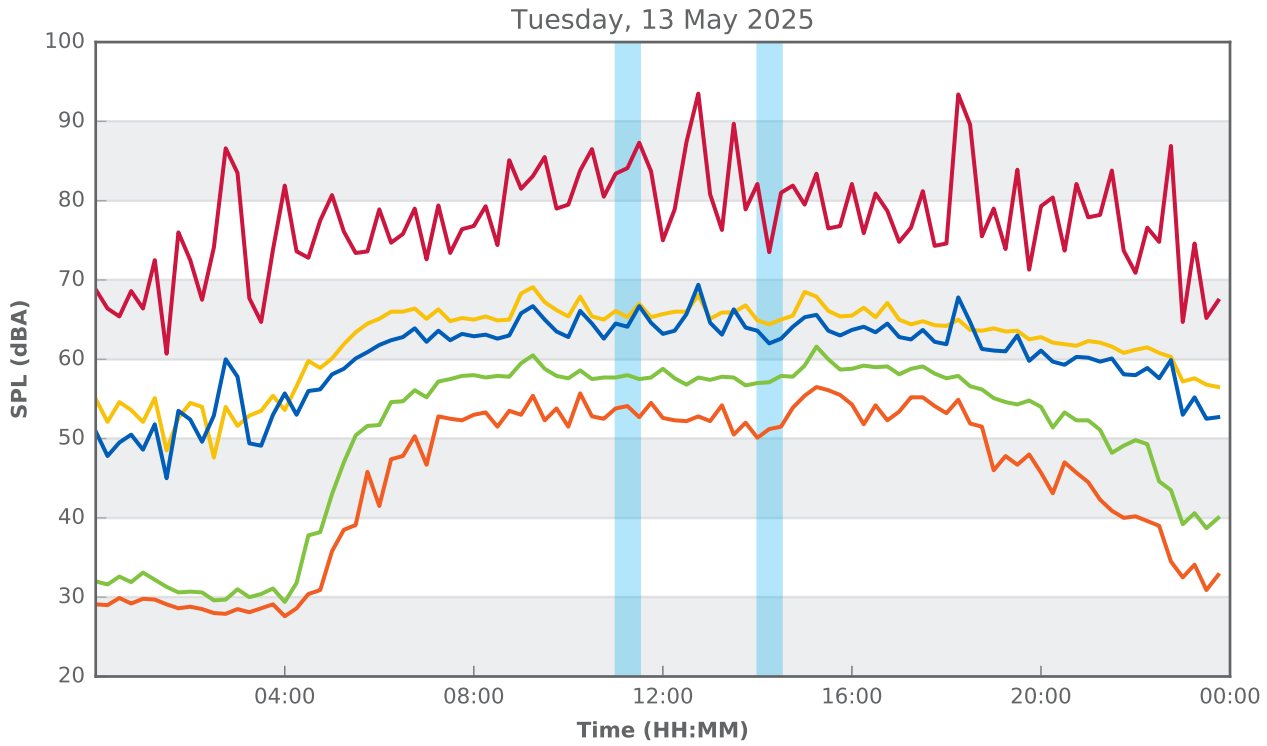
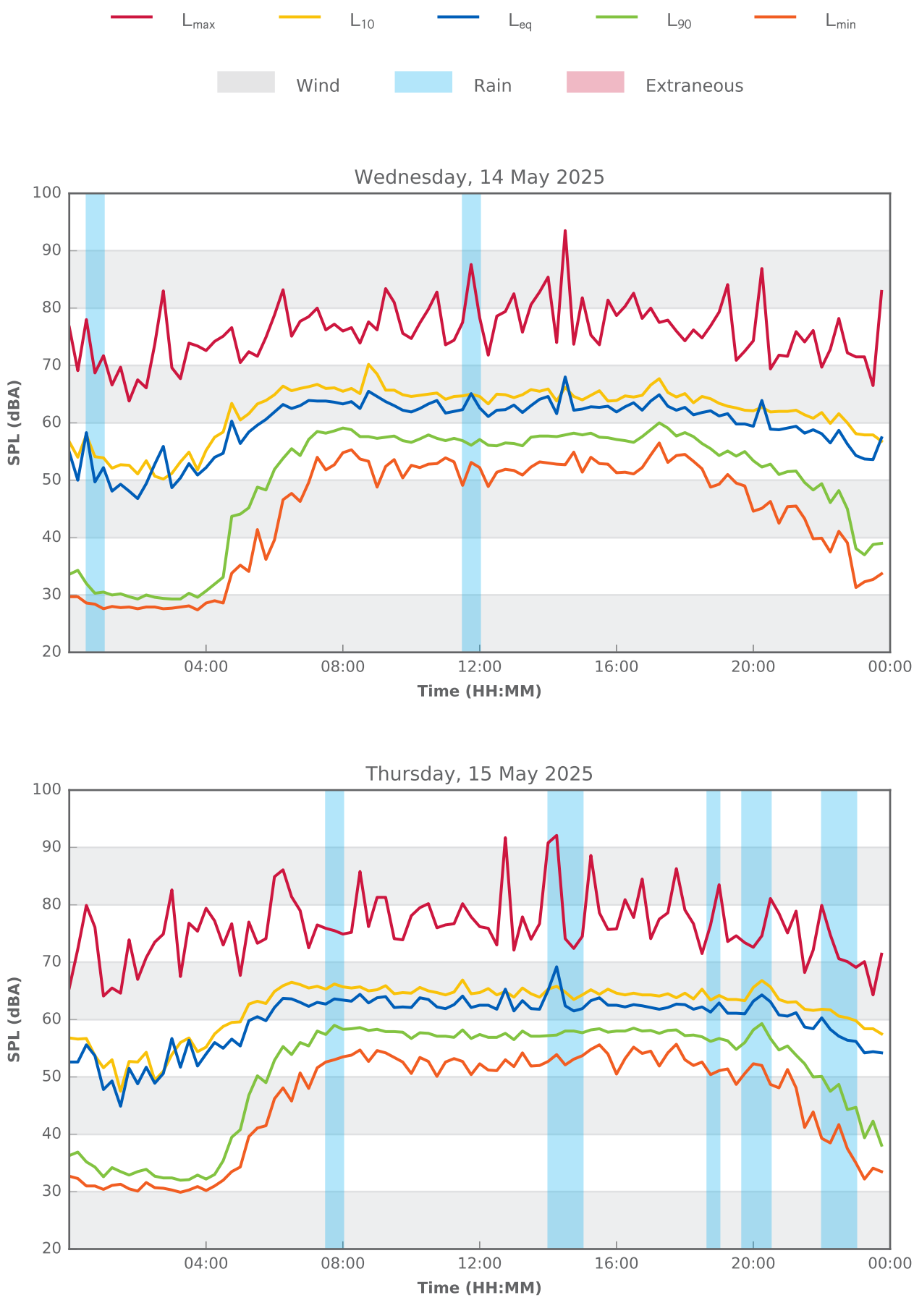
Time (HH:MM)

MP3 - Corner of Old Castle Hill Road and McMullen Avenue

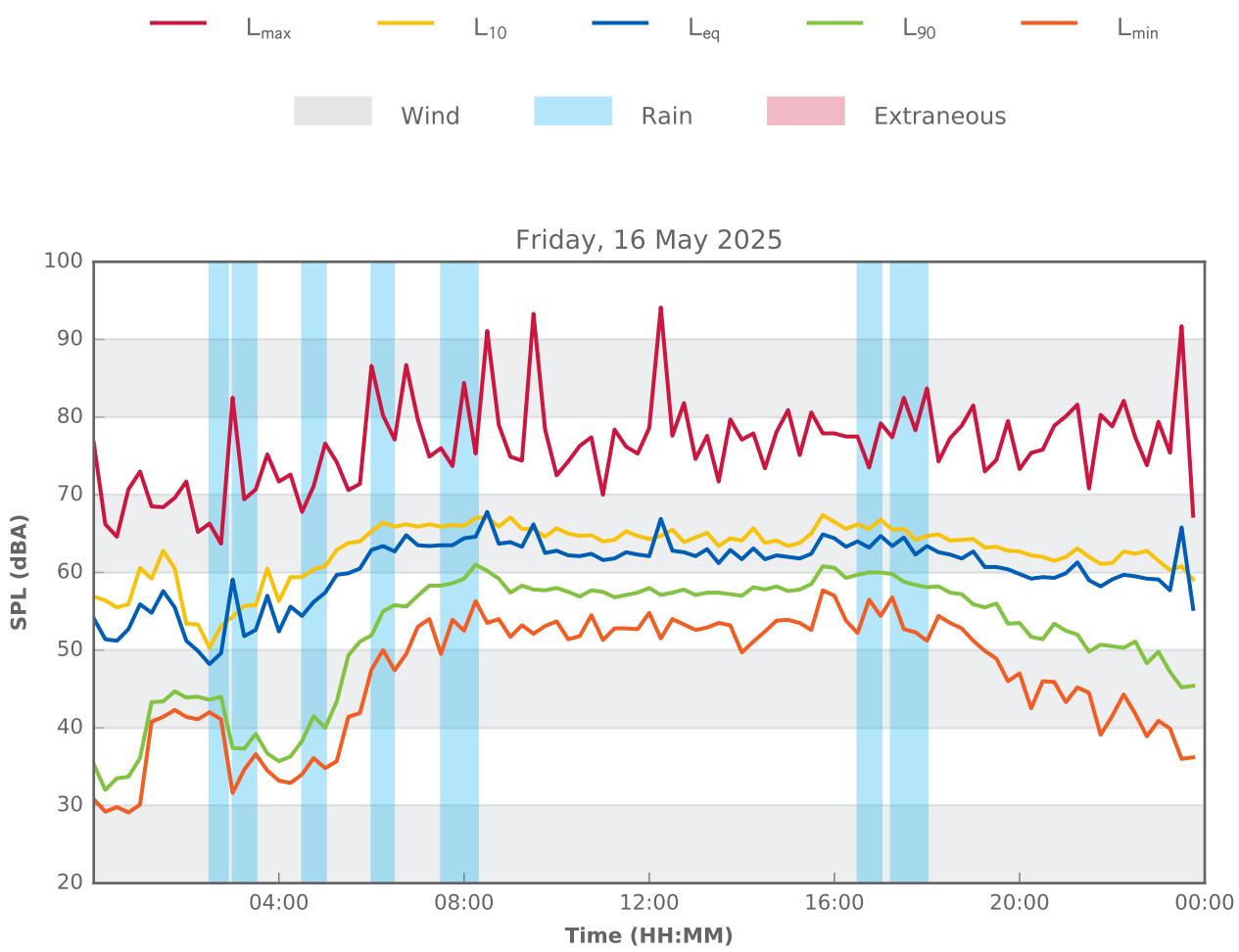


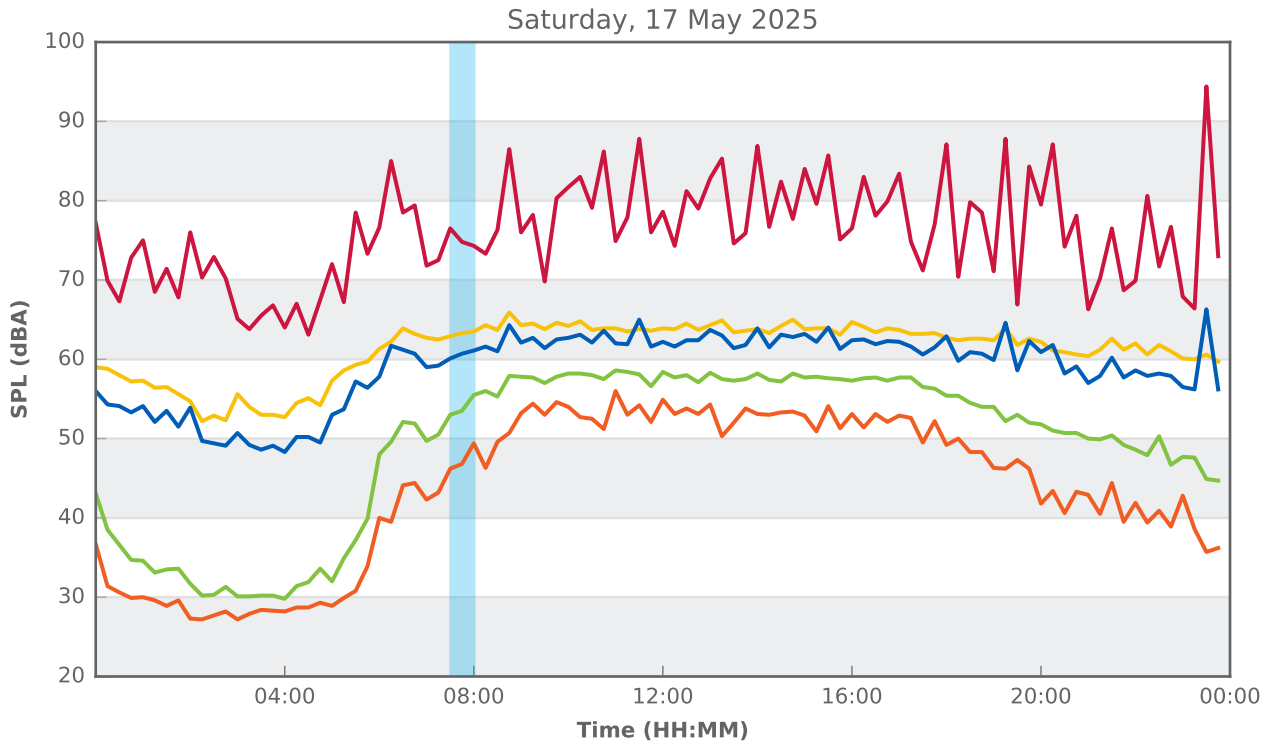


MP3 - Corner of Old Castle Hill Road and McMullen Avenue



MP3 - Corner of Old Castle Hill Road and McMullen Avenue






MP3 - Corner of Old Castle Hill Road and McMullen Avenue
L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Sunday, 18 May 2025
SPL (dBA)
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Time (HH:MM)
Monday, 19 May 2025
SPL (dBA)
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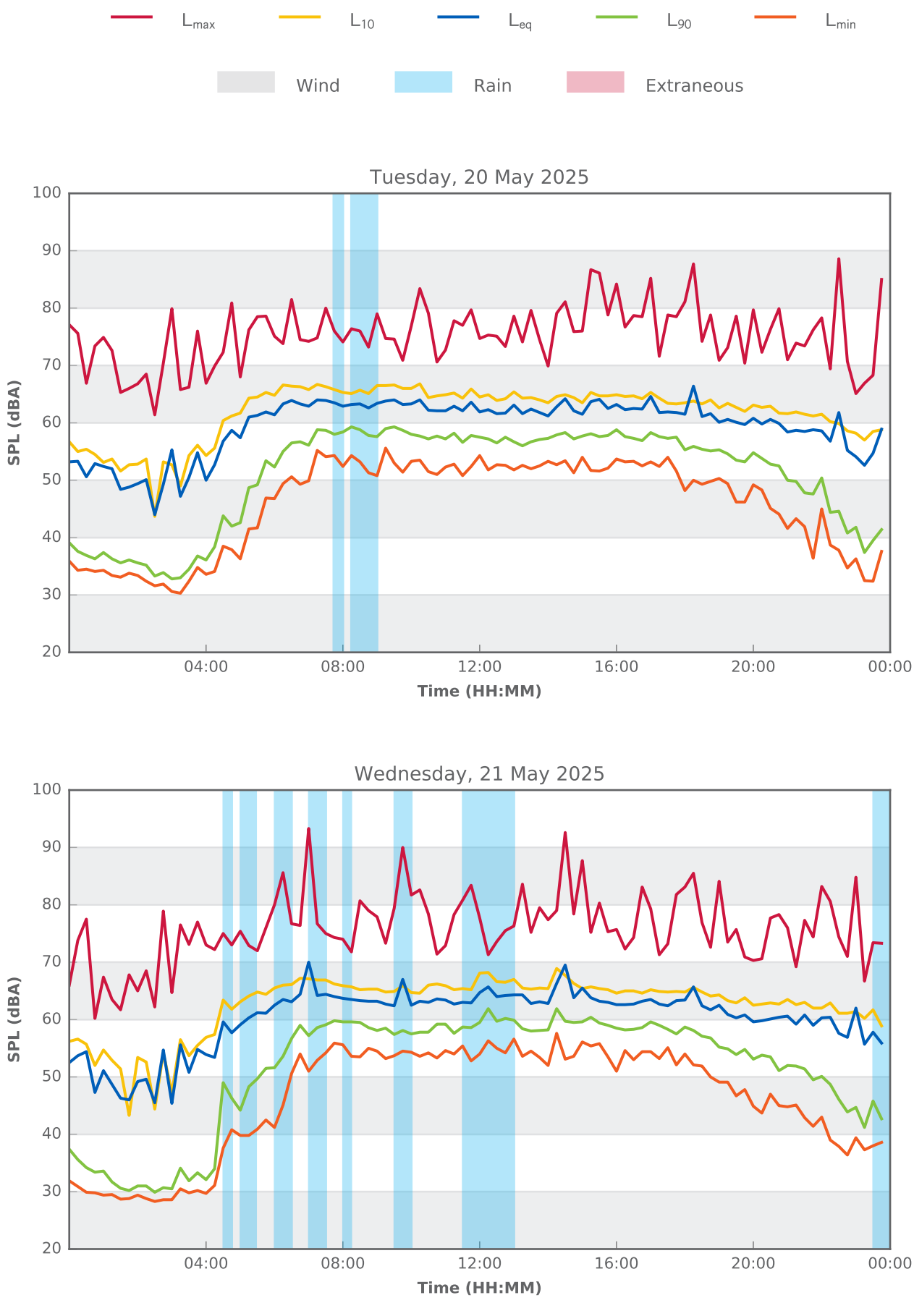
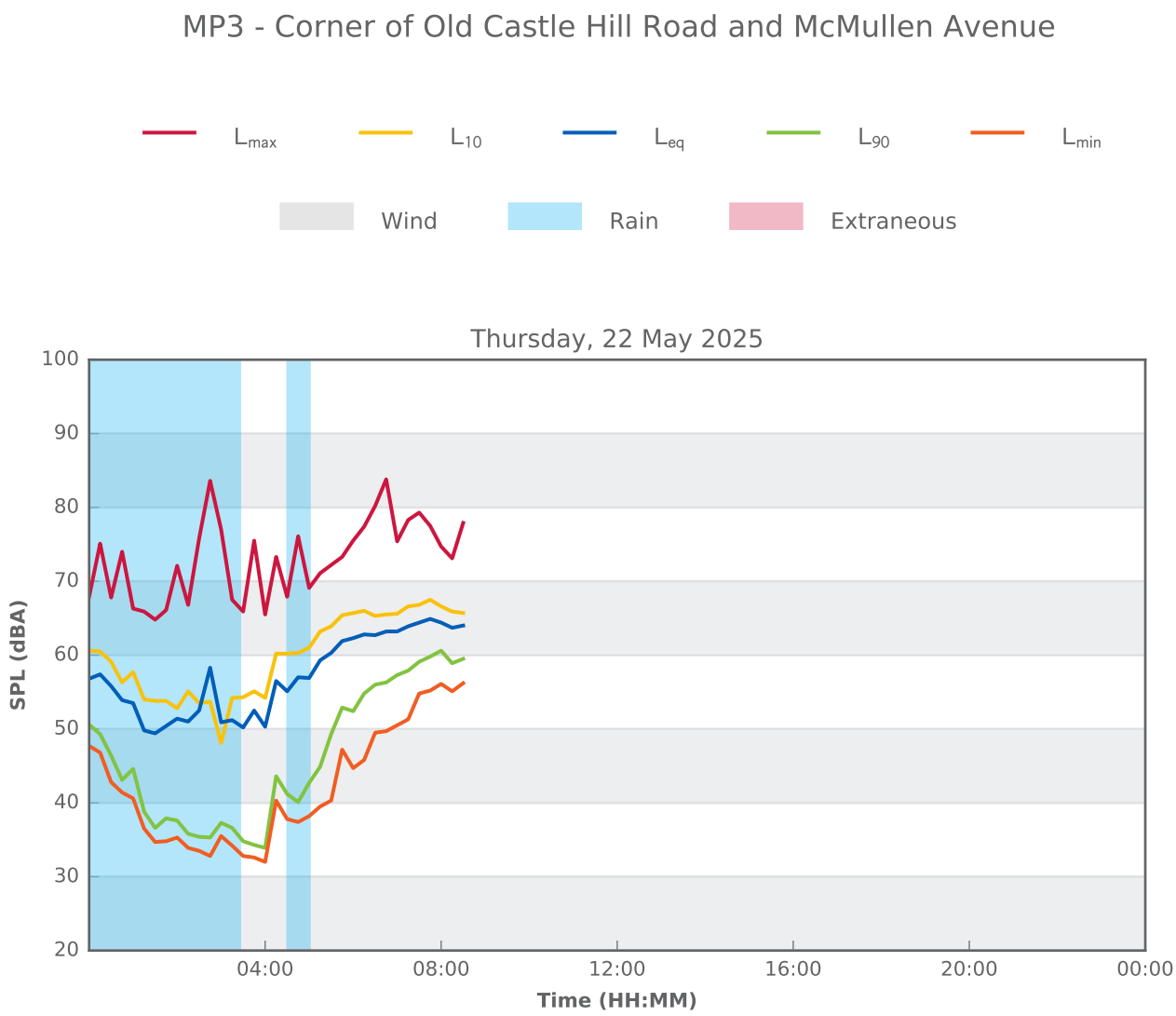
Time (HH:MM)

MP3 - Corner of Old Castle Hill Road and McMullen Avenue




MP3 - Corner of Old Castle Hill Road and McMullen Avenue
Lmax
L10
Leq
L90
Lmin
Wind
Rain
Extraneous
Thursday, 22 May 2025
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SPL (dBA)
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Time (HH:MM)