Pendle Hill High School

SSD Application – Acoustic Assessment

SINSW

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Abbreviations

Term	Meaning
AAAC	Association of Australasian Acoustical Consultants
ANML	Attended noise measurement location
AS	Australian Standard
AVTG	Assessing Vibration: A Technical Guideline (DEC 2006)
DEC, DECC, DECCW	See OEH
DoP	Department of Planning
DoE	Department of Education
EFSG	Educational Facilities Standards & Guidelines
EPA	Environment Protection Authority
EP&A Act	NSW Environmental Planning and Assessment Act 1979
ICNG	Interim Construction Noise Guideline (DECC 2009).
LEP	Local Environmental Plan
LGA	Local Government Area
mm/s	Millimetres per second
m/s	Metres per second
NCA	Noise catchment area
NPfI	Noise Policy for Industry (EPA 2017)
NSW	New South Wales
NML	Noise management level
OEH	The Office of Environment and Heritage (OEH). Formerly the Department of Environment and Conservation (DEC) before becoming the Department of Environment and Climate Change (DECC), later known as the Department of Environment Climate Change and Water (DECCW).
POEOA	Protection of Environment Operations Act (EPA 1997)
RBL	Rating Background Level
RNP	Road Noise Policy (DECCW 2011)
SEARs	Planning Secretary's Environmental Assessment Requirements
SINSW	School Infrastructure NSW
SEPP	State Environmental Planning Policy
TfNSW	Transport for New South Wales
UNML	Unattended noise monitoring location

Qualitative Interpretation of Construction Noise Impacts

This qualitative description of construction noise impacts has been provided to clarify interpretation of the quantitative results presented in this report, and to facilitate understanding of the level of impact for affected receivers. The qualitative descriptions are related to the quantitative predicted noise levels as follows:

- $L_{Aeq(15minute)}$ noise levels within 10 dB of the background - Noticeable
- $L_{Aeq(15minute)}$ noise levels 10 dB to 20 dB above the background – Clearly audible
- $L_{Aeq(15minute)}$ noise levels 20 dB to 30 dB above the background – Moderately intrusive
- $L_{Aeq(15minute)}$ noise levels more than 30 dB above the background – Highly intrusive

Glossary

Term	Meaning
A-weighted decibels [dB(A)]	The A-weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Airborne sound	Airborne sound is sound transmitted through the air/atmosphere, e.g. conversation between people.
Ambient noise	The prevailing noise level at a location due to all noise sources but excluding the noise from the specific noise source under consideration. Generally measured as a dB(A) noise level.
Background noise	The noise level exceeded for 90% of the measurement period ($L_{A90)}$ i.e. the underlying level of noise present and does not include transient noise such as intermittent traffic or dogs barking.
Community	A group of people living in a specific geographical area or with mutual interests that could be affected by the Project.
Decibel [dB]	The measurement unit of sound.
Decibel scale	The decibel scale is logarithmic. Sound pressure levels are expressed in decibels as a ratio between the measured sound pressure level and the reference pressure. A 3dB increase in the sound pressure level corresponds to a doubling in the sound energy.
Equivalent continuous sound pressure level [$L_{eq,T}$] and A-weighted equivalent continuous sound pressure level [$L_{Aeq,T}$]	The equivalent continuous A-weighted sound pressure level is the value of the A-weighted sound pressure level of a continuous steady sound that has the same acoustic energy as a time-varying A-weighted sound pressure level when determined over the same measurement period, T. The ICNG defines $L_{Aeq(15min)}$ as 'the A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as industry, road, rail and the community.
Feasible	Feasible relates to engineering considerations such as constructability, reliability, maintenance and safety.
Ground-borne vibration	Ground-borne vibration is vibration transmitted from source to receiver via the medium of the ground.
$L_{A90\ (Time)}$	The A-weighted sound pressure level that is exceeded for 90% of the measurement period. This is considered to represent the background noise.
L_{AFmax}	The maximum sound pressure level measured over the measurement period.
Peak Particle Velocity (PPV)	The maximum vector vibration velocity that occurs in any of the individual x, y or z orthogonal directions. Current practices for assessments of the risk of structural damage to buildings use measurements of PPV in millimetres per second.
Rating Background Level [RBL]	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.
RMS	Root mean square
Sound Power Level (SWL)	The total sound power emitted by a source.
Sound Pressure Level (SPL)	20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level of 20 micro Pascals.
Tonality	Noise containing a prominent frequency or frequencies characterised by a definite pitch
Vibration	The variation in magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, acceleration or velocity. Common units include mm/s (or m/s) and mm/s^2 (or m/s^2).
Vibration dose value (VDV)	Vibration dose value is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration (British Standard 6472 – 2008).
Vibration intensive works	Works which use vibration intensive equipment such as jack hammers, piling rigs and rock breakers.

Executive Summary

Aurecon has been engaged by SINW to undertake an acoustic assessment of the potential impacts associated with the redevelopment of the Pendle Hill High School, in accordance with the *Planning Secretary's Environmental Assessment Requirements* (SEARs) SSD-9579147, issued 26 October 2020. The redevelopment works at this stage are proposed to include the construction of a new three-storey school building '*Building H*' and overall improvement of street presence.

Nearby noise and vibration sensitive receivers were identified, and unattended and attended noise measurements were completed to characterise the existing ambient noise environment. The results of the noise survey were used to determine the level of existing road traffic noise impacts on the new school building and to establish operational and construction noise emission limits.

External (road traffic) noise impact

Existing road traffic noise levels from vehicle movements along Binalong Road will be the principal environmental noise source impacting the proposed new school building. The road has medium traffic volumes, with frequent public bus service in both directions.

Based on the measured noise levels on site, proposed location the new school building and the existing site topography, the Calculation of Road Traffic Noise (CoRTN) prediction model was used to determine the road traffic noise level incident on the façades of this building. The outcomes of this assessment include:

- Compliance with the internal noise recommendations of DoE EFSG can be achieved with standard medium and thick single glazed façade constructions (see Table 6-1).
- No additional treatments are required to the proposed pre-cast concrete external wall construction.
- A solid suspended ceiling system (minimum 250mm cavity with acoustic insulation and single layer plasterboard or MFT ceiling) will be sufficient on Level 2, to comply with the internal noise goals for various spaces.
- Minimum 40mm thick solid core construction is required for any timber external doors. Full perimeter rubber or neoprene acoustic seals (e.g. Raven RP10 to the top and sides and Raven RP38 to the underside of the door) will be required for all external doors.
- Mechanical ventilation will be required for all areas with façade elements proposed along the eastern façade (except *Archive Store* on ground level of Building H – south), as internal noise intrusion goals for these areas can only be achieved with windows and doors closed and effectively sealed. All other areas of the development are predicted to comply with the internal noise intrusion goals with natural ventilation.

Operational noise emissions

Key noise sources associated with the operation of the school include:

- Increased student capacity on outdoor play areas ***(Assessment 2a)***
  - There are several active recreational areas associated with the school, which include, football fields, tennis courts, basketball courts, cricket nets and oval (see Figure 2-1). Students currently use the outdoor play areas during the morning recess break, lunch break, PE classes and weekly sports days, with typical daily continuous use only up to two hours.
  - Maximum capacity for the outdoor play areas are only likely to be reached during the lunch break and weekly sports day. Given the current student enrolment of 378, based on site observations, typically less than half of these students use the outdoor play areas, primarily distributed across Assembly area, Building C and sports field along Binalong Road. This distribution and use were also confirmed as typical by school staff.
  - As there are several play areas associated with the school, it is not practical or accurate to assume maximum capacity use of any one play space. Hence using the existing permanent (approved) capacity as a basis, the proposed increased capacity was distributed across the main outdoor play areas (nearest to the surrounding residences), as detailed in

- Table 7-1.
- Noise emission predictions indicate levels of up to 69dB(A)L_{eq} at the façade of some adjoining residential properties. This ranges between 16-20 dB(A) above criteria typically adopted for the assessment of environmental noise emissions (there are no specific legislative requirements in NSW for outdoor play areas of schools), however when assessing noise impacts from school outdoor play areas, these exceedances are not unreasonable as discussed in Section 7.1.3.

- Building services plant, public address system and school bell servicing Building H ***(Assessment 2b)***
  - Information on the building services design (locations and equipment specifications) are not available at approvals stage and hence an acoustic review of potential impacts is not possible. Typical acoustic treatments such as silencers etc are expected to adequately mitigate building services noise.
  - Proposed location of AC condenser units has been provided at this stage. To achieve compliance with the project operational noise goals (see Table 5-5), the following is recommended:
    - Maximum SWL of units $\leq$ 72dB(A) for NW condenser platform, with three units in total (only 1 x dual unit, i.e. with 2 compressors, acceptable).
    - Maximum SWL of units $\leq$ 75dB(A) for SW condenser platform, with three units in total (2 x dual units acceptable).
    - A minimum 3m high four-sided solid enclosure (open to roof only) is required for both condenser locations. The enclosures will also need to be internally lined with 50-75mm thick absorptive insulation.
  - The design and location of speakers for the PA system is not available at this stage. Generally, both the PA system and school bell are instantaneous noise events, occurring for short durations and can be electronically controlled to achieve compliance with the project noise emission goals. Best practice procedures which should be considered during design in subsequent stages include:
    - Selection of highly directional speakers (typically angled at 45° towards the ground) will help control noise spill.
    - Consideration of appropriate location and direction of the speakers, to maximise distance to surrounding residences and where practical and feasible, pointing them away residential receivers (opposite direction or 90°)
    - Installation of RMS limiter to calibrate output noise spectrum to reduce noise spill to surrounding residences, whilst ensuring suitable noise levels are generated within the school grounds for use (typically between 75-80dBA SPL at 1m).

- Additional traffic on surrounding public road network ***(Assessment 2c)***
  - There is potential for increased traffic on the surrounding public road network, both because of the increased school capacity (student and staff) and also proposed changes to current pick-up and drop off locations.
  - Students are currently dropped-off and picked-up along Cornock Avenue, Knox Street and Binalong Road. Bus pick-up and drop-off is located along Binalong Road.
  - As part of the redevelopment project, multiple options for pick-up and drop-off (PUDO) are propsoed to alleviate the current congestion (during peak hours) on Cornock Avenue and Knox Street. This will disperse the traffic volume to all available surrounding public roads, so as to not congestion on any particular carriageway. New locations are proposed on Bungaree and Burrabogee Roads.
  - Based the forecasted peak hour traffic volumes, comparing against existing traffic volumes and assessing against the requirements of NSW EPA *Road Nosie Policy* (RNP), the following are predicted:
    - potential reduction of traffic noise levels along Cornock Avenue and Knox Street, because of the drop in forecasted traffic volume
    - noise levels of between 59 and 61 dB(A)$L_{eq(15\ hour)}$ at the façade of the residential properties along Binalong Road. Though a marginal exceedance of the RNP criteria (60 dBA $L_{eq(15hour)}$, see Table 5-5) is predicted, these levels are within 2dB of the existing traffic noise levels (see Table 4-2) and hence comply with the relative increase requirement of the RNP

- noise levels of between 49 and 51 dB(A)L_{eq} are predicted at the façade of the residential properties along Bungaree Road, which is within the NSW EPA RNP criteria (see Table 5-5)
- noise levels of between 50 and 51 dB(A)L_{eq} are predicted at the façade of the residential properties along Burrabogee Road, which is within the NSW EPA RNP criteria (see Table 5-5)

Construction noise and vibration

A preliminary assessment of potential noise and vibration impacts resulting from construction operations was also undertaken in this study. All construction works are only expected to occur during the NSW Environment Protection Authority (EPA) recommended standard hours of work. Exceedance of both the noise affected and highly noise affected management levels are predicted at some residential receivers around the site (see Section 8.2.2), based on the indicative equipment/machinery likely to be used for the expected construction works. Typical mitigation measures and management procedures that need to be considered are detailed in Section 8.4. Safe working buffer distances have also been noted for vibration intrusive plant in Table 8-3.

A detailed construction noise and vibration impact study is recommended during subsequent stages of the project (when a detailed programme and construction methodology is developed), to accurately determine the level of impact on surrounding affected receivers and develop site-specific management strategies.

1 Introduction

The Department of Education (DoE) and SINSW is proposing to redevelop Pendle Hill High school, to increase student capacity for up to 1,320 students, in addition to an overall improvement of the site layout, infrastructure and street presence.

Aurecon has been engaged by SINSW to undertake an assessment of the potential noise and vibration impacts associated with the construction of a new three-storey school building '*Building H*', in accordance with the *Planning Secretary's Environmental Assessment Requirements* (SEARs) SSD-9579147, issued 26 October 2020.

This assessment will:

- Provide a general overview of the project and identify key noise and vibration risks (Section 2)
- Characterise features of the project site, including existing environmental noise sources, location of nearby sensitive receivers, land uses and terrain features (Section 3)
- Present the results of noise survey conducted around the site, to quantify the existing ambient noise environment (Section 4)
- Identify relevant noise and vibration standards and guidelines applicable to the project, and formulate project specific criteria for operational and construction impacts (Section 5)
- Assess environmental noise sources around the project site and undertake a noise intrusion assessment to determine minimum building performance requirements (Section 6)
- Assess potential noise impacts associated with the operation of the project (Section 7)
- Undertake a preliminary assessment of potential noise and vibration impacts associated with the construction of the project and develop mitigation measures and management strategies to control impacts (Section 8)

1.1 Reference documentation

- *Al-Faisal College Limited v Campbelltown City Council* (2015) NSWLEC 1083
- *Assessing Vibration: A Technical Guideline* (DEC, 2006)
- Australian/New Zealand Standard *AS/NZS 1668.1:1998 The use of ventilation and air-conditioning in buildings*, *Part 1: Fire and smoke control in multi-compartment buildings*
- Australian/New Zealand Standard *AS/NZS 2107:2016 Acoustics-Recommended Design Sound Levels*
- *Bankstown City Council v Mohamad El Dana* (2009) NSWLEC 68
- *Construction Noise and Vibration Strategy (TfNSW, 2020)*
- *Development Near Rail Corridors and Busy Roads – Interim Guideline* (NSW DoP, 2008)
- Educational Facilities Standards & Guidelines (NSW DoE, 2018)
- Fulton Trotter Architects (2021). SDRP Issue architectural drawings, revision P5, issued 23 February 2021
- *Interim Construction Noise Guideline* (NSW DECC, 2009)
- *Meriden School v Pedavoli (2009)* NSWLEC 183
- *Noise Policy for Industry* (NSW EPA, 2017)
- Planning Secretary's Environmental Assessment Requirements (application no. SSD-9579147), issued 26 October 2020
- *Road Noise Policy (NSW DECCW, 2011)*
- Taylor Thomson Whitting (2021). *Pendle Hill High School – Transport and Accessibility Impact Assessment* report, revision 0, issued 12 February 2021

2 Project Overview

The school currently operates as a high school for students from year 7 to 12 and includes 5 two-storey buildings (Buildings A, B, C, D & E). There are several active recreational areas associated with the school, which include, football fields, tennis courts, basketball courts, cricket nets and an oval. The existing on-site parking is located to the south-west of the site and is split into three parts with a total capacity of 72 spaces. The existing site plan is illustrated in Figure 2-1.

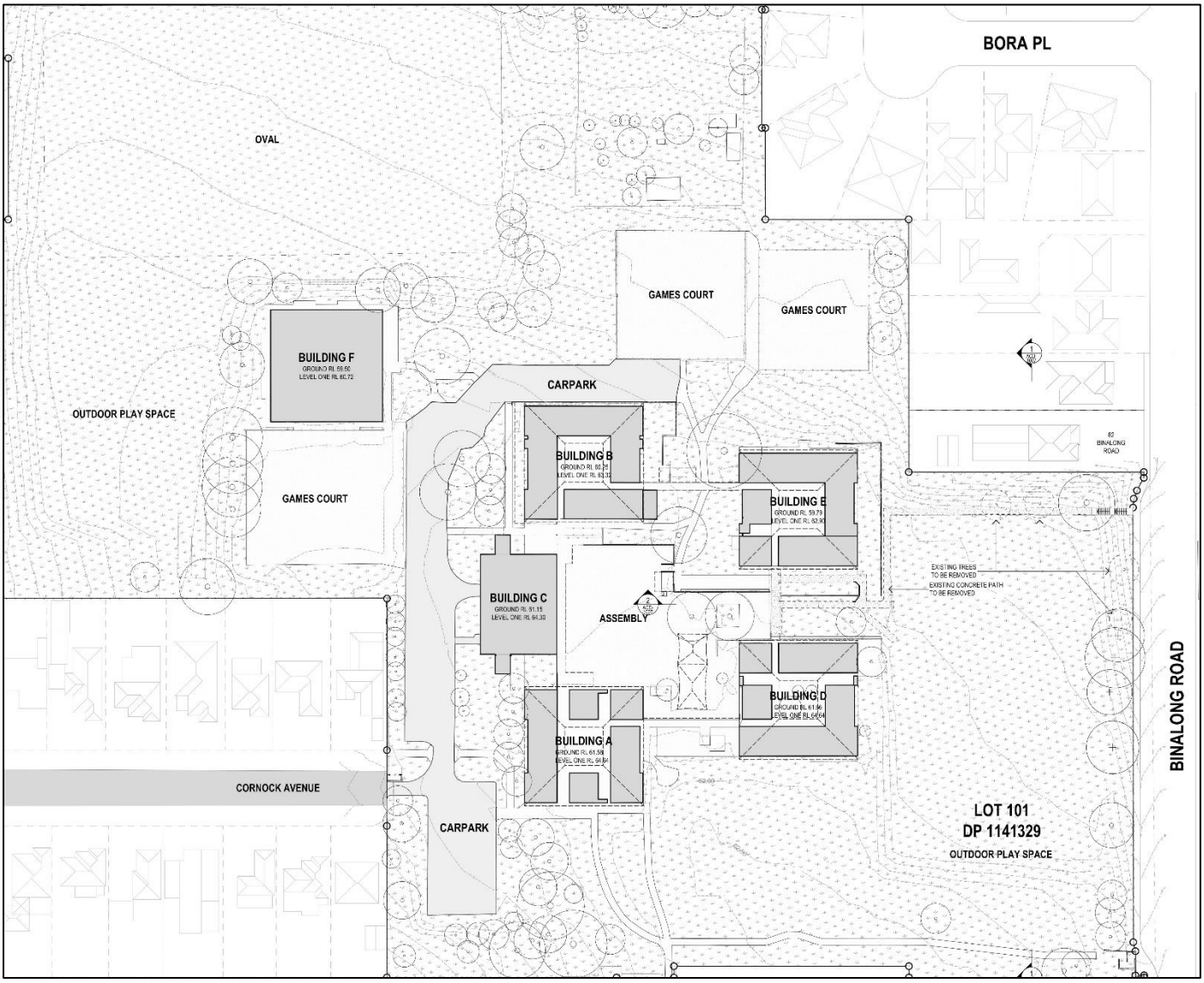

Figure 2-1 : Existing site plan

The total redevelopment of Pendle Hill High School is proposed for expansion to a Stream 12 high school, with the scope of works for this SSD application proposed to include:

- Construction of a new three-storey courtyard building on Binalong Road (Building H), comprising two (2) three-storey wings under a connected roof, which will accommodate a library, staff unit, lecture theatre, multimedia and senior learning spaces, administration unit and student amenities
- External transport infrastructure upgrade works
- New covered walkways and upgraded landscaping
- New hard stand areas for bicycle parking
- Removal of 15 non-compliant car parking spaces (primarily in the northern most part of the car park) reducing total capacity of on-site parking from 72 spaces to 57 spaces

No after-hours use is proposed. The proposed site plan is illustrated in Figure 2-2:

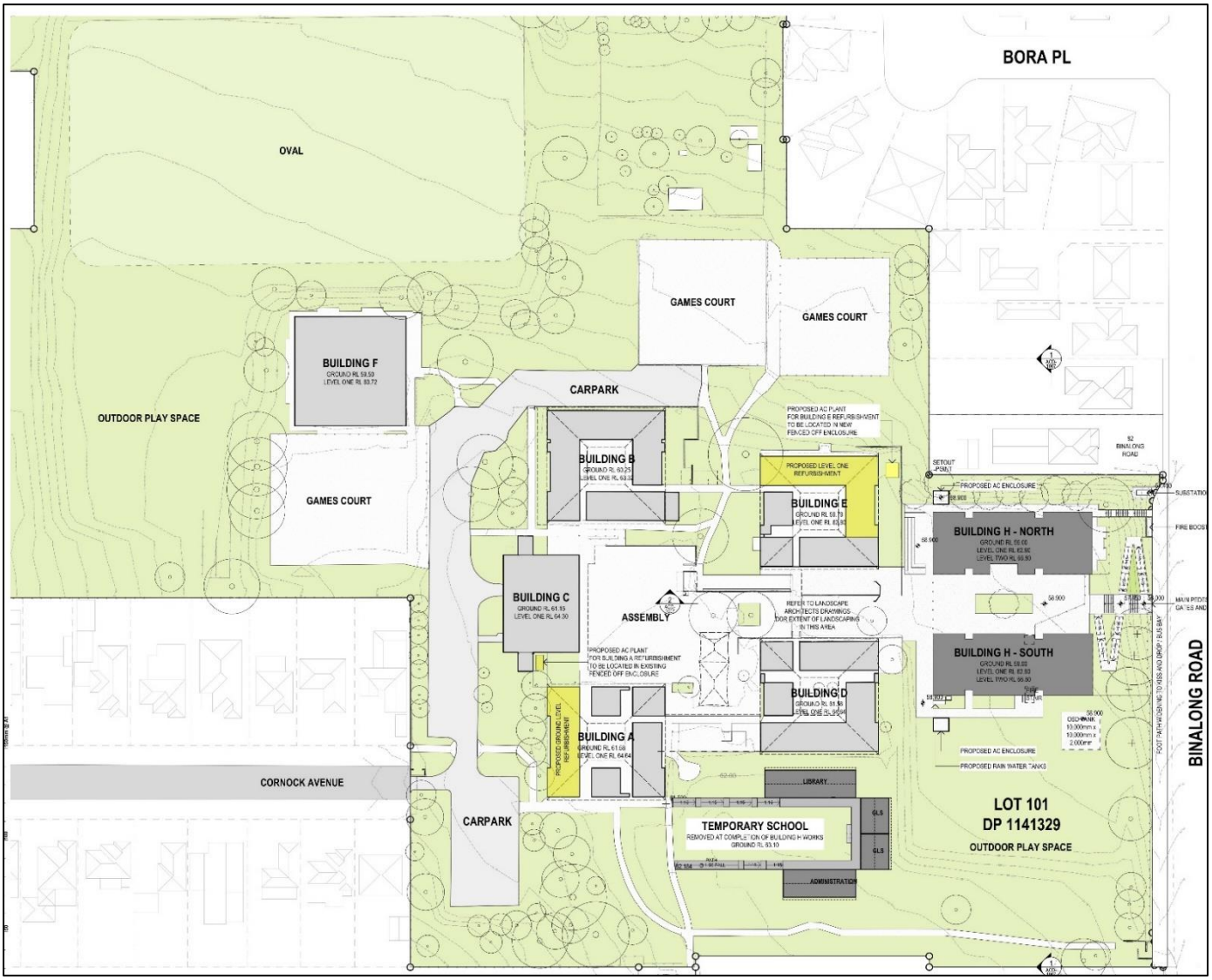

Figure 2-2 : Proposed site plan

Changes to the student and staff capacities are estimated as follows:

Table 2-1: Existing and proposed school capacity

Element	Existing (permanent)	Existing (based on 2019 enrolment)	Proposed	Increase (permanent)	Increase (enrolment)
Students	1080	378	1320	240	942
Staff	84	44	102	18	58

2.1 Key noise and vibration risks

The key noise and vibration risks are:

- External noise (road traffic) impacts on the new school building H ***(Assessment 1)***
- Noise impacts associated with operations: ***(Assessment 2)***
  - Increased student capacity on outdoor play areas ***(Assessment 2a)***
  - Building services plant, public address system and school bell servicing Building H ***(Assessment 2b)***
  - Additional traffic on surrounding public road network ***(Assessment 2c)***
- Construction noise and vibration impacts **(Assessment 3)**

3 Site Description

Pendle Hill High School is located at Cornock Avenue Toongabbie (Lot 101 in DP1141329), within the City of Parramatta local government area (LGA). The school site is bounded by Binalong Road to the east and existing residential properties to the north, south and west. The main entry to the school is situated at the end of Cornock Avenue, which is located near the south-west corner of the school site. A brief description of the surrounding public road network is presented below:

- Cornock Avenue – single travel lane local road with low volume of traffic
- Binalong Road – dual travel lane (one in each direction) sub-arterial road with medium volume of traffic
- Knox Street – single travel lane local road with low volume of traffic
- Burrabogee Road – dual travel lane (one in each direction) sub-arterial road with low-medium volume of traffic
- Bungaree Road – dual travel lane (one in each direction) sub-arterial road with low-medium volume of traffic

Reference to the 2m regional contour data indicates that the site is located on the spur of a local ridgeline, with ground levels highest in the central part of the site (approximately RL 62m AHD), and falling towards the north and north-west (to RL 52m AHD), and slightly towards the east (to RL 58m AHD). Ground levels generally fall from the central building platform.

3.1 Surrounding sensitive receivers

Noise and vibration sensitive receivers are generally categorised by the type of occupancy and/or the activities performed within the property boundary. This includes:

- Residences (including multi-floor dwellings): Each floor of a multi-floor dwelling is considered to be a separate sensitive receiver as each floor could have separate property owners and/or land uses (e.g. commercial ground floor and residential first floor)
- Educational institutes
- Hospitals and medical facilities
- Places of worship
- Commercial or industrial premises

The potentially nearest affected sensitive receivers in relation to the school site are:

- Residential receivers
    - R1 – Residential properties to the east (83-95 Binalong Rd, Toongabbie)
    - R2 – Residential properties to the north-east (82-88 Binalong Rd & 5-12 Bora Pl, Toongabbie)
    - R3 – Residential properties to the north (15-21 Favell St & 2-5 Kim Pl, Toongabbie)
    - R4 – Residential properties to the north-east (6-10 Illoca Pl, Toongabbie)
    - R5 – Residential properties to the west/south-west (3-6 Una Pl & 19-22 Cornock Avenue, Toongabbie)
    - R6 – Residential properties to the south (12-16 Knox St & 60-64 Binalong Rd, Toongabbie)
- Non-residential receivers – There are no other receivers in the immediate vicinity of the school site. Toongabbie West Public school is located approximately 240m to the west (along Ballandella Rd) and a mix of industrial/light-industrial developments are located approximately 300m to the south-west, along Burrabogee Road.

Figure 3-1 illustrates the surrounding road network, location of surrounding sensitive receivers and ambient noise measurement locations, with reference to the school site.

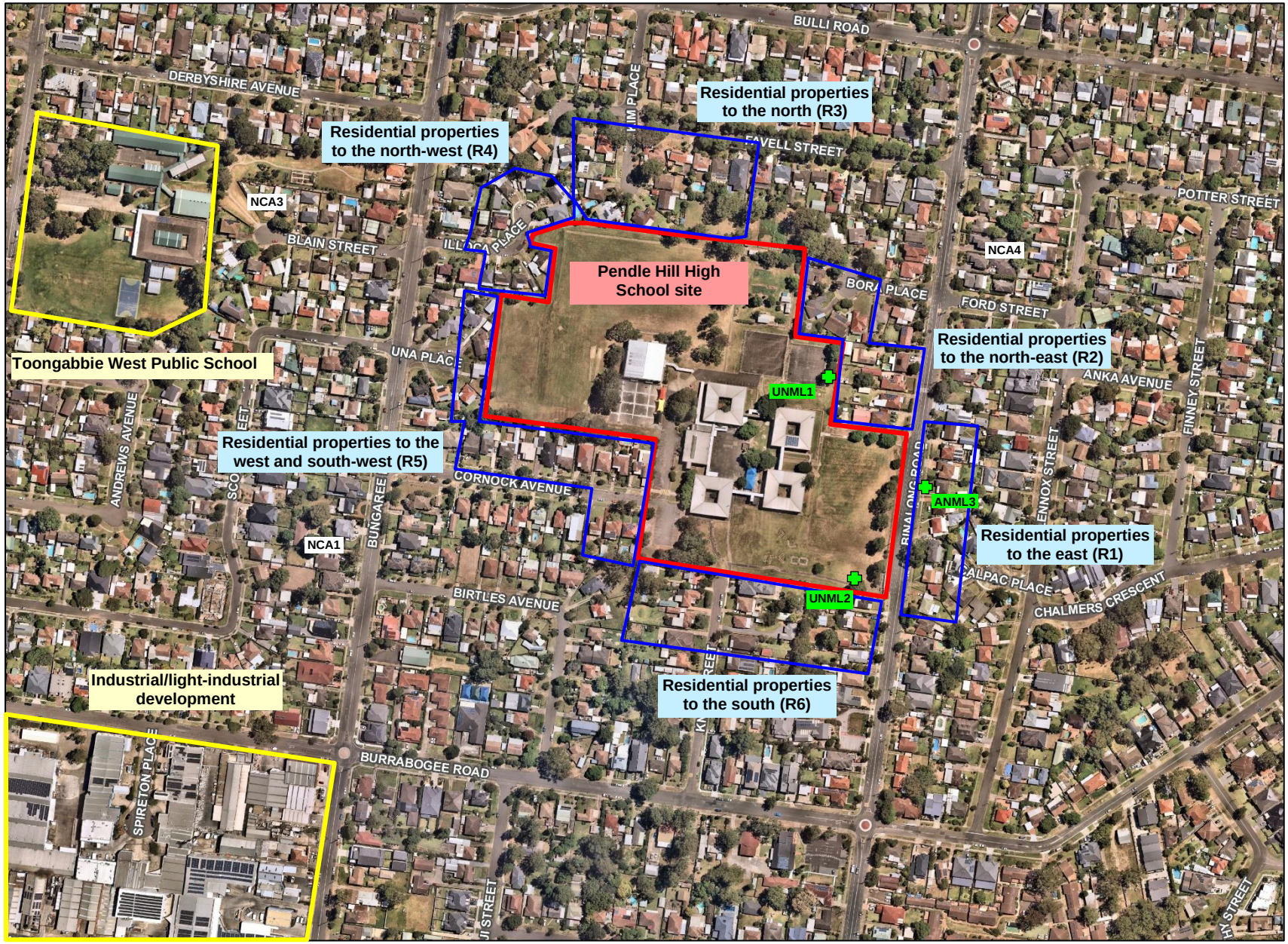

Figure 3-1 : Project area, surrounding sensitive receivers and noise measurement locations

4 Ambient Noise Survey

A survey of the existing ambient noise levels around the school site was conducted using both unattended and attended measurements. All instruments have current calibration from a NATA accredited laboratory and comply with Australian Standard AS-1259: *Sound Level Meters*. Noise measurements were conducted between 7 and 21 December 2020, at locations, UNML 1, UNML 2 and ANML 1 as illustrated in Figure 3-1.

Measured noise levels during COVID19 pandemic may be lower than normal noise levels (due to less road traffic and aircraft noise), resulting in potentially conservative operational noise emission criteria. Daytime peak hour traffic noise measurements were conducted on two separate occasions to determine the existing environmental noise impacts on the school site.

4.1.1 Methodology

Baseline noise measurement location considerations included land topography, distance from school outdoor play areas to surrounding sensitive residencies and contribution from other environmental noise sources (e.g. road traffic).

During a site visit on 7 December 2020 the sports field east of building D and games courts north of building E (see Figure 2-1) were observed to be the main outdoor play areas used by students, during both the recess and lunch break periods. Hence based on the proposed location of the new school building (Building H) and the proximity of the residential properties at 82 to 88 Binalong Road, Toongabbie, location for noise monitoring (unattended, long-term) was selected at UNML 1 (see Figure 3-1). The noise levels measured at this location would also be representative of the noise levels at other residential properties around the school site (to the north, west and south). At this location, the noise monitor is also screened from road traffic noise from Binalong Road and hence would be representative of the noise environment of the area. A second noise monitoring location was selected at UNML 2 (see Figure 3-1), to measure the road traffic noise impacts on the new Building H.

All measurements were performed in accordance with the Australian Standard AS1055 2018 '*Acoustics – Description and measurement of environmental noise*'.

4.1.2 Unattended noise measurements

Long-term unattended noise monitoring was carried out using two (2) Acoustic Research Labs Type EL-316 environmental noise logger, installed with microphone at a height of 1.5m and at least 2.5 from any reflecting façade. Monitoring was conducted from the 7th to 21st December 2020, with both monitors set to measure continuously using an A-weighted fast response mode. The monitors were calibrated before and after the monitoring period and no calibration drift exceeding ±1 dB(A) was observed.

The data collected by the noise monitors was analysed, and any invalid data removed. Invalid data generally refers to periods where average wind speeds were greater than 5m/s and/or when rainfall occurred, in accordance with the requirements of *Noise Policy for Industry* (NPfI) (NSW EPA, 2017). Concurrent weather data was sourced from the Bureau of Meteorology's Olympic Park (station ID: 066212) automatic weather station (AWS), to identify any periods of weather which may have affected the monitoring results.

A summary of the unattended continuous noise monitoring at each location is presented in Table 4-1. Detailed noise monitoring data is attached in Appendix A.

Table 4-1: Unattended noise monitoring results

Location	Rating background noise level (RBL) dB(A)$L_{90(period)}$			Average noise level dB(A)$L_{eq(period)}$						
	Day	Evening	Night	Day	Evening	Night	Day (15hr)	Night (9hr)	Day (worst 1hr)	Night (worst 1hr)
UNML1	39	39	37	52	52	46	53	46	55	51
UNML2	40	40	36	53	52	48	53	48	56	51

Note 1: RBL is the median of the measured LA90 noise level during the day, evening and nigh-time periods of the monitoring programme.
Note 2: For the rating background and ambient noise levels, the periods are defined as per the NPI (EPA, 2017):

- *Day: the period from 7.00 am to 6.00 pm Monday to Saturday or 8.00 am to 6.00 pm on Sundays and public holidays*
- *Evening: the period from 6.00 pm to 10.00 pm*
- *Night: the remaining periods.*

For the 15-hour and 9-hour ambient noise levels, as per the Development Near Rail Corridors and Busy Roads – Interim Guideline (NSW DoP, 2008), day refers to the 7am to 10pm while night refers to 10pm to 7am.

4.1.3 Attended noise measurements

Attended peak hour noise measurements was also conducted along Binalong Road (at location ANML 1, see Figure 3-1) to determine noise impacts from road traffic along this corridor on the school site. These measurements were conducted on two occasions on the 8th and 21st December 2020, during the morning peak hour (between 7:30am and 9am).

Measurements were conducted using a Bruel & Kjaer sound level meter (SLM), equipped with a B&K type ZC0032 pre-amplifier and a 4189 ½" microphone. The SLM was programmed to record using an 'A' frequency weighting, 'F' time weighting, and was fitted with an approved windshield. A Bruel & Kjaer type 4230 calibrator was used to calibrate the sound level meter before and after each series of measurements with no significant calibration drift noted.

Measured noise levels, including a description of the noise environment for each measurement, are presented in Table 4-2.

Table 4-2: Attended noise measurement results

Locations	Date and time	Measured noise level dB(A)$L_{eq(15min)}$	Observations
ANML1 (approx. 4m from curb)	8 December, 07:43AM	62	Road traffic noise dominant. 1 x bus arriving and stopping at bus stop outside school. 1 x bus passby in opposite direction
	8 December, 8:30AM	60	Road traffic noise dominant.1 x bus passby
	21 December, 7:30AM	57	Road traffic noise dominant.1 x bus passby
	21 December, 08:21AM	56	Road traffic noise dominant.1 x bus passby

5 Noise and Vibration Criteria

The aim of this assessment is to address the noise and vibration key issues detailed in the issued Planning Secretary's Environmental Assessment Requirements (SEARs), SSD-9579147, for the proposed school redevelopment. This is detailed below:

10. Noise and Vibration

Provide a noise and vibration impact assessment that:

- *includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction.*
- *details the proposed construction hours and provide details of, and justification for, instances where it is expected that works would be carried out outside standard construction hours.*
- *includes a quantitative assessment of the main sources of operational noise, including consideration of any public-address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities.*
- *outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers.*
- *considers sources of external noise intrusion in proximity to the site (including, road rail and aviation operations) and identifies building performance requirements for the proposed development to achieve appropriate internal amenity standards.*
- *demonstrates that the assessment has been prepared in accordance with polices and guidelines relevant to the context of the site and the nature of the proposed development.*

Relevant Policies and Guidelines:

- *NSW Noise Policy for Industry 2017 (NSW Environment Protection Authority (EPA)*
- *Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009)*
- *Assessing Vibration: A Technical Guideline 2006 (Department of Environment and Conservation, 2006)*
- *Development Near Rail Corridors and Busy Roads - Interim Guideline (Department of Planning, 2008)*

5.1 External (road traffic) noise impacts (Assessment 1)

5.1.1 NSW Department of Planning

The *Development Near Rail Corridors and Busy Roads – Interim Guideline* (NSW DoP, 2008) provides guidance for planning, design and assessment of development in, or adjacent to, rail corridors and busy roads. It applies to development impacted by the provisions of the State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP). The Infrastructure SEPP sets guidelines for developments that are proposed in, or adjacent to, specific roads (clauses 102 and 103) and railway corridors (clauses 85, 86 and 87).

As there is no rail corridor in the immediate vicinity of the school site, only the road provisions clauses are relevant. Clause 102 stipulates:

development for any of the following purposes that is on land in or adjacent to a road corridor for a freeway, a tollway or a transit way or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data available on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:

- *building for residential use*
- *a place of public worship*
- *a hospital*
- *an educational establishment or childcare centre*

Map 14[1] of the traffic volume maps for Infrastructure SEPP does not classify any of the surrounding public roads (see Section 3) as carriageways with > 20,000 AADT and hence is neither mandatory (for carriageways with > 40,000 AADT) nor recommended under clause 102 this guideline.

However, based on the proposed location of new school building H (see Figure 2-2) and its proximity to Binalong Road (sub-arterial road noted with frequent bus corridor and medium volumes of traffic), there is potential for noise impacts on the function/use of this building and an assessment is recommended with reference to the NSW Department of Education (DoE) guidelines.

5.1.2 NSW Department of Education

The Educational Facilities Standards and Guidelines (EFSG) (NSW DoE, 2018) provides guidance on acceptable internal noise levels for the control of steady-state (road traffic, rail, mechanical services etc.) and intermittent (rain noise, hydraulic services etc.) impacts, This is crucial in teaching spaces (teacher's voice or student's voice clearly audible and intelligible at all locations in the teaching space; unacceptably high vocal effort by teacher) and also to main function/use of specialist spaces (lecture theatre, library, music rooms etc.).

Section 11.06 of design guide (DG)11 of the EFSG outlines minimum acoustic performance requirements for various room/activity types and those relevant to the subject proposal are presented in Table 5-1.

Table 5-1: Internal noise level criteria

Type of space		Internal design noise level, dB(A)L_{eq}
Audio-visual areas		35
Computer rooms	Teaching	40
	Laboratories	45
Conference room		35
Corridor and lobbies		45
Stores		50
Interview/counselling rooms		35
Laboratories	Teaching	40
	Working	45
Lecture theatre	without speech reinforcement and > 50 seats	30
	with speech reinforcement	35
Library	General areas	40
	Reading areas	35
	Stack areas	45
Manual arts workshops		40
Medical rooms (First aid)		40
Office areas		40
Open plan teaching areas		40
Professional and Administrative offices		35
Staff common areas		40
Study rooms		35
Teaching spaces	Secondary schools	35
Toilet/change/showers		50

[1] *NSW Government Roads and Maritime website (https://www.rms.nsw.gov.au/about/environment/reducing-noise/traffic-volume-maps-for-infrastructure-sepp.html)*

- Notes on Table 5-1:
    - where spaces and their acoustic requirements are not specifically listed, the requirements should be based on the recommendations of Australian/New Zealand Standard™ *AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors*.
    - traffic noise ingress must be assessed as a $L_{Aeq,1hr}$, during the worst 1-hour external noise period
    - building services noise must be assessed as a $L_{Aeq,1min}$, and
    - where noise contains annoying characteristics such as tonality, intermittency or dominant low-frequency content, the internal design noise levels for the affected space must be corrected in accordance with methodology detailed in Appendix D of AS/NZS 2107:2016.

5.2 Operational noise emissions (Assessment 2)

There are no specific provisions in NSW, under a noise policy, standard or guideline, that provides guidance on noise impacts associated with schools. The *Noise Policy for Industry* (NPfI) (NSW EPA, 2017) is generally referenced for the assessment of environmental noise emissions, however this policy is specifically aimed at assessing noise from industrial sources scheduled under the Protection of Environment Operations Act (POEOA) (NSW EPA, 1997). The proposed school redevelopment is not a *schedule activity* under *Schedule 1* of the POEOA and as such will not require an Environment Protection License (EPL).

- While the NPfI is not strictly applicable for the proposed school redevelopment, it provides a useful framework for the assessment of operational noise emissions, whether they are intrusive or non-intrusive.
- The NSW Land & Environment Court (NSWLEC) has provided context on acceptable levels of noise impacts from outdoor play areas in its decision's history. As outdoor play areas are used periodically and generally for timed durations (recess/lunch break vs PE classes and sports days), a decision of background level + 10dB(A) noise criterion was reached for impacts associated with use of outdoor play areas, for a two hours maximum use, on several NSWLEC decisions (*Meriden School v Pedavoli* (2009) NSWLEC 183 and *Bankstown City Council v Mohamad El Dana* (2009) NSWLEC 68).
- The Association of Australasian Acoustical Consultants (AAAC) provides guidance for the assessment of noise impacts from proposed childcare centre developments, in its publication *Guideline for Child Care Centre Acoustic Assessment* (Version 3.0, 2020). Although this guideline applies for childcare centre developments, there are similarities in noise emission from uses of outdoor play areas for schools and childcare centres. As students do not play outdoors continuously for extended periods of time, as the duration of time students playing outside reduces, so does the overall noise annoyance. Therefore, it is reasonable to allow for a marginally higher noise level requirement as that adopted for steady and continuous noise source assessments (i.e background + 5 dB or amenity levels as per the NSWE EPA NPfI). The AAAC guideline states that if the total outdoor play time is limited to no more than 2 hours in the morning and 2 hours in the afternoon, the contributed $L_{eq,15minute}$ noise level emitter from the outdoor play shall not exceed the background noise level by 10dB.

Based on this information relevant guidelines/polices referenced for the assessment of operational noise emissions are as follows:

- Increased student capacity on outdoor play areas ***(Assessment 2a)*** – NSWLEC decision of background noise level + 10 dB(A).
- All other operational noise emissions (building H – PA system, school bell and building services plant) associated with school ***(Assessment 2b)*** – *Noise Policy for Industry* (NPfI).

5.2.1 NSW EPA Noise Policy for Industry (Assessment 2b)

The NPfI provides the framework and process for deriving the noise limits for assessments under the *Protection of the Environment Operations Act* 1997. The guideline specifies that there are two aspects of environmental noise that require assessment. The first relates to the intrusiveness of a noise source, and allows for the noise under assessment to be a margin above the background, whilst the other procedure relates to the acceptability of the resulting noise, in

relation to maintaining the amenity of the surrounding area. The more stringent of the amenity or intrusive criteria would define the appropriate criteria for a project.

Project intrusiveness noise level

The intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment. A noise source would generally be considered non-intrusive, if the monitored average noise level (L_{Aeq}) for a period does not exceed the RBL by more than 5 dB(A). Intrusive noise levels are only applied to residential receivers (residences).

Based on the results of noise monitoring detailed in Section 4, the following project intrusive noise criteria have been calculated.

Table 5-2: Project intrusiveness noise criteria

Location	Time period	Rating background noise level (RBL) dB(A)$L_{90(period)}$[2]	Allowance	Intrusiveness noise level dB(A)$L_{eq(15min)}$
Any affected surrounding residential receivers	Daytime (7am – 6pm)	39	+5dB	44
	Evening (6pm – 10pm)	39		44
	Night-time (10pm – 7am)	36		41

Project amenity noise level

To limit continuing increases in noise levels from the application of intrusiveness objective alone, this guideline recommends amenity noise levels for different receivers within a study area (Table 2.2 of the NPfI), to ensure ambient levels from all sources combined within this area are suitably controlled. To ensure the noise levels (existing + new) remain within the recommended amenity noise levels for an area, the project amenity noise level is defined by the recommended noise levels minus 5 dB(A).

For this project, all residential receivers have been defined as 'Suburban'. This classification is based on the measured existing ambient noise levels and the description of noise environments in the NPfI.

Table 5-3: Project amenity noise criteria

Receiver	Time of day	NPfI recommended amenity noise level dB(A)$L_{eq(period)}$	Project amenity noise level dB(A)$L_{eq(15min)}$[3]
Residential – suburban	Daytime (7am – 6pm)	55	53
	Evening (6pm – 10pm)	45	43
	Night-time (10pm – 7am)	40	38

5.2.2 Noise from increased traffic generation on surrounding public road network (Assessment 2c)

The redevelopment project is proposed to increase the total school capacity as detailed in Table 2-1. This will result in increased traffic volumes on the surrounding public road network, which in turn has the potential for noise impacts to the surrounding residential properties.

For land use developments with the potential to create additional traffic on public streets, guidance is provided in the *Road Noise Policy* (RNP) (NSW DECCW, 2011). Section 2.3.1 of this policy sets out road traffic noise assessment criteria for residential land uses. Criteria relevant to this project are summarised in Table 5-4.

[2] *Given the minor difference in calculated RBL at the two monitoring locations (+1dB(A), see Table 4-1), the lower level is adopted to establish the project operational noise limits, which will represent the most stringent requirement to the school site.*

[3] *Converted from LAeq(period) to LAeq(15mins) for consistence and ease of comparison with intrusiveness noise level requirement. This conversion is in accordance with the guidance provided in Fact Sheet E of the NPfI.*

Table 5-4: Road traffic noise assessment criteria for residential land uses

Road category	Type of project/land use	Assessment criteria, dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Sub-arterial roads	Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 50 (external)
Local roads		$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

In addition to the assessment criteria outlined in Table 5-4, any increase in the total traffic noise level at a location due to a proposed project must be considered. Where existing traffic noise levels are above the noise assessment criteria, Section 3.4 of the RNP outlines that the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. An increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

5.2.3 Sleep disturbance criteria during operations

The proposed after-hours use of some areas of the redevelopment project will be restricted to the evening period (6pm – 10pm). No operations are proposed during the night-time period (10pm – 7am), hence assessment of sleep disturbance impacts to surrounding residential receivers is not required.

5.2.4 Summary of operational noise criteria

The relevant project specific operational noise criteria are summarised in Table 5-5 below.

Table 5-5: Project operational noise criteria for surrounding affected residences

Operational noise element	Time period	Project operational noise criteria[4]
Outdoor play areas ***(Assessment 2a)***	Daytime (7am – 6pm)	49 dB(A)$L_{eq(15min)}$ – NSWLEC decisions and AAAC guideline 53 dB(A)$L_{eq(15min)}$ – NPfI project amenity level
Building H – school bell, PA system, building services plant and after-hours use ***(Assessment 2b)***	Daytime (7am – 6pm)	44 dB(A)$L_{eq(15min)}$
Additional traffic on surrounding public roads ***(Assessment 2c)***	Daytime (7am – 6pm)	Binalong Rd – 60 dB(A)$L_{eq(15hour)}$ (external) All other roads – 55 dB(A)$L_{eq(1hour)}$ (external)

5.3 Construction noise and vibration (Assessment 3)

The *Interim Construction Noise Guideline* (ICNG) (NSW DECC 2009) generally applies to the management of construction noise in NSW and is also referenced by the SEARs. This guideline provides recommendations on standard construction hours and construction noise management levels (NMLs).

5.3.1 Recommended standard hours of work

Section 2.2. of the ICNG recommends standard hours for construction work as follows:

- Monday to Friday: 7am to 6pm,
- Saturday: 8am to 1pm, and

[4] *Project noise trigger levels are to be assessed at the reasonably most-affected point on or within the residential property boundary or, if the property boundary is more than 30 metres from the residence, at the reasonably most-affected point within 30 metres of the residence, but not closer than 3 metres to a reflective surface and at a height of between 1.2 – 1.5 metres above ground level.*

- No work on Sundays or public holidays

The ICNG notes that the recommended standard hours of work are not mandatory and acknowledges that some activities could be undertaken outside the recommended standard hours of work, assuming all feasible and reasonable mitigation measures are implemented to minimise the impacts to any surrounding sensitive land uses. These activities include:

- the delivery of oversized plant or structures that police or other authorities determine requires special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- public infrastructure works that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours
- works which maintain noise levels at receivers to below the noise management levels outside of the recommended standard construction hours.

5.3.2 Construction noise management levels

Recommended construction NMLs for residential receivers and non-residential receivers are presented in Table 5-6 and Table 5-7 respectively. The NMLs represent a noise level that, if exceeded, would require management measures including the following:

- reasonable and feasible work practices
- contact with residences to inform them of the nature of works to be carried out, the expected noise levels and durations and contact details.

The management measures aim to reduce noise impacts on the residential receivers; however, it may not be reasonable and feasible to reduce noise levels to below the noise affected management level. The construction NMLs during recommended standard hours of work are not intended as a noise limit but rather a level where noise management is required. The construction NMLs outside of recommended standard hours would be considered as noise limits unless a private agreement has been reached with the affected residential receivers.

Table 5-6: ICNG recommended construction noise criteria for residential receivers

Time of day	Management level dB(A)Leq(15min)[5]	How to apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays.	Noise affected RBL + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(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 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: ■ times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) ■ if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (OOHW)[6]	Noise affected RBL + 5 dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Table 5-7: ICNG recommended construction noise criteria for non-residential receivers

Receiver type	Time of day	Management level dB(A)Leq(15min)[7]
Commercial properties	When in use (typically, daytime only, during standard business hours)	70 (external)
Industrial properties		75 (external)
Educational institutes		45 (internal) 55 (external)[4]
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)		75 (external)

5.3.3 Sleep disturbance impacts during construction

All construction works associated with the project are only expected to be undertaken during the recommended standard hours of work. Hence assessment of sleep disturbance impacts to surrounding residential receivers is not required.

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

[6] *OOHW Period 1 (Day) – Saturdays 7am to 8am and 1pm to 6pm; Sundays and public holidays 8am to 6pm.*
OOHW Period 1 (Evening) – Monday to Saturday 6pm to 10pm.
OOHW Period 2 – Monday to Saturday 10pm to 7am; Sundays and public holidays 6pm to 8am.

[7] *Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most affected point within 50 metres of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10 dB. Some buildings may achieve greater performance, such as where windows are fixed (that is, cannot be opened).*

5.3.4 Project construction noise criteria

The relevant project specific construction NMLs are presented in Table 5-8 for residential receivers and Table 5-9 for non-residential receivers. The NMLs have been calculated based on the ambient noise survey results (see Section 0) and the guidance in Section 5.3.2.

Table 5-8: Residential construction NML

Location	Recommended standard hours NML dB(A)$L_{eq(15min)}$	Outside of standard hours NML dB(A)$L_{eq(15min)}$			Highly affected NML dB(A)$L_{eq(15min)}$
		OOHW period 1 (day)	OOHW period 1 (evening)	OOHW period 2 (night)	
All affected surrounding residential receivers (see Figure 3-1)	49	44	44	41	75

Table 5-9: Non-residential construction NMLs

Receiver type	Noise management level (NML) dB(A)$Leq_{(15min)}$
All commercial properties (including retail, offices etc.)	70 (external)
All industrial properties	75 (external)
Educational institutes	55 (external)
Active recreation areas	65 (external)

5.4 Construction Vibration criteria

The effects of vibration impacts on buildings and structures can be divided into two categories:

- Human comfort impacts – where the occupants or users of the affected building are possibly disturbed
- Structural impacts – effects on building contents and structural integrity

The ICNG make reference to the *Assessing Vibration: A Technical Guideline* (AVTG) (NSW DEC, 2006), for consideration of acceptable vibration levels. This guideline is also referenced by the SEARs.

5.4.1 Human comfort

Construction vibration can adversely affect the amenity of occupants inside buildings as it may affect their quality of life or working efficiency. Human comfort impacts are experienced at levels well below those that can damage of affect a structure and its contents. Though it may not always be possible to comply with the more stringent human comfort criterion for infrastructure projects in close proximity to residential dwellings, human comfort should always be used as the objective to aim for and be the basis of assessment.

Guidance in relation to acceptable vibration levels for human comfort are provided in AVTG, which in turn is based on the guidelines contained in British Standard *BS 6472 – 1992*, *Guide to Evaluation of Human Exposure to Vibration in Buildings (1 hertz (Hz) to 80 Hz)*. *BS 6472-1:2008* superseded this British Standard in 2008. Although a new version of BS 6472 has been published, AVTG still references the 1992 version of this standard and the EPA still advises vibration to be assessed in accordance with this version of the standard.

AVTG classifies vibration as one of three types:

- Continuous – where vibration occurs uninterrupted and can include sources such as machinery and constant road traffic.

- Impulsive – where vibration occurs over a short duration (typically less than two seconds) and occurs less than three times during an assessment period. This may include activities such as occasional dropping of heavy equipment or loading / unloading activities.
- Intermittent – occurs where continuous vibration activities are regularly interrupted, or where impulsive activities recur. This may include activities such as rock hammering, drilling, pile driving and pavement breakers.

Construction activities typically generate ground vibrations of an intermittent nature and are assessed using vibration dose value (VDV). VDV is calculated using the acceleration rate of the vibration event and the time over which it occurs. This method emphases on the level of vibration rather than its duration and is a measure of the total quantity of vibration perceived. The VDV method is the most suitable for assessing human comfort amenity from intermittent vibration sources and the vibration limits relevant to the surrounding sensitive receiver types (see Section 3.1) are presented in Table 5-10.

Table 5-10: Human comfort intermittent vibration limits

Receiver type	Assessment Period	Intermittent vibration dose value, m/s^2	
		Preferred values	Maximum values
Residences	Daytime[8]	0.2	0.4
Offices, schools, educational institutions and places of worship		0.4	0.8
Workshops		0.8	1.6

5.4.2 Structural damage (including impact to heritage structures)

Vibration transmission through the ground can cause a structure and structure coupled elements (walls, windows, roof etc.) to radiate. The transmitted vibration energy has the potential to damage and compromise the integrity of a structure as well as increase the risk of damage to building contents.

There is no current Australian Standard that sets criteria for the assessment of building damage caused by vibrations. Guidance on limiting vibration values with the potential to cause structural damage is typically referenced from the German Standard DIN 4150: Part 3 – 2016 *Effects of Vibration on Structures* (DIN guideline).

The DIN guideline recommended maximum permissible levels of vibration (expressed as peak particle velocity or PPV) that reduce the likelihood of building damage caused by vibration and are presented in Table 5-11. PPV is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

It should be noted that heritage structures should be considered on a case by case basis, as a heritage listed structure may not necessarily be more sensitive to vibration than a standard structure. Where a historic heritage structure is deemed to be sensitive to damage, the criteria in Line 3 of Table 5-11, should be considered.

[8] *The NSW EPA's Assessing Vibration guideline defines daytime period as 7am – 10pm.*

Table 5-11: Guideline values for short-term vibration on structures

Line	Type of Structure	Peak Particle Velocity (PPV), mm/s			
		at foundation @ a frequency of			plane of floor of uppermost storey
		< 10Hz	10Hz to 50Hz	50Hz to 100Hz[9]	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Residential dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and have intrinsic value (e.g. heritage structures/buildings that are under a preservation order)	3	3 to 8	8 to 10	8

[9] *At frequencies above 100 Hz, the values given in this column may be used as minimum values.*

6 External (Road Traffic) Noise Intrusion Assessment (Assessment 1)

6.1 Methodology for assessment

Existing road traffic noise levels from vehicle movements along Binalong Road were measured and are detailed in Table 4-2. The road has medium volumes of traffic, with frequent public bus service in both directions. Given the location of a bus stop immediately adjacent to the eastern site boundary and use of this carriageway as a bus corridor, it is more practical to consider worst 1-hour period traffic noise impacts as opposed to an average for a period (i.e. daytime or night-time). Hence the measured worst 1-hour period L_{eq} noise levels (see Section 4) will be considered as a basis for this assessment.

Based on the proposed location the new school building (Building H) and the existing site topography, the Calculation of Road Traffic Noise (CoRTN) prediction model was used to determine the road traffic noise level incident on the façades of this building. Selection of appropriate noise control treatments and recommendation of minimum construction requirements, would allow external noise impacts to be sufficiently attenuated to achieve compliance with the internal noise goals (see Table 5-1) for various spaces.

6.2 Recommended acoustic treatment

Internal noise levels were calculated based on the traffic noise level incident on the façade, spectral characteristics of the external noise, building fabric design (area of building element exposed to noise) and internal configurations (type of space, absorption characteristics of room etc.) illustrated in the architectural drawings (Fulton Trotter, SDRP issue, revision P4 dated 23 February 2021).

6.2.1 Glazed windows and doors

The minimum glazing specification to the proposed internal areas in Building H, are detailed in Table 6-1. The installation of façade elements in building openings and the design of window mullions, door frames and perimeter seals, must not reduce the sound insulation of the glazing assembly (i.e. glass, frame and seals) below the values nominated in Table 6-1. Key items to note to prevent this include:

- Acoustic seals nominated for all external windows and doors, are required to be fitted with Q-lon type acoustic seals or equivalent rubber bulb acoustic seals. ***Mohair of fin type seals are not acceptable for the windows and doors requiring acoustic seals.***
- Perimeter of opening around façade element is acoustically sealed i.e. space between frame (before architraves are installed for windows) and wall structure is sealed with silicone or polyurethane acoustic sealant and foam backing rod.

The glazing specification is indicative only and other constructions that provide the same or better sound transmission loss performance are also acceptable. The window/door supplier/manufacturer shall provide evidence that the glazing system proposed has been tested in a registered laboratory, with results showing compliance with the minimum listed R_W requirements. Also, the glazing installer should certify that the window/doors have been constructed and installed in a manner equivalent to the tested samples.

Table 6-1: Recommended minimum façade glazed elements constructions

Building	Level	Space	Façade	Minimum R_W of glazing assembly	Indicative glazing specification	Acoustic seals
H – north	Ground level	Library	East	35	10.38mm laminate	Yes
			North and South	32	6.38mm laminate	Yes
			West	30	6mm float/toughened	Yes
	Level 1	Lecture Theatre	Any	35	10.38mm laminate	Yes
		All other spaces	East	32	6.38mm laminate	Yes
			North and South	30	6mm float/toughened	Yes
	Level 2	Multimedia	East	35	10.38mm laminate	Yes
			North	32	6.38mm laminate	Yes
		All other spaces	North, South and West	30	6mm float/toughened	Yes
H – south	Ground level	Principal's Office & Interview/Meeting Room	East	35	10.38mm laminate	Yes
			North and South	32	6.38mm laminate	Yes
		All other spaces	Any	30	6mm float/toughened	Yes
	Level 1 & 2	GLS	East	35	10.38mm laminate	Yes
			North, South and West	30	6mm float/toughened	Yes

6.2.2 External wall

All external walls are proposed of pre-cast concrete construction which will provide adequate sound insulation. There should not be vents on the internal skin of external walls. All penetrations in the internal skin of external walls should be acoustically sealed (i.e. airtight). All precast panels should be effectively sealed,

6.2.3 Roof and ceiling systems

A pitched metal deck roof is proposed to the new Building H. A solid suspended ceiling system (minimum 250mm cavity with acoustic insulation and single layer plasterboard or MFT ceiling) is expected to be sufficient for all occupied areas on level 2, to comply with the internal noise goals (see Table 5-1) for various spaces. This will be reviewed in detailed design stage (when internal room design is finalised) when minimum ceiling requirements (i.e. thickness and type of plasterboard and/or minimum CAC rating for MFT) are determined. Penetrations and openings in all occupied areas on level 2 must be sealed (airtight) with a flexible acoustic sealant. Penetrations will also need to be reviewed during detailed design stage, to determine extent of acoustic treatment required.

6.2.4 Timber External Doors

Any timber external doors are to be minimum 40mm thick solid core timber doors, with full perimeter rubber acoustic seals (e.g. Raven RP10 to the top and sides and Raven RP38 to the underside of the door). If glazed viewing panels are proposed in timber external doors, they should be limited to maximum 1m^2 in size and minimum 6.38mm laminate glazing.

6.2.5 Mechanical ventilation

For natural ventilation, the *Development near Busy Roads and Rail Corridors - Interim Guideline* stipulates the following:

"If internal noise levels with windows or doors open exceeds the criteria by more than 10dB(A), 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."

Generally, up to 10 dB noise reduction can be achieved across the façade, with the windows/doors open for natural ventilation (i.e. aggregate opening > 5% of the floor area of an enclosed space). On this basis we note the following:

- Eastern façade – With the exception of *Archive Store* (ground level Building H – south), internal noise goals for all other areas can only be achieved with windows and doors closed. An alternative method of ventilation, such as an air-conditioning system with fresh air supply, will be required to provide fresh air while the windows and doors are closed.
- All other areas of the development are predicted to comply with the internal noise goals (see Table 5-1) with natural ventilation.

7 Operational Noise Emissions (Assessment 2)

As detailed in Section 2.1, the key noise sources associated with the operation of the school include:

- Increased student capacity on outdoor play areas ***(Assessment 2a)***
- Building services plant, public address system and school bell servicing Building H ***(Assessment 2b)***
- Additional traffic on surrounding public road network ***(Assessment 2c)***

7.1 Outdoor play areas (Assessment 2a)

7.1.1 Overview

Students currently use the outdoor play areas during the morning recess break, lunch break, PE classes and weekly sports days. After hours use of the outdoor play areas is currently not permitted and also not proposed as part of the redevelopment. The current operational conditions are as follows:

- Morning recess break – 30-minute duration, five days a week (Mondays 10:40am, Tuesdays 10:27am and Wednesday-Friday 10:33am). During the site visit on 7th December 2020, approximately 100 students were observed in the Assembly area (see Figure 2-1) and an additional 50 students were in Building C (partially enclosed canteen area, see Figure 2-1). No students were observed using the oval, games courts or outdoor play areas (see Figure 2-1) during this break. It was confirmed by staff that this use was typical for the morning recess period, however the outdoor play area along Binalong Road and the two games courts north of Building E are also occasionally used during his period.
- Lunch break – 30-minute duration, five days a week (Mondays 1:02pm, Tuesdays 12:30pm and Wednesday-Friday 12:49pm). During the site visit on 7th December 2020, approximately 100 students were noted in the Assembly area, approximately 30 students in Building C, approximately 20 students in the outdoor play area along Binalong Road and approximately 10 students in the two games courts north of Building E. No students were noted on any other play areas.
- PE classes – generally 50-minutes in duration, not exceeding 100-minutes (double classes). Maximum 30 students per session.
- Sports day – every Tuesday at 1pm, for maximum duration of 2 hours. Everyone is encouraged to participate.

Based on this information and our observations during the site visit, maximum capacity for the outdoor play areas, are only likely to be reached during the lunch break and weekly sports day. Given the current student enrolment of 378, based on site observations, typically less than half of this no. of students is expected to regularly use the outdoor play areas on a particular day. Additionally, given there are several play areas associated with the school, assuming the maximum capacity use of any one play space is not practical.

It should also be noted that the school is currently approved for a maximum capacity of 1080 students. As this is significantly higher than the current enrolment of 378 students, noise emissions from the increased student capacity will be compared against this *'Existing Permanent'* condition (see Table 2-1). The proposed increase to the maximum capacity as a result of the redevelopment project is for 1320 students, which accounts for an increase of 240 students.

7.1.2 Predicted noise levels

On the basis of the information detailed in Section 7.1.1, we have assumed the following to model a worst-case scenario of noise emissions from students using outdoor play areas:

- Maximum students in the main outdoor play areas (nearest to the surrounding residences) are presented in Table 7-1.

Table 7-1: Student capacity for outdoor play areas

Outdoor play area	Existing (permanent) – total 1080 students	Proposed – total 1360 students
Oval and adjoining outdoor play space (see Figure 2-1)	Up to 500	Up to 650
Outdoor play space along Binalong Rd (see Figure 2-1)	Up to 300	Up to 350
Games Courts north of Building E (see Figure 2-1)[10]	Up to 30	Up to 30[11]

- Remaining students will use the Assembly space, Building C, Building F and other games courts. Given the distance between these play areas and the surrounding residences and the screening effect provided by school buildings, noise impacts from these areas are unlikely to impact on the level predicted from the use of main outdoor play areas identified in Table 7-1.

- Noise level measurements of students playing were conducted during the morning recess and lunch breaks on the 7th December 2020. Noise sources included students running on hard surface, ball being kicked around, students screaming and talking in raised voices, music from phones and basketball bouncing in games courts. Calculated Sound Power levels (SWLs) are presented in Table 7-2.

Table 7-2: Sound Power Levels of students playing in outdoor play areas

Description	Sound Power Level (dB) in octave band centre frequencies (Hz)								
	63	125	250	500	1k	2k	4k	8k	Overall dB(A)
Approx. 100 students playing (measured in Assembly area)	87	88	89	96	98	92	86	75	**100**
Approx. 10 students playing in games court	75	78	81	85	85	83	76	62	**89**

Predicted noise levels based on the measured SWLs of students (Table 7-2) playing and corrected for number of students (see Table 7-1), at the upper most level of the potentially nearest affected residential receivers, are presented in Table 7-3.

Table 7-3: Predicted outdoor play areas noise impacts

Outdoor play area	Receiver location	Predicted noise levels dB(A)$L_{eq(15mins)}$		NSWLEC decisions & AAAC guideline criteria dB(A)$L_{eq(15mins)}$	Npfl project amenity level dB(A)$L_{eq(15mins)}$
		Existing (permanent)	Proposed		
Oval and adjoining outdoor play space	R3	65	66	49	53
	R4	68	69		
	R5	65	66		
Outdoor play space along Binalong Rd	R1	61	62		
	R2[12]	47	47		
	R6	64	65		
Games courts north of Building E	R2	56	56		

7.1.3 Discussion on outdoor play areas noise impacts

Exceedance of both the NSWLEC decisions/AAAC guideline criteria and the NPfI project amenity noise levels are predicted, at the nearest affected façade of the surrounding residential receivers, when the identified main play areas

[10] *This play area is included in this assessment given nature of its use and proximity to R2 residential receivers.*

[11] *Given the function of these courts, it is unlikely more than 30s students will use these areas at any given time.*

[12] *The new school building will act as a barrier, screening noise impacts at this receiver location*

are at typical maximum capacities (see Table 7-1). These exceedances are predicted for the existing approved total capacity if the school's current enrolment grew in the coming years.

In our opinion, these exceedances are not unreasonable for the following reasons:

- Suburban schools (existing or proposed new) are generally always located within proximity of residential development and it is common for outdoor play areas to be located adjacent to shared property boundaries. Within the current LGA (City of Parramatta), Toongabbie West Public School (83 Ballandella Road, Toongabbie) and Toongabbie Public School (59 Fitzwilliam Road, Old Toongabbie) are located approximately 240 metres and 400 metres to the west and north-east of the subject school (see Figure 7-1).

Figure 7-1 : Other school developments around the site

As can be seen in Figure 7-1, both schools also have outdoor play areas adjacent to residential properties. Based on the location of these schools, it would be safe to assume a similar daytime background noise level at these locations (residences to the north, east and south of Toongabbie West Public School and residences to the west, south and east of Toongabbie Public School) and hence a similar level of noise impact from the use of outdoor play areas if not more (Toongabbie Public School is significantly larger than Pendle Hill High School) is likely for residences around these schools.

- The NSW Land and Environment Court in its decision for *Meriden School v Pedavoli* (2009) NSWLEC 183 noted that "All noise that emanates from the normal activities at a school is not offensive". Justice Pain considered the fact that there were other school developments in the LGA with playgrounds adjoining residential properties and also the permissibility of the proposed school use in the land zoning. Moreover, in a more recent decision *Al-Faisal College Limited v Campbelltown City Council* (2015) NSWLEC 1083, commissioner Sue Morris concluded that an exceedance of +14dB(A) was an acceptable level of impact for school children playing outdoors.

- The proposed increase to the total student capacity is only forecasted to result in an increase of between 1 to 2 dB for noise impacts from the use of outdoor play areas, when compared to noise impact predictions of existing (permanent) capacity. This increase would be considered negligible and, in our opinion acceptable.

7.2 Building services plant, school bell and public address system (Assessment 2b)

7.2.1 Building services plant

Information on the building services design (locations and equipment specifications) are typically not available at approvals stage and hence an acoustic review of potential impacts is not possible.

At this stage, we have only been advised of the proposed location of AC condenser units, as illustrated below.

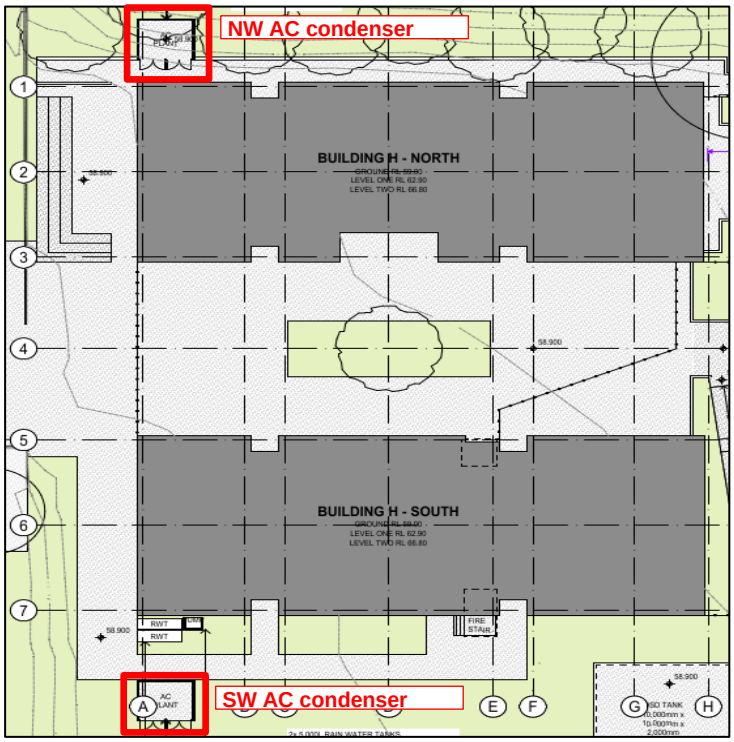

Figure 7-2 : Proposed AC condenser platforms

Based on total quantity of condenser units required for each location and indicative equipment selections, the following minimum acoustic treatments will be required to achieve compliance with the project noise goals at the boundary of R2 and R6 residential receivers:

- NW location
  - Three units proposed in total with one model a dual unit (2 compressors). Maximum SWL of units $\leq$ 72dB(A).
  - A minimum 3m high four-sided solid enclosure (open to roof only) around the condensers (typically 1.3m-1.5m higher than top of condenser units). The enclosure will also need to be internally lined (inside face of the enclosure facing the condensers) with 50-75mm thick absorptive insulation, with a perforated metal facing required if facing is proposed to protect against wind and rain.
- SW location
  - Three units proposed in total with 2 x models dual units (2 compressors). Maximum SWL of units $\leq$ 75dB(A).
  - A minimum 3m high four-sided solid enclosure (open to roof only) around the condensers (typically 1.3m-1.5m higher than top of condenser units). The enclosure will also need to be internally lined (inside face of the enclosure facing the condensers) with 50-75mm thick absorptive insulation, with a perforated metal facing required if facing is proposed to protect against wind and rain.

A detailed review of all building services plant/equipment should be undertaken during subsequent stages of the project design (once plant selections and locations are finalised), to determine the suitable acoustic treatments required so that cumulative impacts can achieve compliance with the project operational noise criteria detailed in Table 5-5.

Based on the proposed location of the new school building (see Figure 2-2), we believe all plant can be satisfactorily attenuated to levels complying with the project noise emission criteria, through appropriate location and (if necessary) standard acoustic treatments such as noise screens, enclosures, in-duct treatments (silencers/lined ducting) or similar.

7.2.2 School bell ad public address system

A public address system (PA system) and bell similar to the systems used for existing school buildings will be installed for the new school building, to signal the start and end of classes. Confirmation on the design and location of speakers is not available at this stage, but must be reviewed during subsequent stages of the project design to achieve compliance with the project operational noise criteria detailed in Table 5-5.

Generally, both the PA system and school bell are instantaneous noise events, occurring for very short durations and can be electronically controlled to achieve compliance with the project noise emission goals. Nevertheless, the following best practice procedures should be considered:

- Selection of highly directional speakers (typically angled at 45° towards the ground) will help control noise spill.
- Consideration of appropriate location and direction of the speakers, to maximise distance to surrounding residences and where practical and feasible, pointing them away residential receivers (opposite direction or 90°)
- Installation of RMS limiter to calibrate output noise spectrum to reduce noise spill to surrounding residences, whilst ensuring suitable noise levels are generated within the school grounds for use (typically between 75-80dBA SPL at 1m).

7.3 Additional traffic on surrounding public road network *(Assessment 2c)*

7.3.1 Overview

There is potential for increased traffic on the surrounding public road network, both because of the increased school capacity (student and staff) and also proposed changes to current pick-up and drop off locations.

The *Pendle Hill High School – Transport and Accessibility Impact Assessment* report (Taylor Thomson Whitting, 2021) notes that the existing school does not include designated pick-up and drop-off (PUDO) zone. Students are currently being dropped-off and picked-up along Cornock Avenue and Knox Street. PUDO in the school carpark was prohibited as a result several near misses and incidents between students and vehicles, with alternative locations for PUDO also now occurring along Binalong Road near the pedestrian entrances, or at the end of Knox Street or Cornock Avenue.

Section 2.8.3 of the traffic report illustrates the existing traffic movements for the AM (7:45am to 8:45am) and PM (3:00pm to 4:00pm) peak periods at all the key intersections around the school site. This is reproduced in Figure 7-3 and Figure 7-4 below.

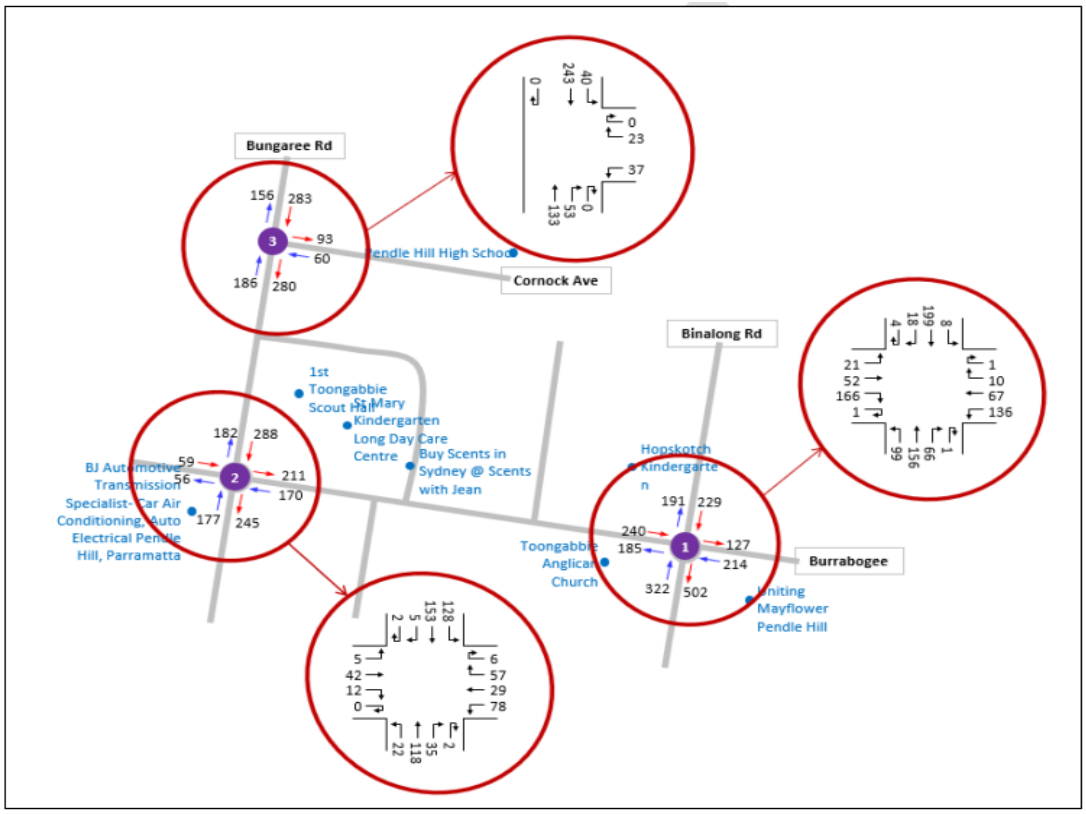

Figure 7-3 : Trip volume summaries during AM peak AM (7:45am to 8:45am)

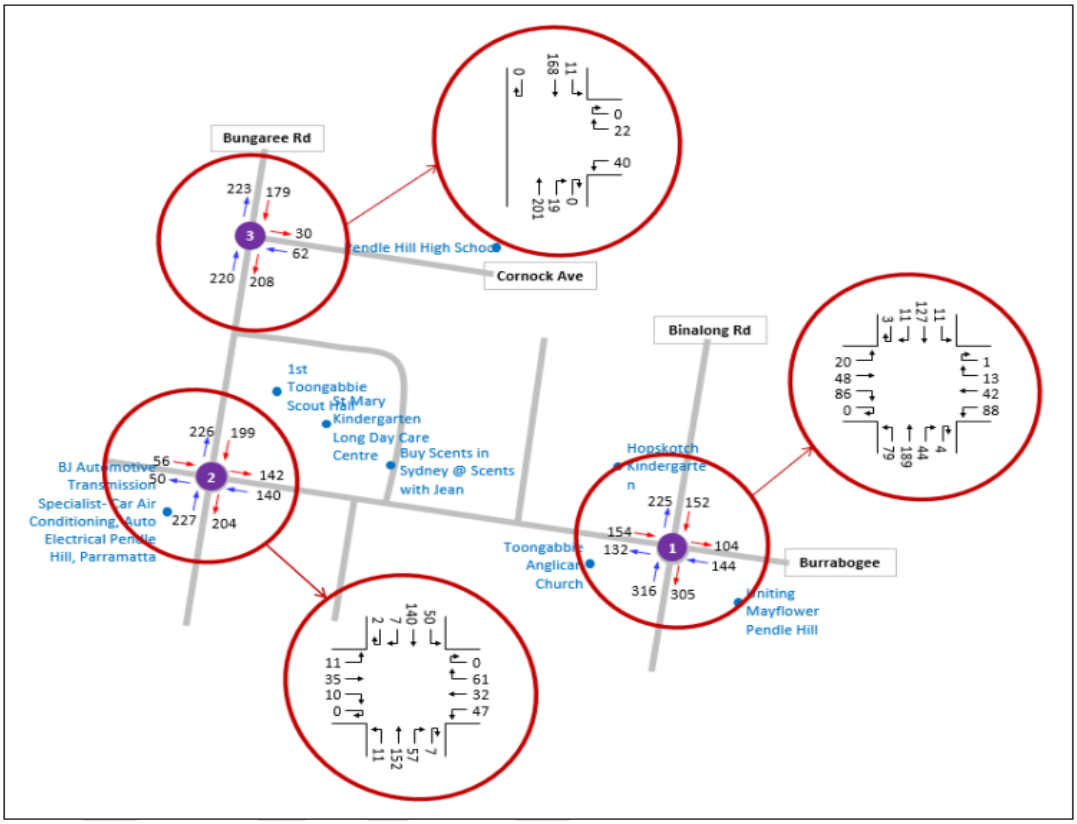

Figure 7-4 : Trip volume summaries during AM peak AM (3:00pm to 4:00pm)

7.3.2 Predicted noise levels

As part of the redevelopment project, multiple options for PUDO are proposed to alleviate the current congestion (during peak hours) on Cornock Avenue and Knox Street. This will disperse the traffic volume to all available surrounding public roads, so as to not congestion on any particular carriageway. This is illustrated in Figure 7-5.

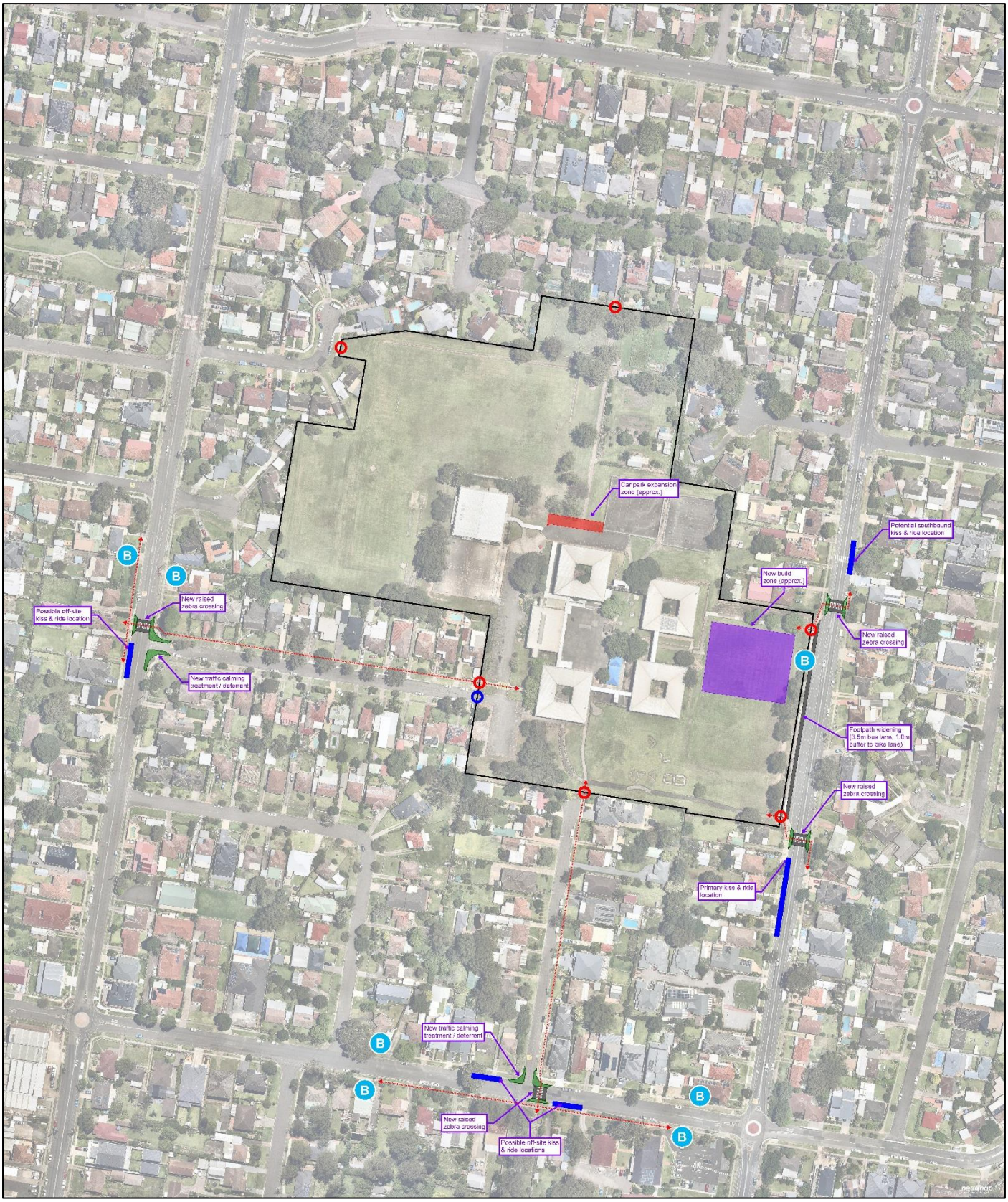

Figure 7-5 : Proposed overall road traffic works

We have been informed of the following peak hour movements:

Table 7-4: Existing traffic volume at peak hours

Element and location		AM peak hour	PM peak hour
Pick up and Drop off area peak	Cornock Avenue	58	30
	Knox Street	26	13
	Binalong Road (2 locations on this road)	26	13
Staff vehicles to/from parking		35	26
School bus at Binalong Road Bus Bay		2	4

Table 7-5: Forecast traffic volume at peak hours

Element and location		AM peak hour	PM peak hour
Pick up and Drop off area peak	Cornock Avenue	20	10
	Bungaree Rd	62	32
	Burrabogee Rd (2 locations on this road)	62	32
	Knox Street	20	10
	Binalong Road (2 locations on this road)	125	65
Staff vehicles to/from parking		79	58
School bus at Binalong Road Bus Bay		14	15

Road traffic noise levels are dependent on several input factors such as the traffic volume, % of heavy vehicles, road surface, road gradient/slope and speed of vehicles. Generally, for school developments, the peak hour traffic movements will result in congestion and cars travelling at low speeds, decelerating, and constantly breaking. The SWLs associated with this kind of vehicular operations, based on measurements previously conducted by Aurecon are detailed in Table 7-6.

Table 7-6: Vehicular sound power levels

Description	Sound Power Level (dB) in octave band centre frequencies (Hz)								
	63	125	250	500	1k	2k	4k	8k	Overall dB(A)
Car travelling at speed of 12km/hr[13]	96	79	78	76	79	78	74	71	**84**
Car decelerating (from 18km/hr) and breaking[13]	92	80	82	77	79	76	71	64	**83**
Bus decelerating and stopping at a stop (includes air brake)	87	78	71	71	75	78	75	88	**88**
Bus accelerating away from stop	95	93	89	87	89	84	77	75	**92**

Based on this information, the CoRTN prediction model was used to determine the road traffic noise level at the nearest affected receivers. The outcomes are:

- Cornock Avenue – the road traffic noise level for residences along this corridor are predicted to decrease as a result of the drop in forecasted traffic volume during period hours (less than half the existing volume forecasted, see Table 7-4 and Table 7-5).
- Knox Street– the road traffic noise level for residences along this corridor are predicted to decrease as a result of the drop in forecasted traffic volume during period hours (see Table 7-4 and Table 7-5).
- Staff accessing carpark – no change to existing noise impacts for residences along Cornock Avenue is forecasted for increase in staff vehicles from 35 to 79 (worst-case AM peak) during worst 1-hour period.

[13] *Measurements of VW golf on standard asphalt road during dry conditions.*

- Binalong Road – as assessment against the NSW EPA RNP criteria for this carriageway is for a 15-hour assessment period (as opposed to 1-hour for all other roads), we need to consider total car movements generated on this road by the school site. As majority of the vehicle movements associated with the school will occur during peak periods, it is safe to assume the sum of AM and PM peak volume forecast will be a good estimate of total car movements generated by the school. As a conservative approach, we have assumed half of the forecast traffic volumes for all other roads (including staff volume forecast) will also travel on this carriageway, resulting in total of 375 movements. Noise levels of between 59 – 61 dB(A)$L_{eq(15hour)}$ are predicted at the façade of the residential properties along Binalong Road. Though a marginal exceedance of the RNP criteria (60 dBA $L_{eq(15hour)}$, see Table 5-5) is predicted, these levels are within 2dB of the existing traffic noise levels (see Table 4-2) and hence comply with the relative increase requirement of the RNP.
- Bungaree Road – based on morning (this is higher than afternoon peak) peak hour forecast 62 car movements, noise levels of between 49 – 51 dB(A)L_{eq} are predicted at the façade of the residential properties along Bungaree Road and is within the NSW EPA RNP criteria (see Table 5-5).
- Burrabogee Road – based on morning (this is higher than afternoon peak) peak hour forecast of 62 car movements, noise levels of between 50 – 51 dB(A)L_{eq} are predicted at the façade of the residential properties along Burrabogee Road and is within the NSW EPA RNP criteria (see Table 5-5).

8 Construction Noise and Vibration (Assessment 3)

A detailed construction programme and methodology of proposed activities/works is not available at this early stage. Therefore, only a preliminary assessment of the potential noise and vibration impacts associated with the construction of the new school building is possible.

A detailed construction noise and vibration impact study is recommended during subsequent stages of the project, when a detailed programme and construction methodology is developed, to accurately determine the level of impact on surrounding affected receivers and develop site-specific noise mitigation measurements and management strategies.

8.1 Construction overview

The baseline project programme envisages an approximate twelve- and half-month construction period, commencing December 2021 and completing January 2023. All works are expected to occur in one (1) stage *Main Works*, with the following works expected:

- Contractor mobilisation and site establishment
- Earthworks
- Services and utilities installation (including installation of substation)
- Construction of three-storey school building
- Landscaping

This staging is based on the current design and may change once the detailed design methodology is finalised. The construction methodology and equipment list should be developed further during the detailed design of the project, by the nominated Contractor in consultation with SINSW.

8.1.1 Hours of Work

All works are currently proposed to only occur during the recommended standard hours as per the ICNG (see Section 5.3.1):

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 1:00pm Saturdays
- No work on Sundays or public holidays.

8.2 Construction noise assessment

8.2.1 Typical construction noise sources and sound levels

The main sources of noise typically associated with earthworks and construction of buildings include piling, rock breaking, excavators, dozers and hand-held pneumatic and electric power tools. A geotechnical investigation of the site was undertaken by Douglas and Partners (*Report on Geotechnical Investigation Pendle Hill High School*, document: R.003.Rev1, revision 1 dated 02 March 2020), with borehole logs providing the following ground profile:

- Topsoil/fill at 0 metres (depth to top of unit) – clayey silt and gravelly sand
- Residual silty clay at 0.3-1.6 metres (increasing from stiff to hard with depth)
- Shale at 1.1 – 3.1 metres (very low and low strength)

It is reasonable to assume excavation will be required for the project, most likely for the construction of flat platforms for the new school building, and / or for related landscaping purposes. Hence, in addition to standard excavation (fill and residual soil), excavation of shale and siltstone may be required for deeper cuts. Excavation of low strength or stronger rock would likely require ripping, rock hammering or rock sawing techniques.

On this basis, the likely noisiest equipment and their corresponding SWLs are detailed in Table 8-1. The SWLs have been sourced from:

- Table A1 of Australian Standard *AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites*.
- Department for Environment Food and Rural Affairs (DEFRA) *Update of Noise Database for Prediction of Noise on Construction and Open Sites*.

Table 8-1: Construction scenario, staging and activity SWLs

Equipment/Machinery	Sound Power Level (SWL) dB(A)L_{eq}
Hydraulic Rock Breaker	118
Excavator (20-40 tonnes – breaking out and loading operations[14])	103 – 109
Compactor	110
Dozer (upto 25 tonnes – earthworks)	111
Circular Saw	112
Concrete pump truck	109
Pneumatic and electric hand tools (up to 4 operating simultaneously)	115[15]
Diesel Scissor Lift (up to 6 tonnes)	106
Diesel generator	103[15]

8.2.2 Predicted noise impacts

Potential construction noise impacts were calculated at the nearest affected residential property boundaries, for the identified surrounding residential receivers (see Section 3.1). Predicted noise levels are presented in Table 8-2 and are governed by source noise level, the distance between source and receiver and any screening/barrier effect from site topography or existing structures.

As a conservative approach, an activity or associated equipment/machinery was assumed operating continuously for the 15-minute assessment period, with level range representing the potentially nearest and furthest distances at which each item of machinery can operate, respective to a receiver location. However, construction equipment/machinery are generally mobile, largely intermittent and may only occur for short durations or may be present for a few days, with a significant intervening period before the activity occurs again. There may also be differences between predicted and noise level measurements conducted on site, due to variations in instantaneous operating conditions, machinery in operation during the measurement period and also the location of the equipment. Actual source noise levels should be verified based on on-site operational noise measurements, during construction.

Table 8-2: Predicted construction noise impacts at surrounding residential receivers

Equipment/Machinery	Predicted noise levels dB(A)$L_{eq(15min)}$	Noise management level dB(A)$L_{eq(15min)}$	Exceedance
R1 – Residential properties to the east (83-95 Binalong Rd, Toongabbie)			
Hydraulic Rock Breaker	71 – 76	49	**Up to 27**
Excavator (20-40 tonnes – breaking out and loading operations)	60 – 67		**Up to 18**
Compactor	63 – 68		**Up to 19**
Equipment/Machinery	**Predicted noise levels dB(A)$L_{eq(15min)}$**	**Noise management level dB(A)$L_{eq(15min)}$**	**Exceedance**

[14] *Ground excavation/earthworks operations noise impacts will be lower ~ 99 – 107 dB(A) SWL.*

[15] *Certain activities will cause particular annoyance at receivers, due to tonality, spectral content or impulsiveness. They typically include hand tools such as grinders, jackhammers and other activities involving impacts. A penalty of +5dB(A) is added to account for this annoyance.*

Dozer (upto 25 tonnes – earthworks)	62 – 69	49	**Up to 20**
Circular Saw	64 – 71		**Up to 22**
Concrete pump truck	61 – 67		**Up to 18**
Pneumatic and electric hand tools (up to 4 operating simultaneously)	68 – 73		**Up to 24**[16]
Diesel Scissor Lift (up to 6 tonnes)	58 – 65		**Up to 16**
Diesel generator	55 – 62		**Up to 13**
R2 – Residential properties to the north-east (82-88 Binalong Rd & 5-12 Bora Pl, Toongabbie)			
Hydraulic Rock Breaker	77 – 84	49	**Up to 35**
Excavator (20-40 tonnes – breaking out and loading operations)	68 – 75		**Up to 26**
Compactor	69 – 76		**Up to 27**
Dozer (upto 25 tonnes – earthworks)	70 – 77		**Up to 28**
Circular Saw	65 – 84		**Up to 35**
Concrete pump truck	61 – 75		**Up to 26**
Pneumatic and electric hand tools (up to 4 operating simultaneously)	74 – 81		**Up to 32**
Diesel Scissor Lift (up to 6 tonnes)	61 – 74		**Up to 25**
Diesel generator	58 – 71		**Up to 22**
R3 – Residential properties to the north (15-21 Favell St & 2-5 Kim Pl, Toongabbie)			
Hydraulic Rock Breaker	55 – 58	49	**Up to 9**
Excavator (20-40 tonnes – breaking out and loading operations)	46 – 49		**Nil**
Compactor	47 – 50		**Up to 3**
Dozer (upto 25 tonnes – earthworks)	48 – 51		**Up to 2**
Circular Saw	49 – 53		**Up to 4**
Concrete pump truck	41 – 45		**Nil**
Pneumatic and electric hand tools (up to 4 operating simultaneously)	52 – 55		**Up to 6**
Diesel Scissor Lift (up to 6 tonnes)	43 – 47		**Nil**
Diesel generator	40 – 44		**Nil**
R4 – Residential properties to the north-east (6-10 Illoca Pl, Toongabbie)			
Hydraulic Rock Breaker	46 – 51	49	**Up to 2**
Excavator (20-40 tonnes – breaking out and loading operations)	<45		**Nil**
Compactor	<45		**Nil**
Dozer (upto 25 tonnes – earthworks)	<45		**Nil**
Equipment/Machinery	**Predicted noise levels dB(A)$L_{eq(15min)}$**	**Noise management level dB(A)$L_{eq(15min)}$**	**Exceedance**
Circular Saw	43 – 46	49	**Nil**

[16] *Note – when the external building fabric of the new school building is complete, this structure will act as a noise barrier, screening internal fitout works to the surrounding affected residential receivers. This can result reductions on noise levels from 5 – 15 dB (based on level of external building fabric completion and orientation of receiver).*

Concrete pump truck	<40		Nil
Pneumatic and electric hand tools (up to 4 operating simultaneously)	<47		Nil
Diesel Scissor Lift (up to 6 tonnes)	<40		Nil
Diesel generator	<40		Nil
R5 – Residential properties to the west/south-west (3-6 Una Pl & 19-22 Cornock Avenue, Toongabbie)			
Hydraulic Rock Breaker	48 – 55	49	Up to 6
Excavator (20-40 tonnes – breaking out and loading operations)	Up to 46		Nil
Compactor	Up to 47		Nil
Dozer (upto 25 tonnes – earthworks)	Up to 48		Nil
Circular Saw	46 – 50		Up to 1
Concrete pump truck	45 – 49		Nil
Pneumatic and electric hand tools (up to 4 operating simultaneously)	45 – 52		Up to 3
Diesel Scissor Lift (up to 6 tonnes)	40 – 44		Nil
Diesel generator	<40		Nil
R6 – Residential properties to the south (12-16 Knox St & 60-64 Binalong Rd, Toongabbie)			
Hydraulic Rock Breaker	67 – 72	49	Up to 23
Excavator (20-40 tonnes – breaking out and loading operations)	56 – 63		Up to 14
Compactor	59 – 64		Up to 15
Dozer (upto 25 tonnes – earthworks)	58 – 65		Up to 16
Circular Saw	61 – 67		Up to 18
Concrete pump truck	59 – 65		Up to 16
Pneumatic and electric hand tools (up to 4 operating simultaneously)	62 – 69		Up to 20
Diesel Scissor Lift (up to 6 tonnes)	55 – 61		Up to 12
Diesel generator	52 – 58		Up to 9

8.2.3 Discussion on construction noise impacts

- Exceedance of the ICNG recommended noise management level is forecasted for the construction works expected to be undertaken for the construction of the new school building. This is predominantly expected for the residential properties to the east (R1 – 83-95 Binalong Rd, Toongabbie), north-east (R2 – 82-88 Binalong Rd & 5-12 Bora Pl, Toongabbie) and south (R3 – 12-16 Knox St & 60-64 Binalong Rd, Toongabbie), with exceedances of up to 35 dB(A) predicted.
- Exceedance of the highly noise affected management level of 75 dB(A)$L_{eq(15mins)}$ is also predicted for the R2 residential receivers (82-88 Binalong Rd & 5-12 Bora Pl, Toongabbie), as the property boundary of these receivers are nearest to the Building H development area (approx. 10m).

Typically, construction activities move within the construction site and are largely intermittent. Impacted receivers would only experience the predicted worst-case noise levels when construction works are located closest to the receiver. At other times, the receivers would experience levels below the worst-case noise levels predicted as construction activities would progressively move away from the receiver as works are completed.

The level of construction impact is generally based on the level of exceedance above the NML which depends on the following factors:

- type of construction equipment and machinery being operated
- location of the construction machinery relative to the sensitive receiver
- existing background noise levels
- attenuation effects from intervening terrain and structures
- time of day for construction works

As the latter three factors have already been considered for this assessment, the level of exceedance is governed by the type of operational construction equipment and the distance between the construction works and receiver. Given the predicted exceedance of noise management levels, mitigation measures and management controls should be implemented where feasible and reasonable and are recommended in Section 0.

8.3 Construction vibration assessment

Excavation and earthworks have the potential to generate vibrations which cam impact human comfort and/or cause structural damage to surrounding buildings. Give the proximity of the development site to the existing residential properties to the north-east (R2, see Section 3.1), there is potential for both human comfort and structural vibration impacts to these properties. The highest vibration level will be associated with rock breaking, excavation (ripping) and other impulsive type operations (based on ground conditions).

Vibration is generated when energy from equipment is transmitted into the ground and is generally attenuated with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- the ground type and topography
- the impact medium stiffness
- the efficiency of the energy transfer mechanism of the equipment (i.e. impulsive, reciprocating, rolling or rotating equipment)
- the frequency content, and
- the type of wave (surface or body)

On this basis ground borne vibrations can vary significantly at specific distances for different sites and hence will need to be evaluate on a project by project basis. The *Construction Noise and Vibration Strategy* (TfNSW, 2020) provides guidance on safe working buffer distances for typical vibration intrusive equipment/machinery (Section 6.3 of this guideline), with relevant equipment associated with this project presented below.

Table 8-3: Vibration safe working buffer distances

Equipment/machinery		Human comfort (Assess Vibration: A Technical Guideline)	Minimum distance – Structural damage (DIN 4150-3)
Vibratory Roller	Up to 4 tonnes	20 m	6 m
	4 – 6 tonnes	40 m	12 m
	7 – 13 tonnes	100 m	15 m
	13 – 18 tonnes	100 m	20 m
	> 18 tonnes	100 m	25 m
Small Hydraulic Hammer (300kg – 5 to 12t excavator)		7 m	2 m
Medium Hydraulic Hammer (900kg – 5 to 12t excavator)		23 m	7 m
Medium Hydraulic Hammer (1600kg – 5 to 12t excavator)		73 m	22 m

There are no heritage listed structures/buildings within the existing school boundary. Moreover, there are no known places of Heritage significance within the immediate vicinity of the new Building H. Therefore, no structural damage to heritage listed buildings/structures are expected from the proposed construction works.

8.4 Mitigation measures & management procedures

Based on the predicted exceedances from the preliminary assessment above, there may be community reaction to noise and vibration impacts resulting from the construction of the new school building. Hence, all feasible and reasonable work practices should be implemented, and appropriate noise and vibration control measures developed, to limit exposure for all residences around the school site.

The following noise mitigation measures and management strategies must be considered for the project, with this section updated accordingly following a detailed noise impact assessment (when contractor engagement is confirmed, and detailed noise emission predictions of proposed activities and associated machinery is conducted).

8.4.1 Remedial actions

- Undertake appropriate site planning i.e. select site access points (e.g. access along Binalong Road will help mask some of the construction vehicle noise impacts with existing traffic noise along this sub-arterial carriageway, as opposed to having access points at Cornock Ave or Knox St), loading/unloading zone and stationary construction equipment (tower crane, concrete pumps, generators etc.) locations, so they are strategically located to maximise distance to surrounding residences and cause least disruption.
- Scheduling of works should consider staggering noisy activities (rock breaking, ripping, sawing and pneumatic hammering) by moving these activities to other locations around the site (increasing distance to the affected receiver) and reducing prolonged noise impacts to any particular receiver.
- Manage noise impacts exposure by introducing regular respite periods (e.g. +1 hour start at 7am and 1-hour respite period during lunch time).
- A review should be conducted with regard to selection of alternate equipment or process. Where it may be possible to select an alternative approach or appliance that emits lower noise levels, this should be considered (e.g. use of wheeled machinery in place of tracked machinery, electric tools etc.)
- Barriers or shrouding shall be considered as temporary mitigation to enclose particularly noisy equipment. Resilient mats in material handling areas can also greatly reduced noise impacts.
- For certain construction equipment/machinery, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.
- The contractor must ensure all equipment and machinery are regularly serviced and maintained at optimum operating conditions, to ensure excessive noise emissions are not generated from faulty, overused or unmaintained machinery.
- Training all staff working on site on the appropriate use of machinery/equipment and promoting good work practices (see Section 8.4.3 below) to minimise noise nuisance.

8.4.2 Noise and vibration monitoring plan

- Based on the construction noise predictions from a preliminary assessment (see Section 8.2.2), exceedances of both the noise affected and highly noise affected management levels are forecasted. Hence a noise monitoring plan should be developed during subsequent stages of the project (when a detailed construction noise and vibration impact study is undertaken) and should consider the following at a minimum:
  - Attended reference operational measurements are recommended prior to commencement of any works on site, to determine noisy activity/equipment applicable for the project and help collate information to facilitate accurate prediction of noise impacts and formulation of mitigation measures and strategies as required.
  - Noise monitoring will likely be required for R2 residential receivers (82-88 Binalong Rd & 5-12 Bora Pl, Toongabbie), given the proximity of these receivers to the proposed new school building site. The monitor should be installed at the receiver location prior to the commencement of the earthworks (i.e. before

excavation, sawing, rock breaking operations commence), to establish a benchmark to inform of the noise impacts from the proposed construction works.

  - Attended benchmark noise measurements are also recommended for R1 (83-95 Binalong Rd, Toongabbie), and R3 (12-16 Knox St & 60-64 Binalong Rd, Toongabbie) residential receivers for rock breaking, ripping, sawing and pneumatic hammering operations.
  - All acoustic instrumentation used to measure construction noise impacts, shall comply with the requirements of AS IEC 61672.1:2004 Electroacoustics - Sound level Meters-Specifications. Attended noise measurements should be conducted in accordance with the procedures outlined in Australian Standard AS1055 Acoustics - Description and measurement of environmental noise and in accordance with methods outlined in the NPfI. All sound level meters must have a current calibration certificate from a NATA accredited laboratory in accordance with NATA guidelines. Instrument calibration shall be checked before and after each measurement survey, with the variation in calibrated levels not exceeding + 0.5 dB.
  - Benchmark and reference measurements should be analysed to determine the duration and extent of construction noise monitoring.
  - Noise monitoring exceedances should be reviewed to accurately inform of the noise impacts to surrounding receivers. Additional management strategies should be devised as required, to control impacts.

- Given the proximity of R2 residential receivers (82-88 Binalong Rd & 5-12 Bora Pl, Toongabbie), there is also potential for vibration impacts from earthworks and compacting activities, based on the safe working buffer distances detailed in Table 8-3. This is primarily only expected to impact on human comfort, with structural damage impacts unlikely for the project.
  - Benchmark vibration monitoring is recommended for R2 residential receiver, for any ripping, rock breaking and rolling operations proposed within the safe buffer distances.
  - The vibration monitors must be installed on the ground floor slab or nearest affected external wall of the residential property.
  - The benchmark testing will inform on the vibration velocity levels generated at the receptor location for a specified activity, which can then be assessed against the project vibration criteria (see Section 5.4) to determine the duration and extant of vibration monitoring.

8.4.3 Work practices

The following guidelines of good construction work practices should be communicated and practiced by all construction personnel, to manage and reduce annoyance from standard site operations/procedures.

- No amplified music or use of radios.
- Use designated access pathways.
- Use designated routes for materials.
- Locate disposal bins away from sensitive receivers.
- Stationary plant should be place as far away as possible from sensitive receivers.
- Turn off plant and equipment when not in use (this includes trucks idling).
- Avoid heavy handling or materials and equipment (i.e. do not drop items).
- Ensure construction materials and equipment do not obstruct operational areas such as public roads.
- Avoid shouting within the site.

8.4.4 Community consultation and complaints handling

The contractor must be committed to ensure that the local community is well informed about the construction activities. Any complaints regarding environmental noise emissions from the construction site are to be recorded and investigated.

A Community and Stakeholder Management Plan and communication method will be established to respond to all construction related enquiries and to ensure any complaints regarding environmental noise emissions and vibration resulting from the road works and construction activities is recorded and investigated.

- Provide in the form of notification letters, information pamphlets, and/or progress updates in due time with information such as overall project timeline, what works are expected to be noisy, duration and frequency of noisy works, what is being done to minimise noise and when respite periods will occur.
- Maintain good communication between the community and project staff and appoint a community liaison officer to facilitate where required.
- Complaints should be treated sensibly and be given a fair hearing in consultation with communications personnel and stakeholders and an acoustic consultant.
- Have a documented complaint process, including an escalation procedure so that if a complainant is not satisfied there is a clear procedure.
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
- Implement all feasible and reasonable measures to address the source of complaint.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, time of verbal response and timeframe for written response where appropriate.

In some cases, it may be necessary that two or more control measures be implemented to minimise noise. It is recommended that the above noise management measures be implemented into a construction noise management plan.

9 Conclusion

Aurecon was engaged by SINSW to undertake an acoustic assessment of the potential noise and vibration impacts associated with the redevelopment of the Pendle Hill High School, located at Cornock Avenue, Toongabbie. The redevelopment at this stage is proposed to include the construction of a new three-storey school building '*Building H*' and overall improvement of street presence.

- The relevant noise and vibration criteria applicable to the project are detailed in Section 5, with project specific external (road traffic) noise intrusion, operational noise emissions and construction noise criteria presented in Table 5-1, Table 5-5 and Table 5-8 respectively. Construction vibration limits are specified in Section 5.4.
- An external (road traffic) noise intrusion assessment was undertaken and recommendations for external building fabric construction, to comply with the recommended internal design noise levels, are detailed in Section0. Ventilation requirements to ensure internal acoustic amenity is not compromised is detailed in Section 6.2.5.
- Operational noise impacts associated with the redevelopment project were also assessed in Section 7, for the following key noise sources:
  - Increased student capacity on outdoor play areas ***(Assessment 2a)*** – Section 7.1
  - Building services plant, public address system and school bell servicing Building H ***(Assessment 2b)*** – Section 7.2
  - Additional traffic on surrounding public road network ***(Assessment 2c) –*** Section 7.3

  In general terms, based on the discussions and provided the considerations and management strategies outlined in this section of the report are followed, noise levels emitted from the operations of the redevelopment school, will be able to meet the relevant project operational noise limits.
- A preliminary assessment of potential noise and vibration impacts resulting from construction operations was also undertaken in this study. Exceedance of both the noise affected and highly noise affected management levels are predicted for some residential receivers around the site (see Section 8.2.2), based on the indicative equipment/machinery likely to be used for the expected construction works. Safe working buffer distances have also been noted for vibration intrusive plant in Table 8-3.

  A detailed construction noise and vibration impact study is recommended during subsequent stages of the project (when a detailed programme and construction methodology is developed), to accurately determine the level of impact on surrounding affected receivers and develop site-specific management strategies. Typical mitigation measures and management procedures that need to be considered are presented in 0.

A

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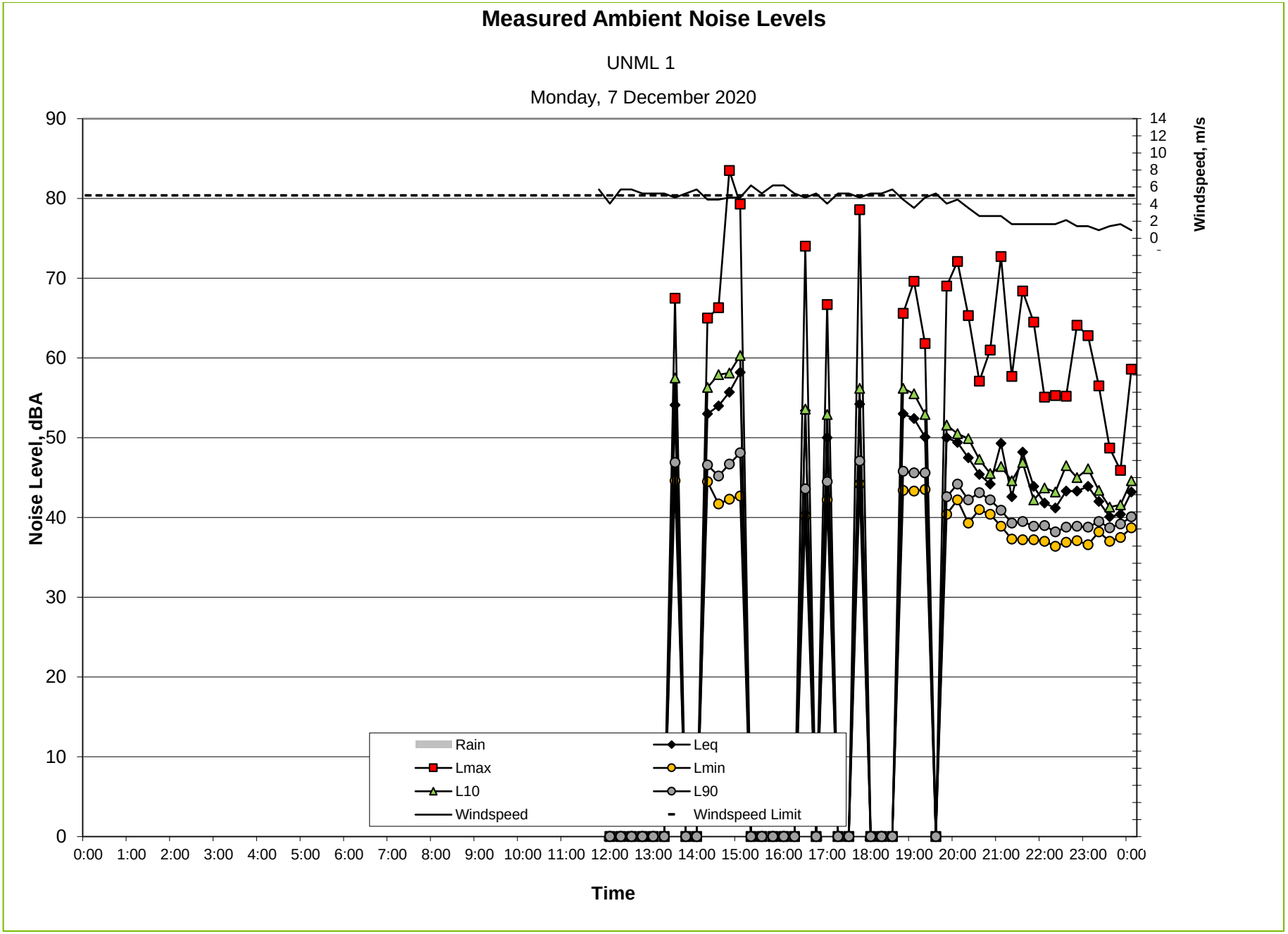
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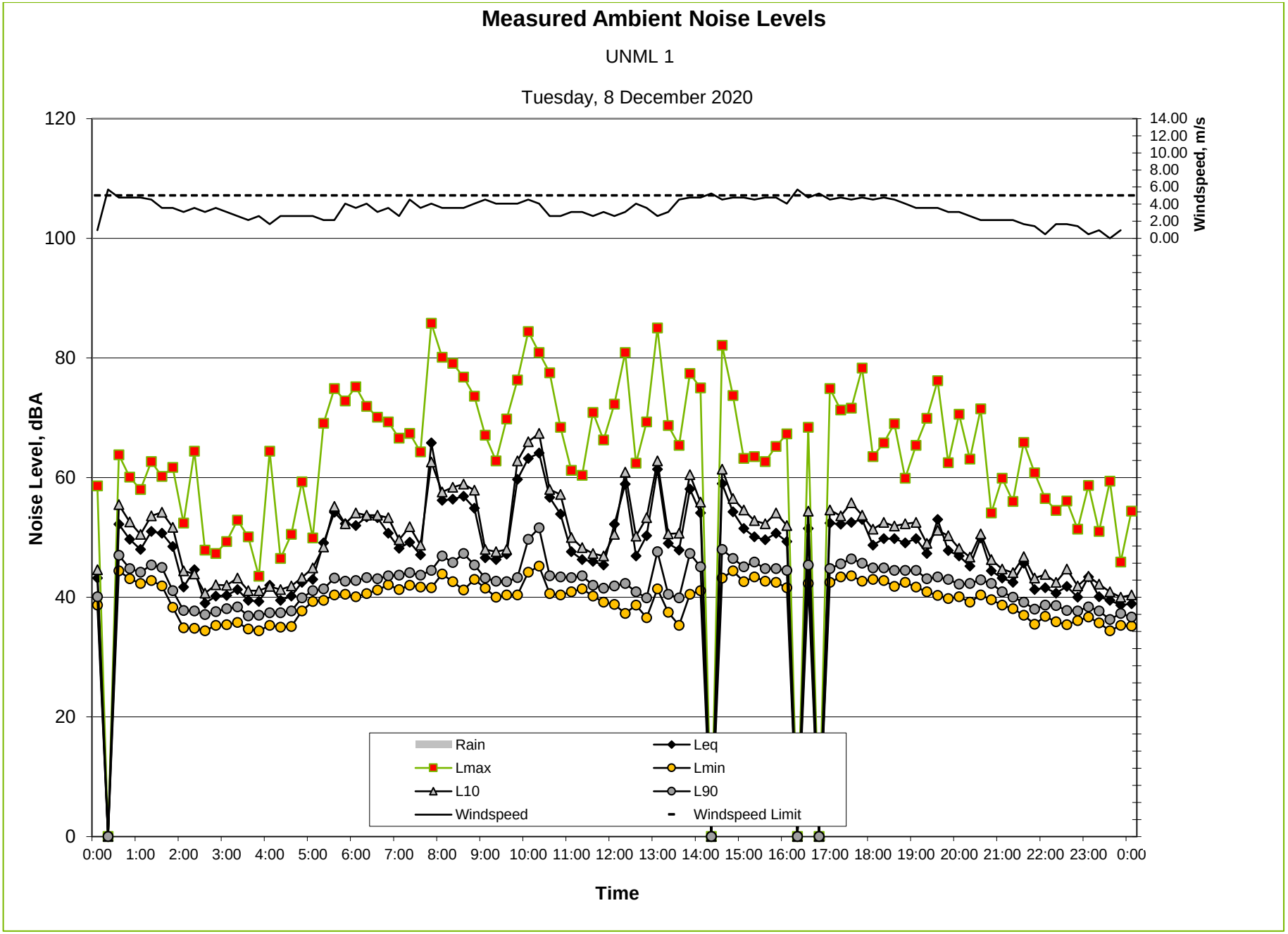
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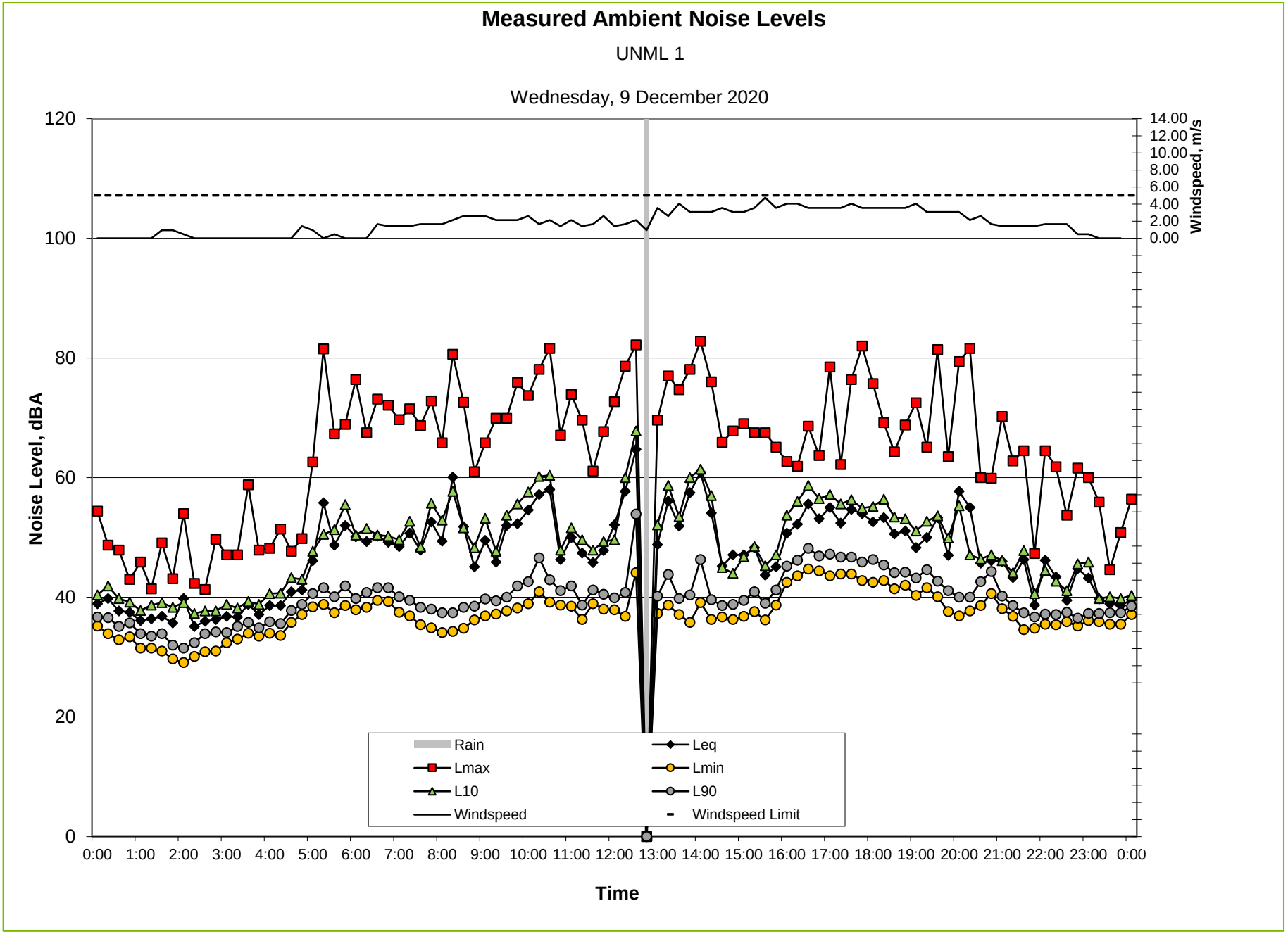
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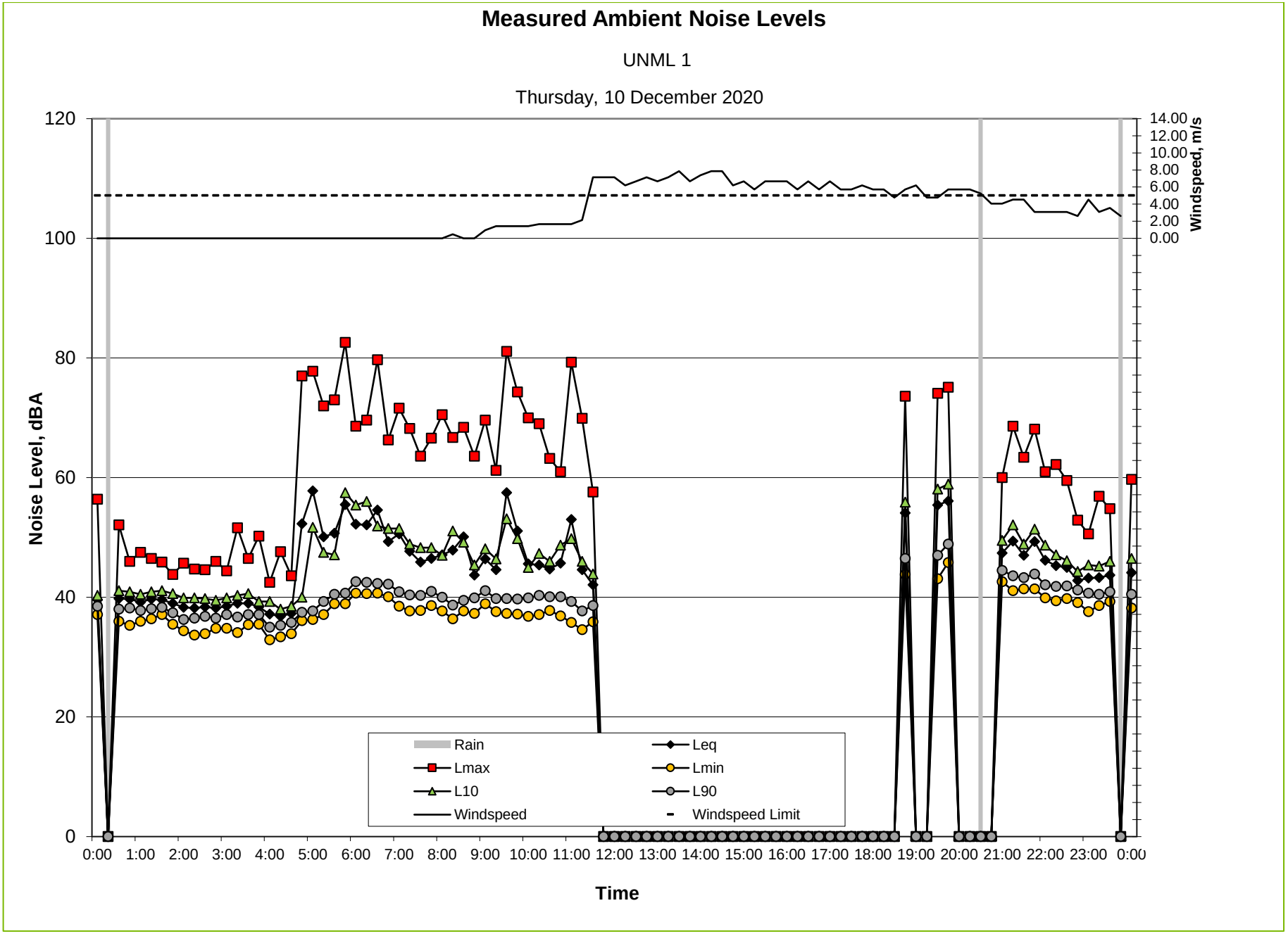
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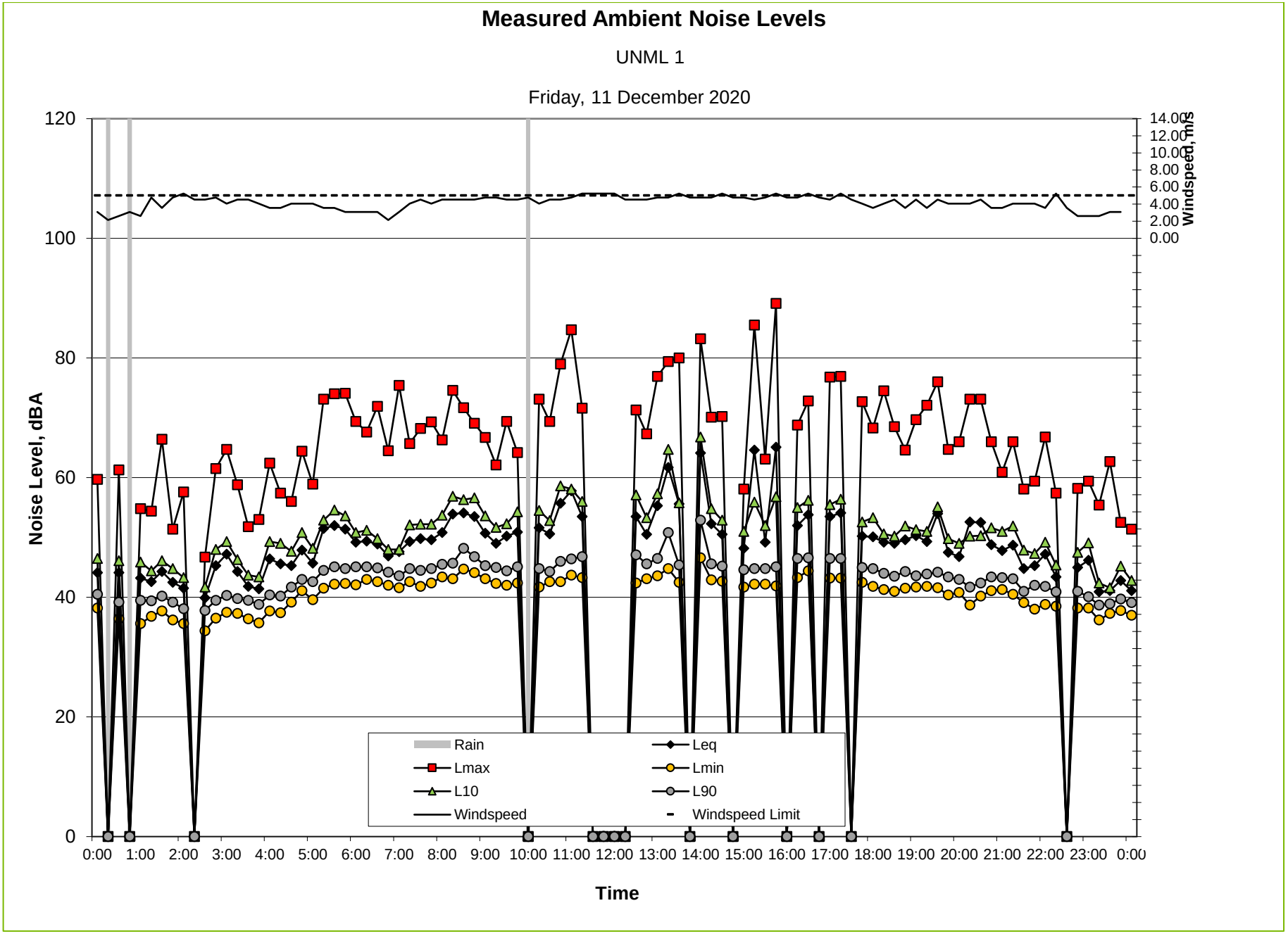
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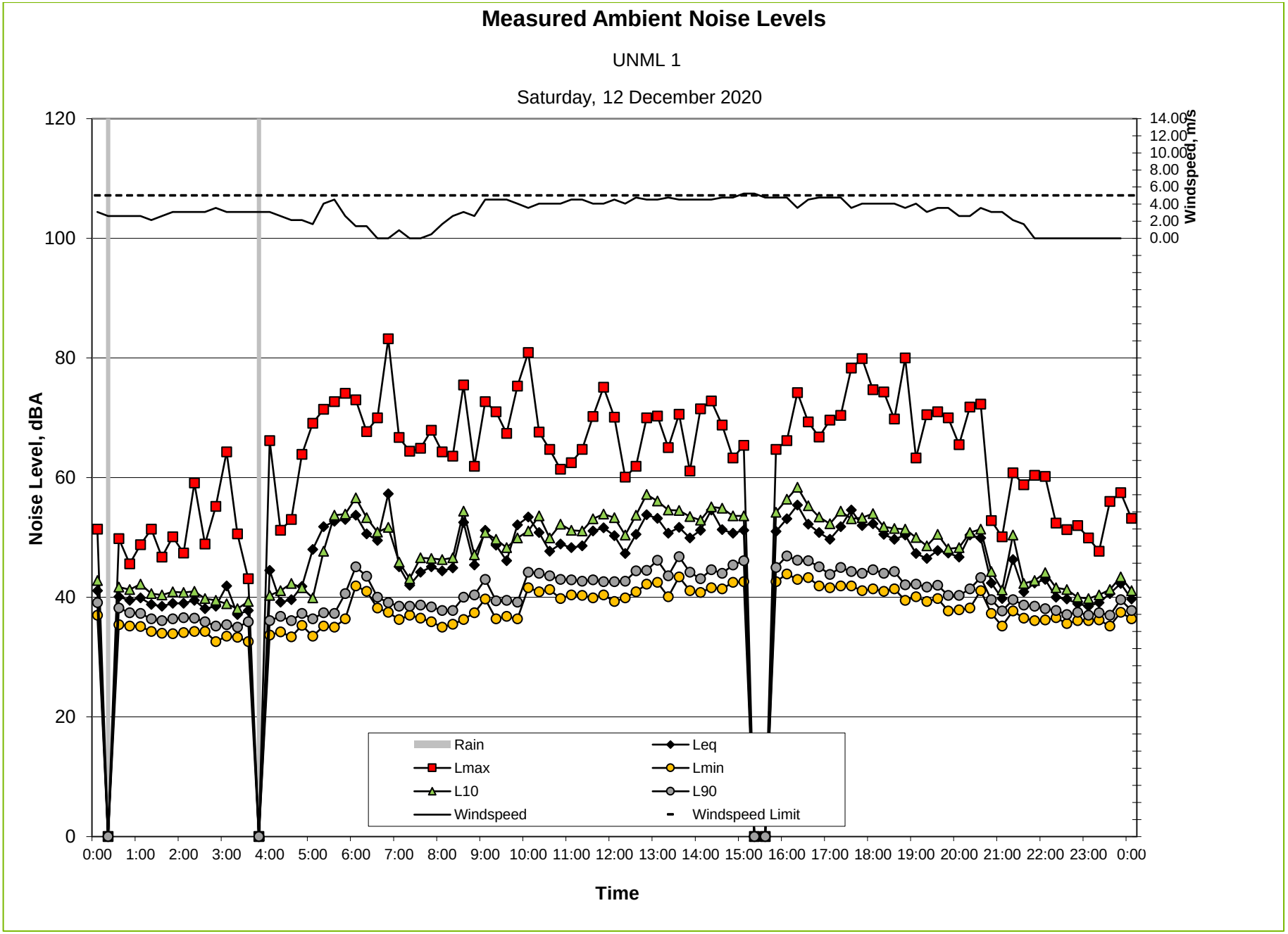
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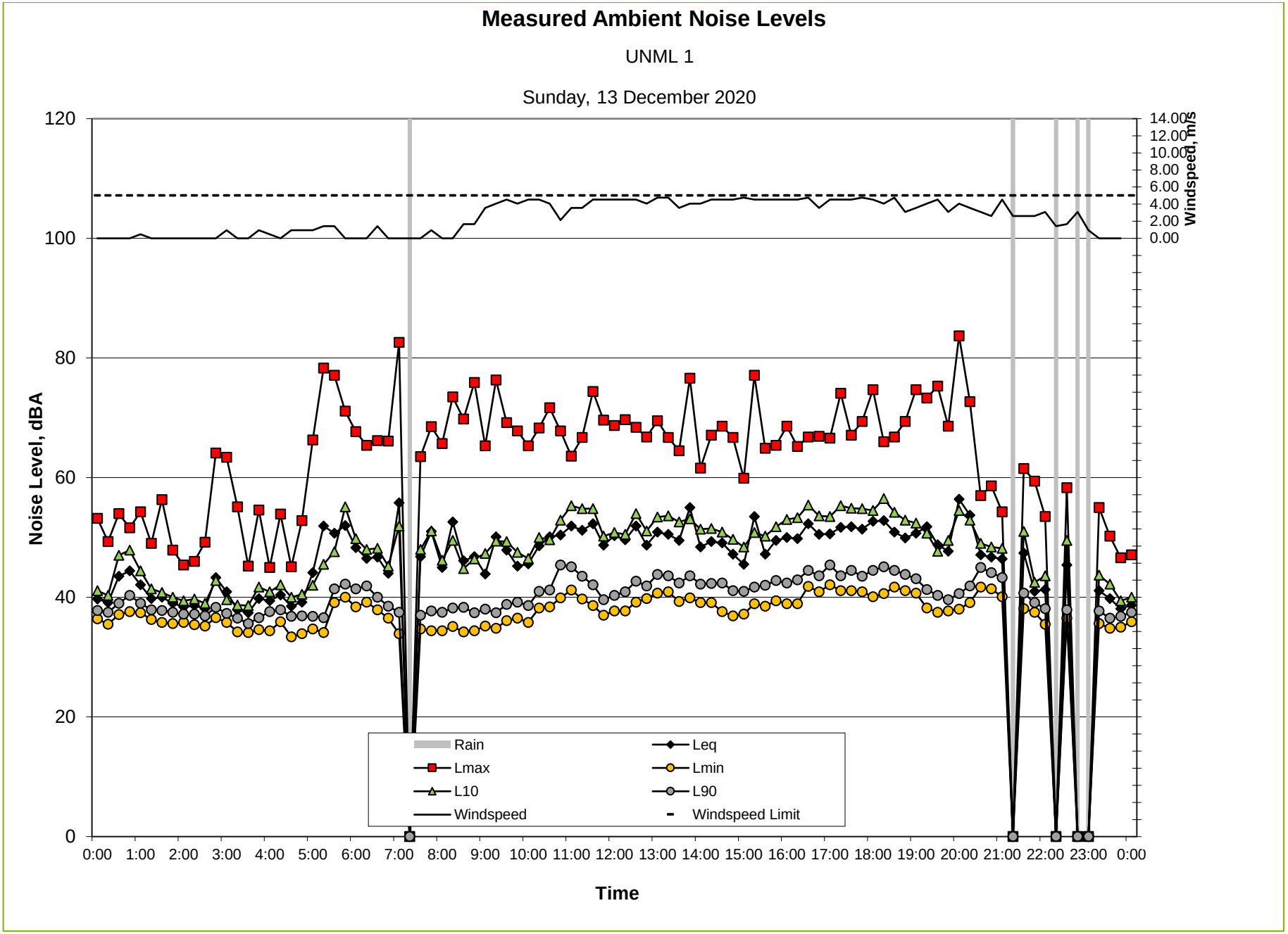
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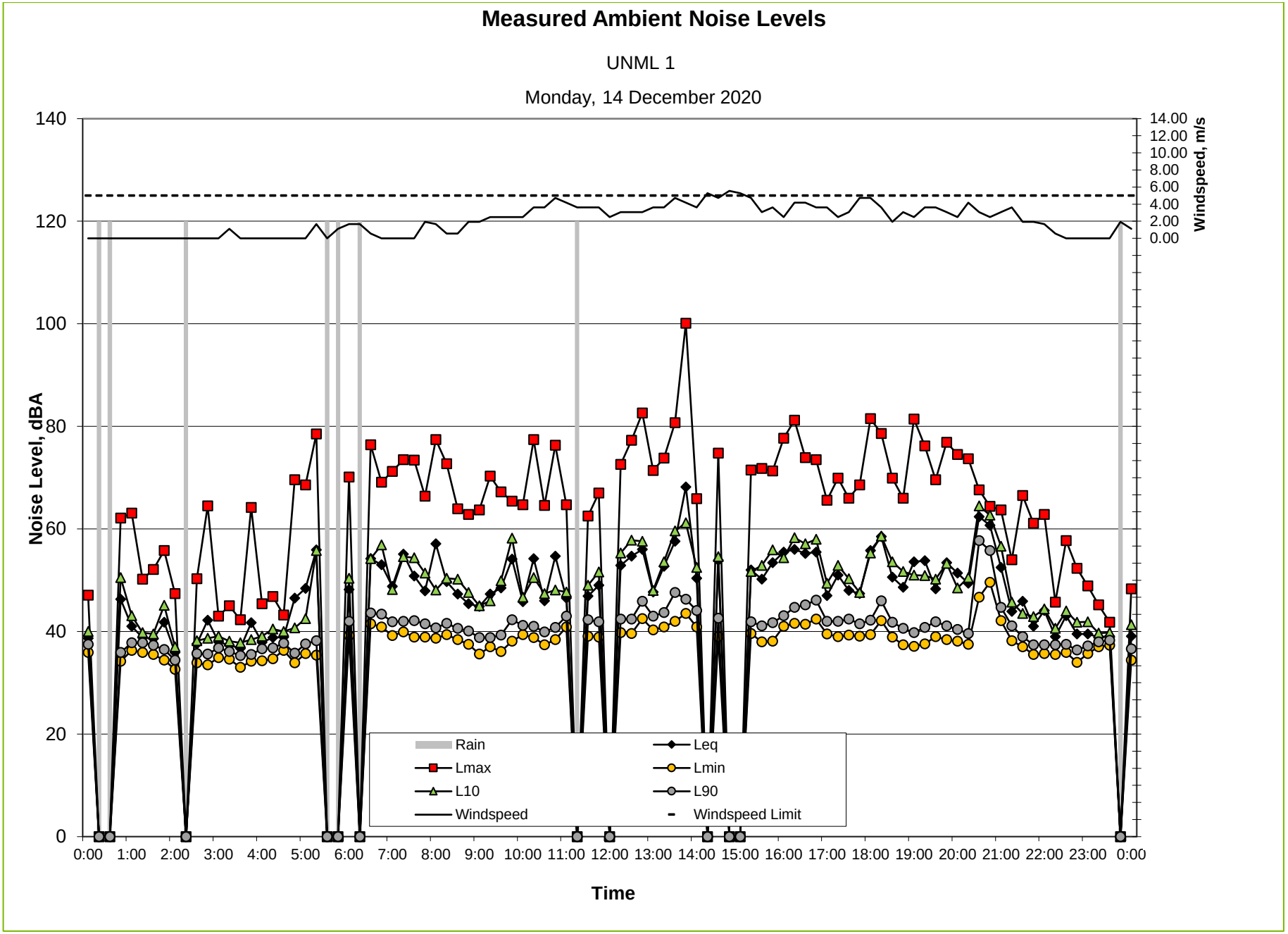
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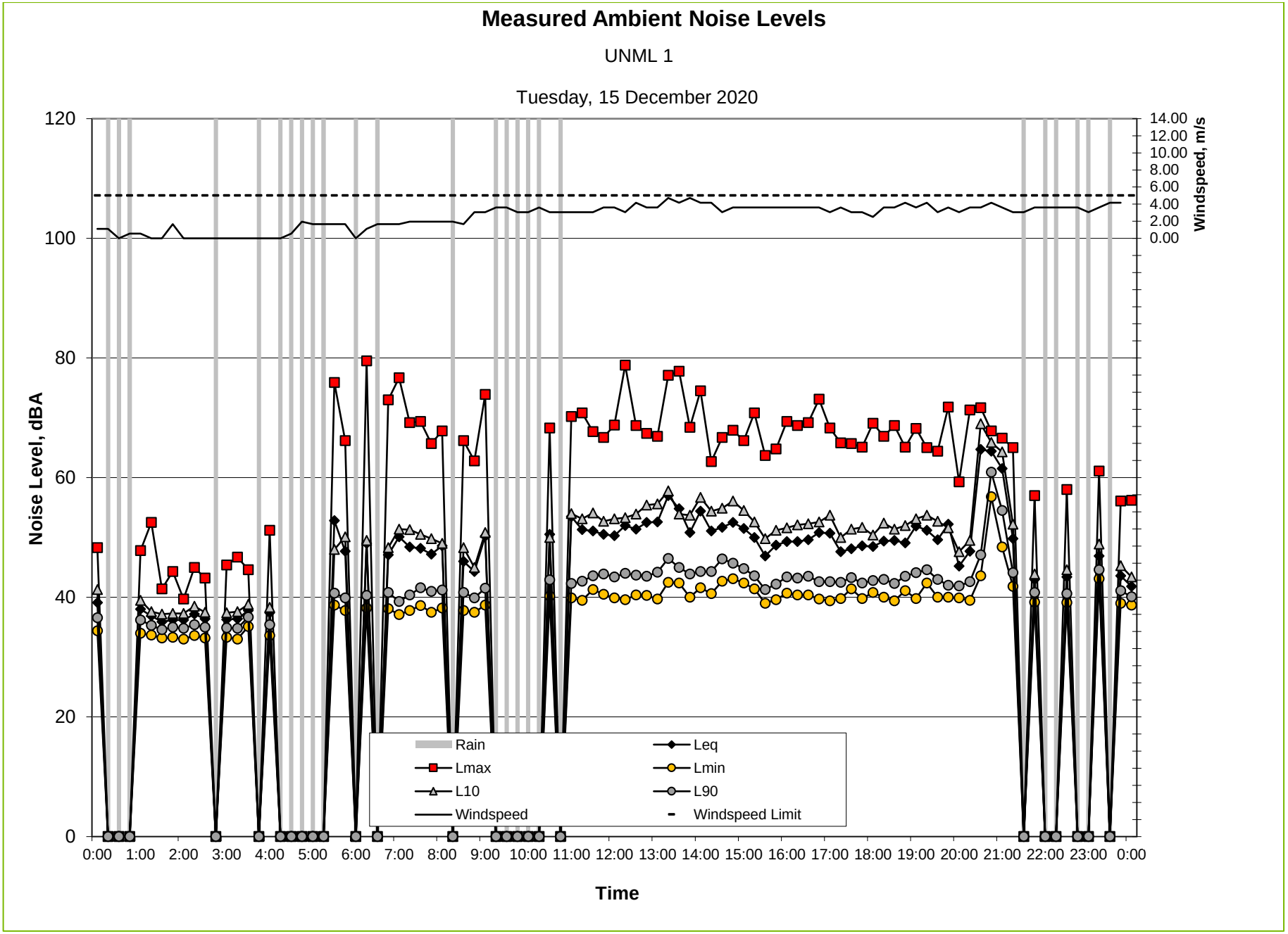
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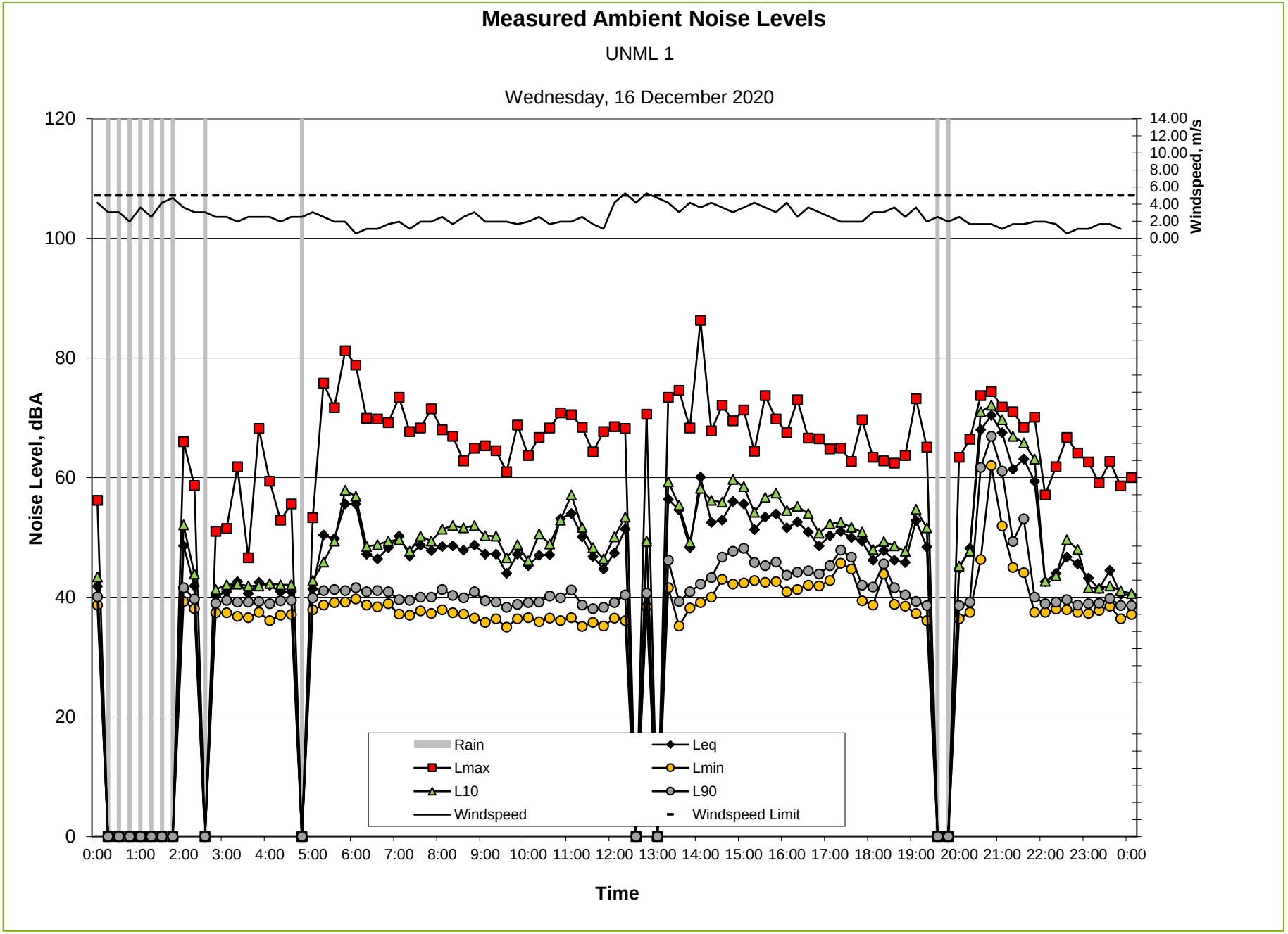
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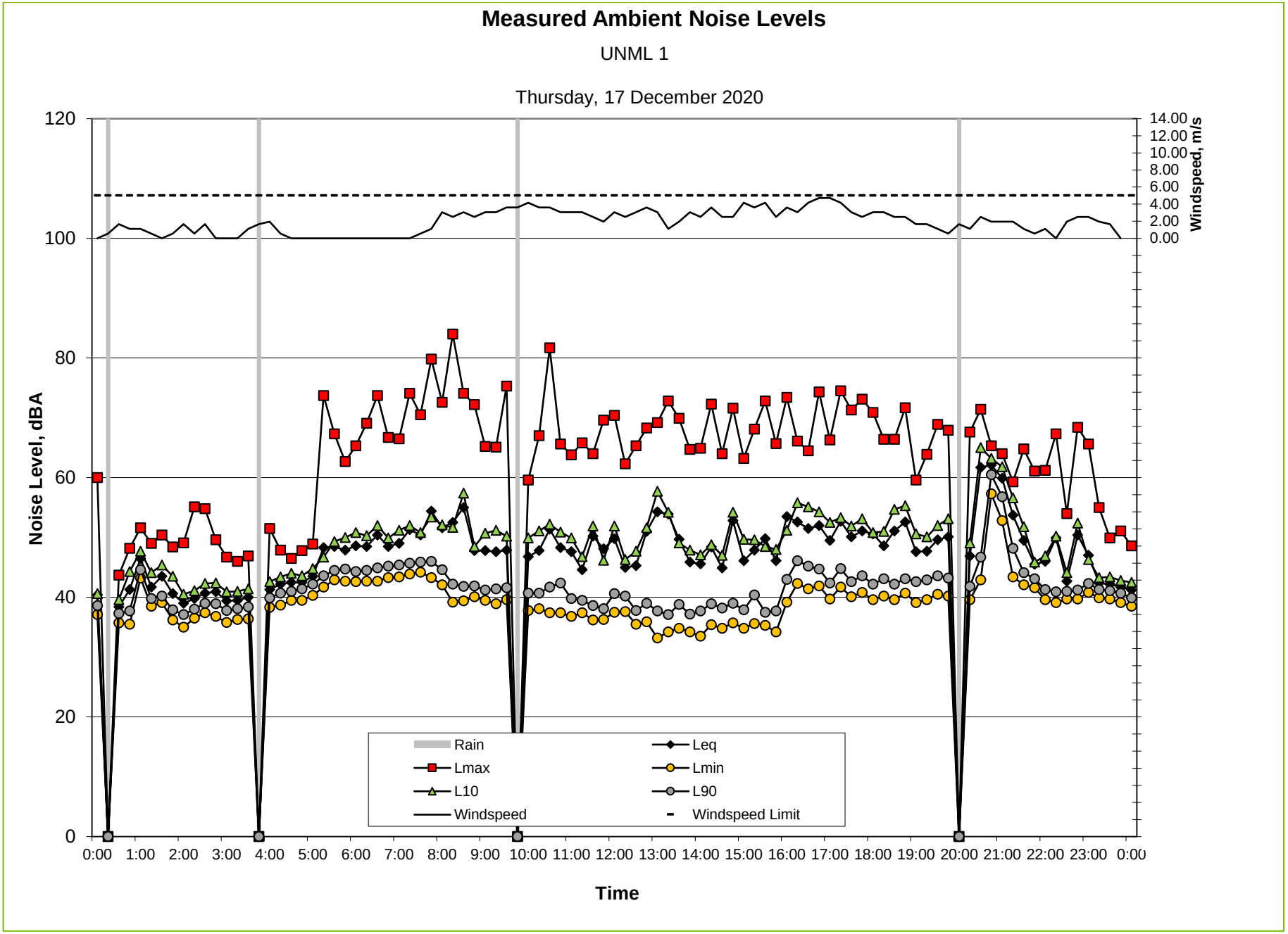
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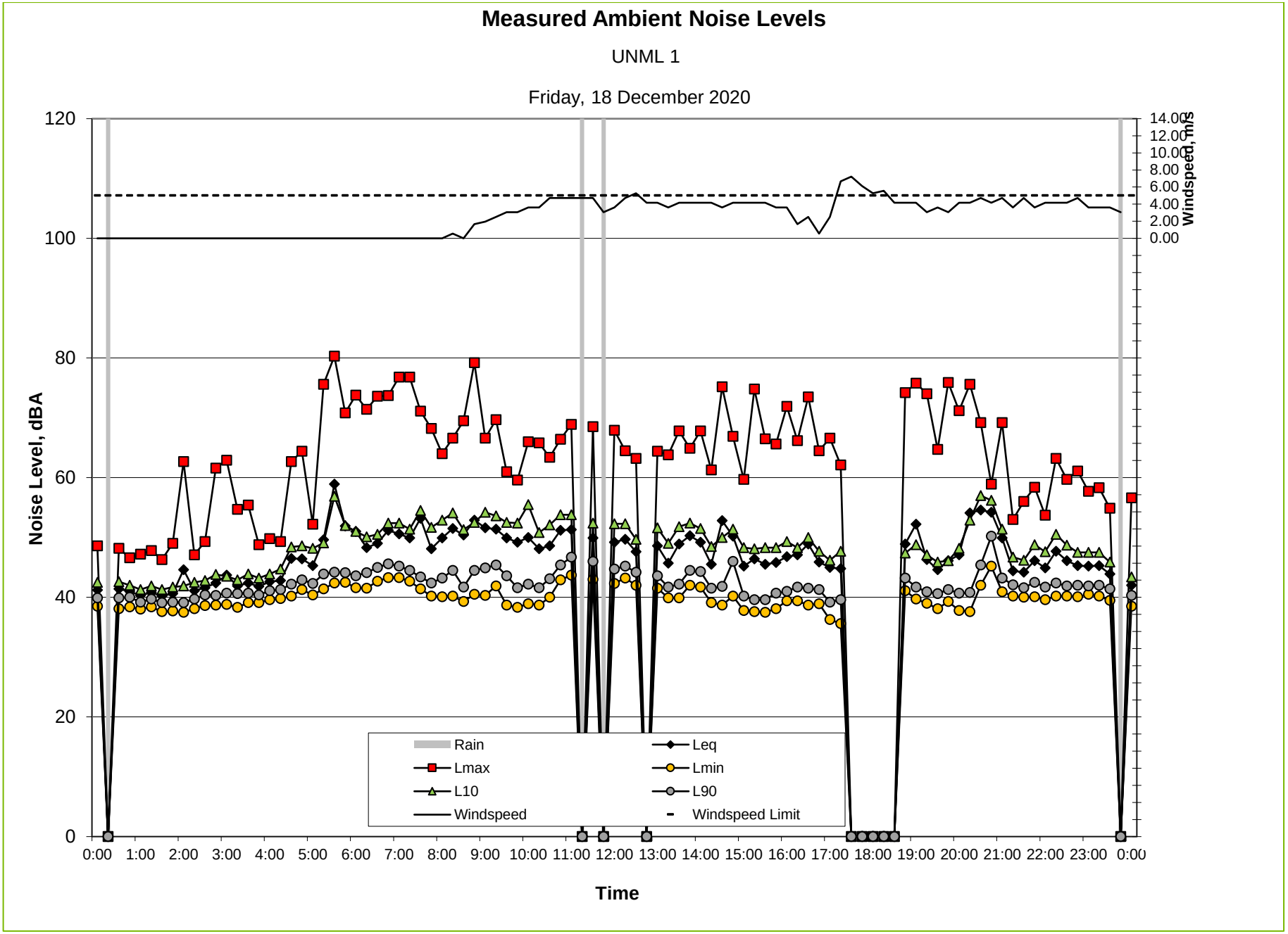
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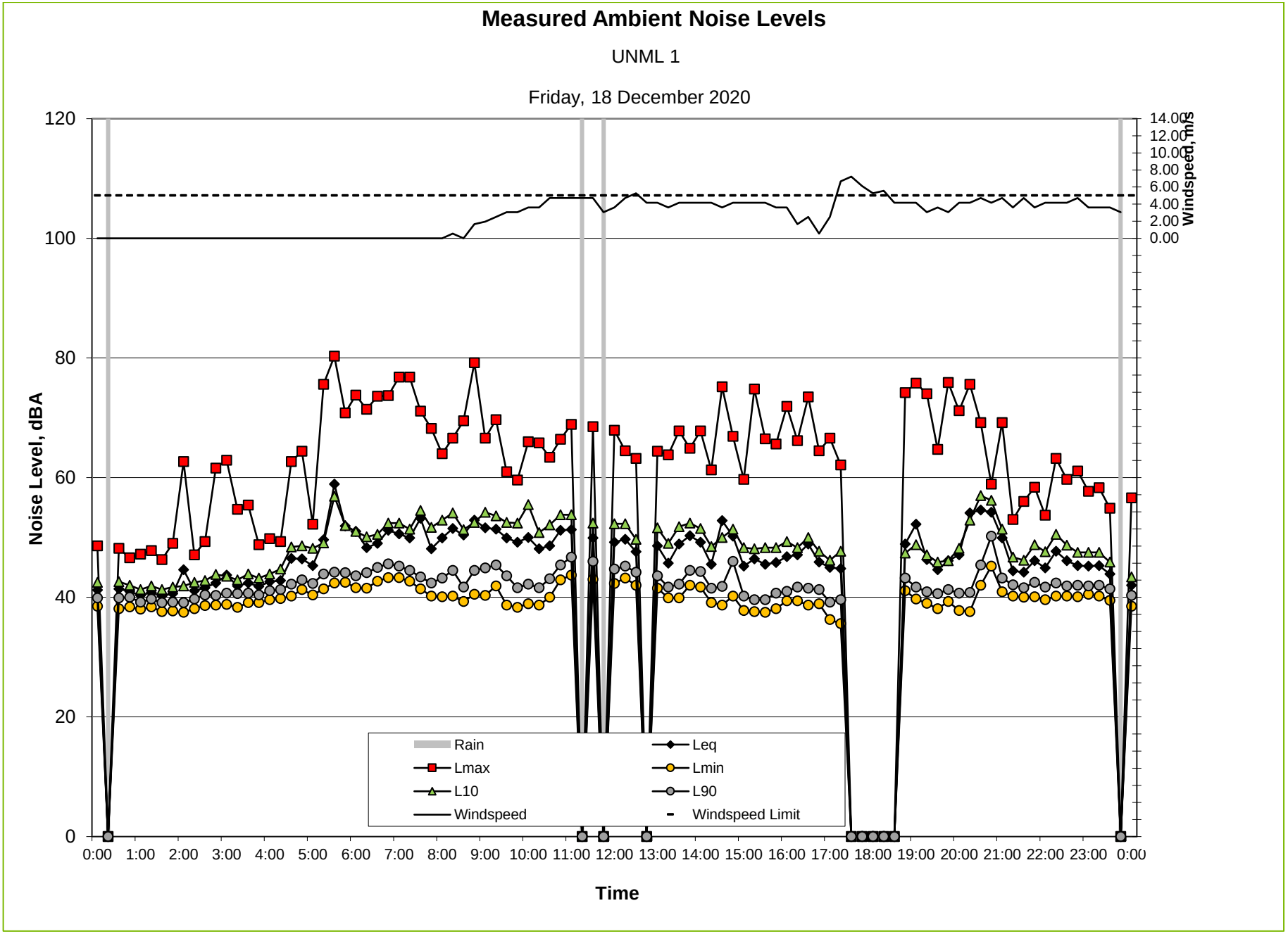
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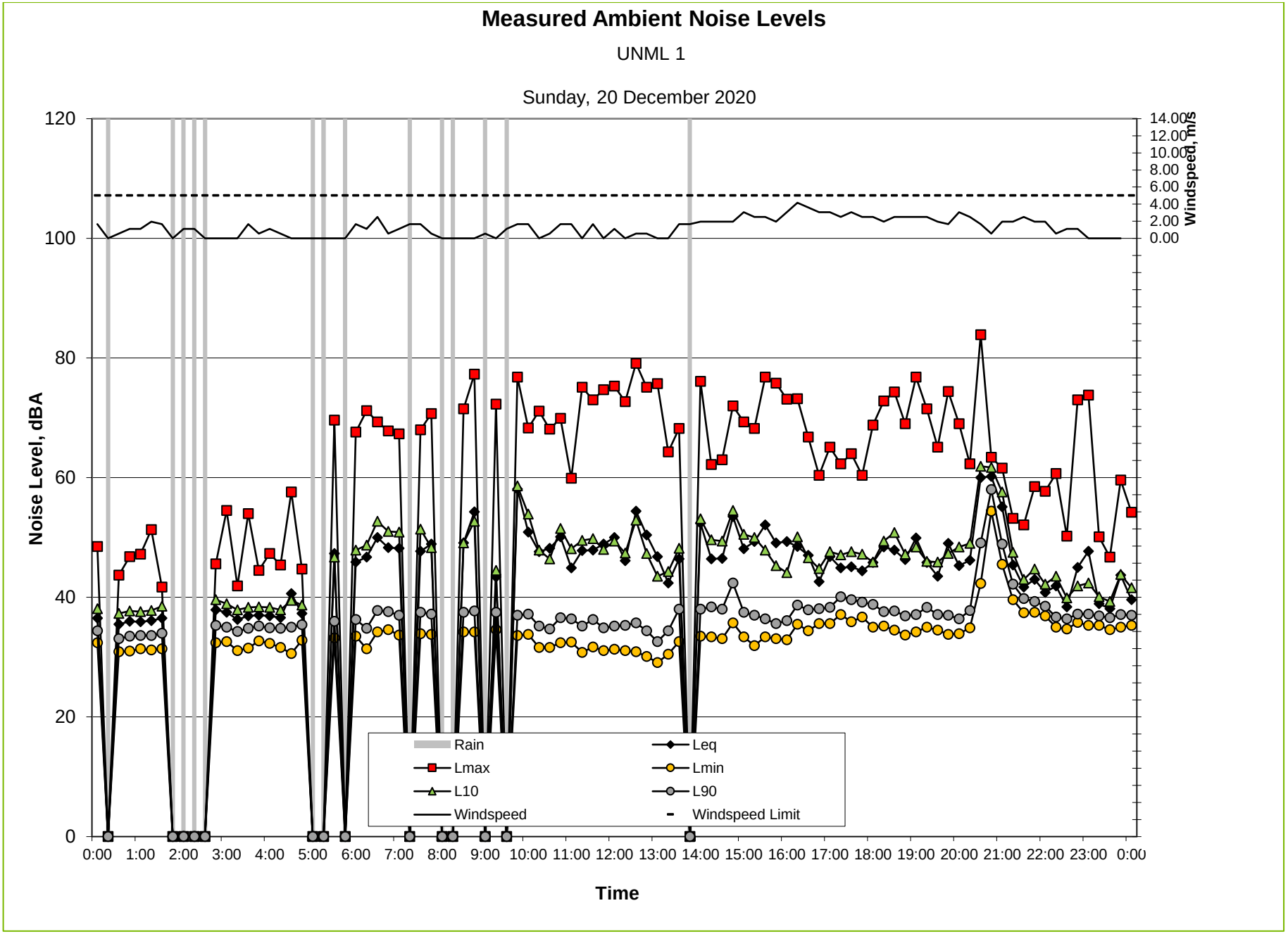
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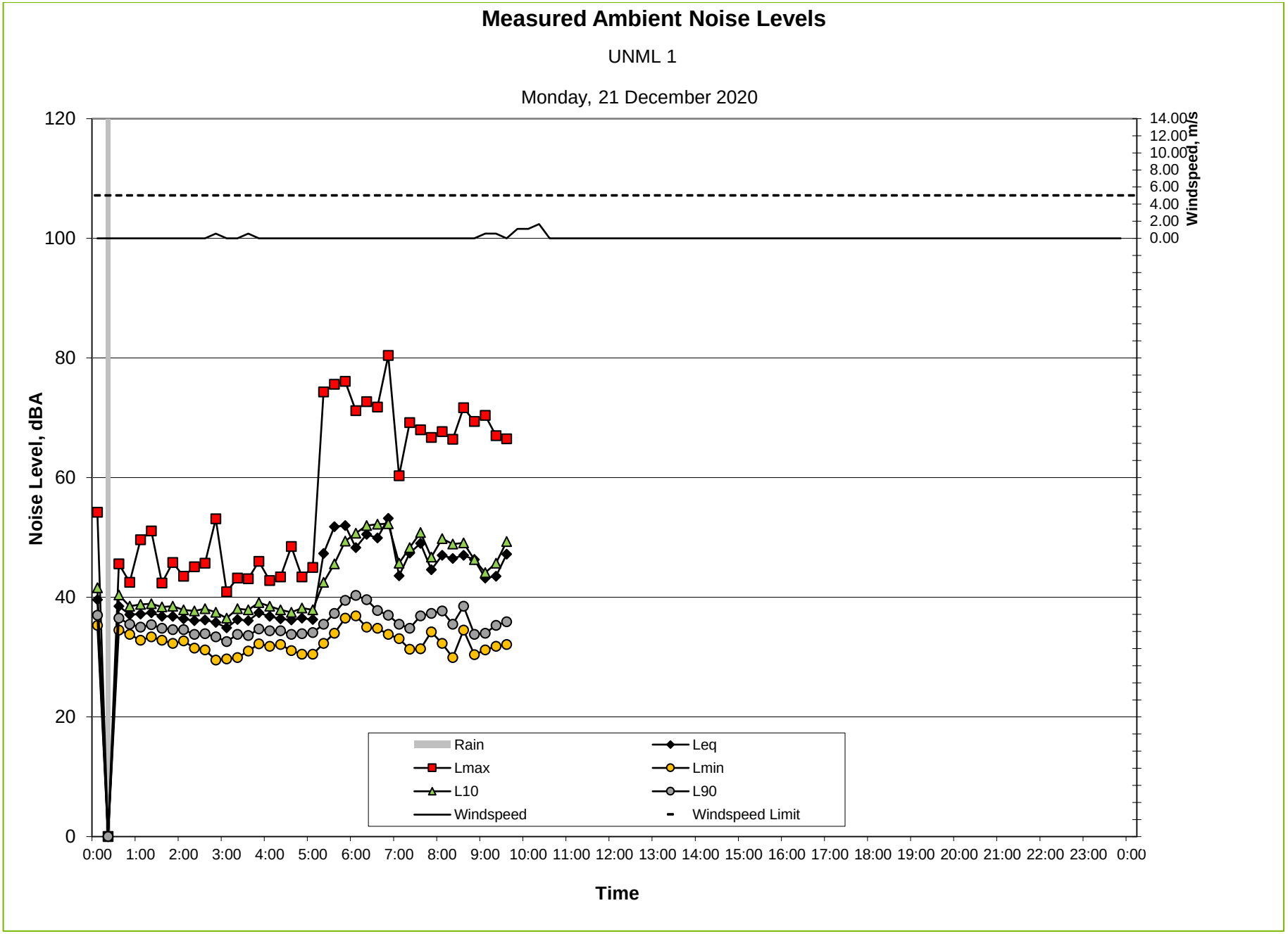
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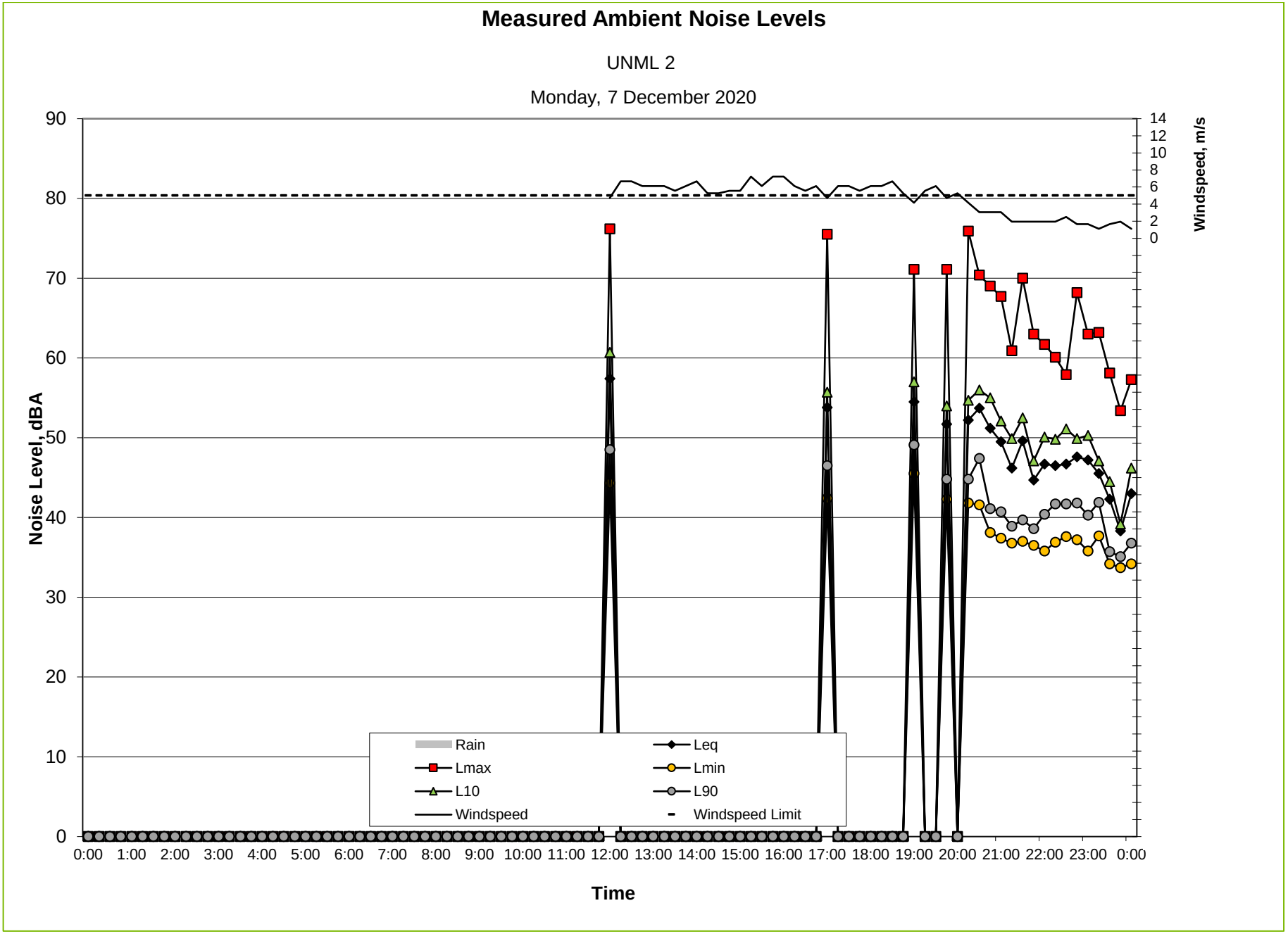
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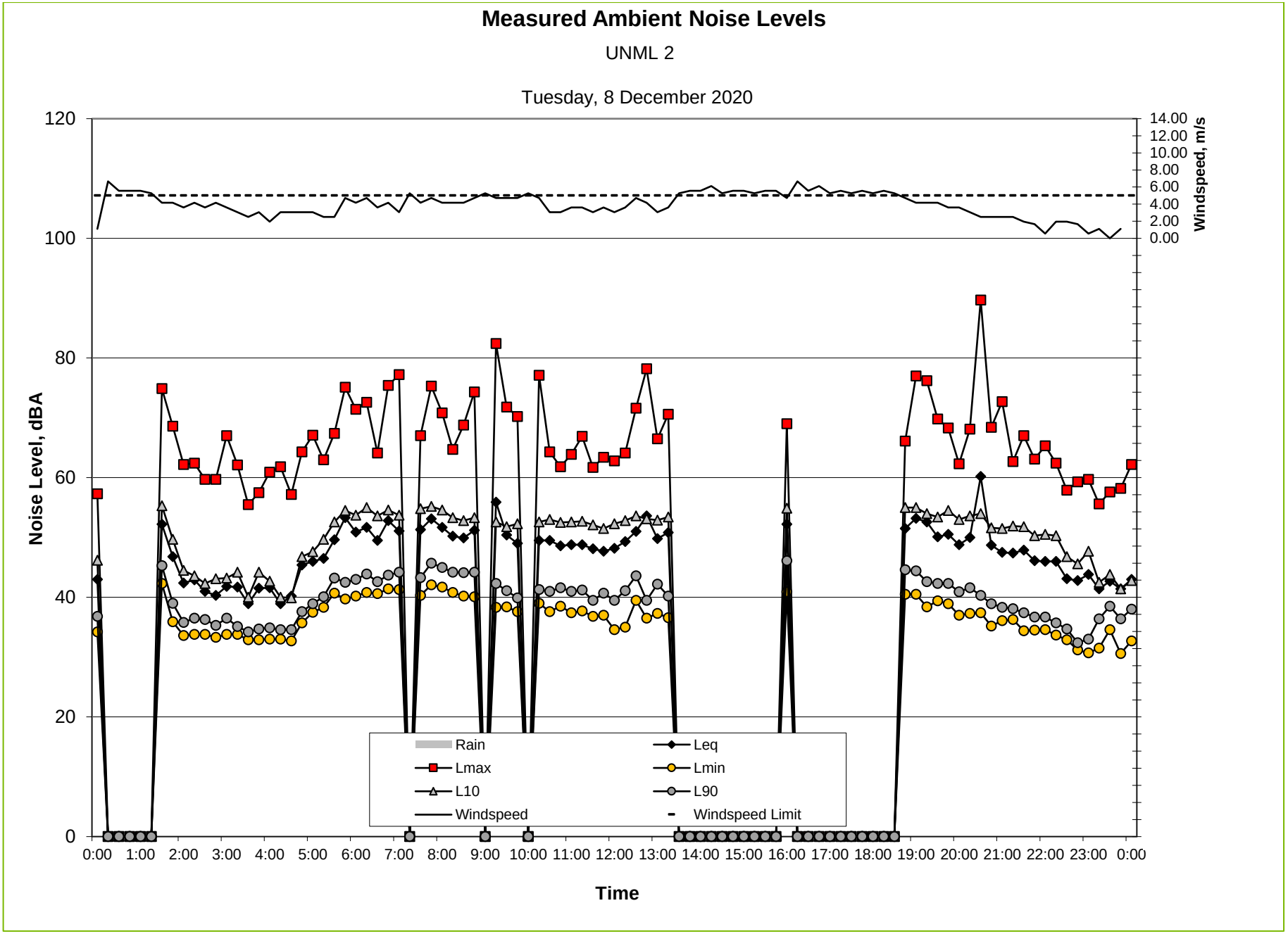
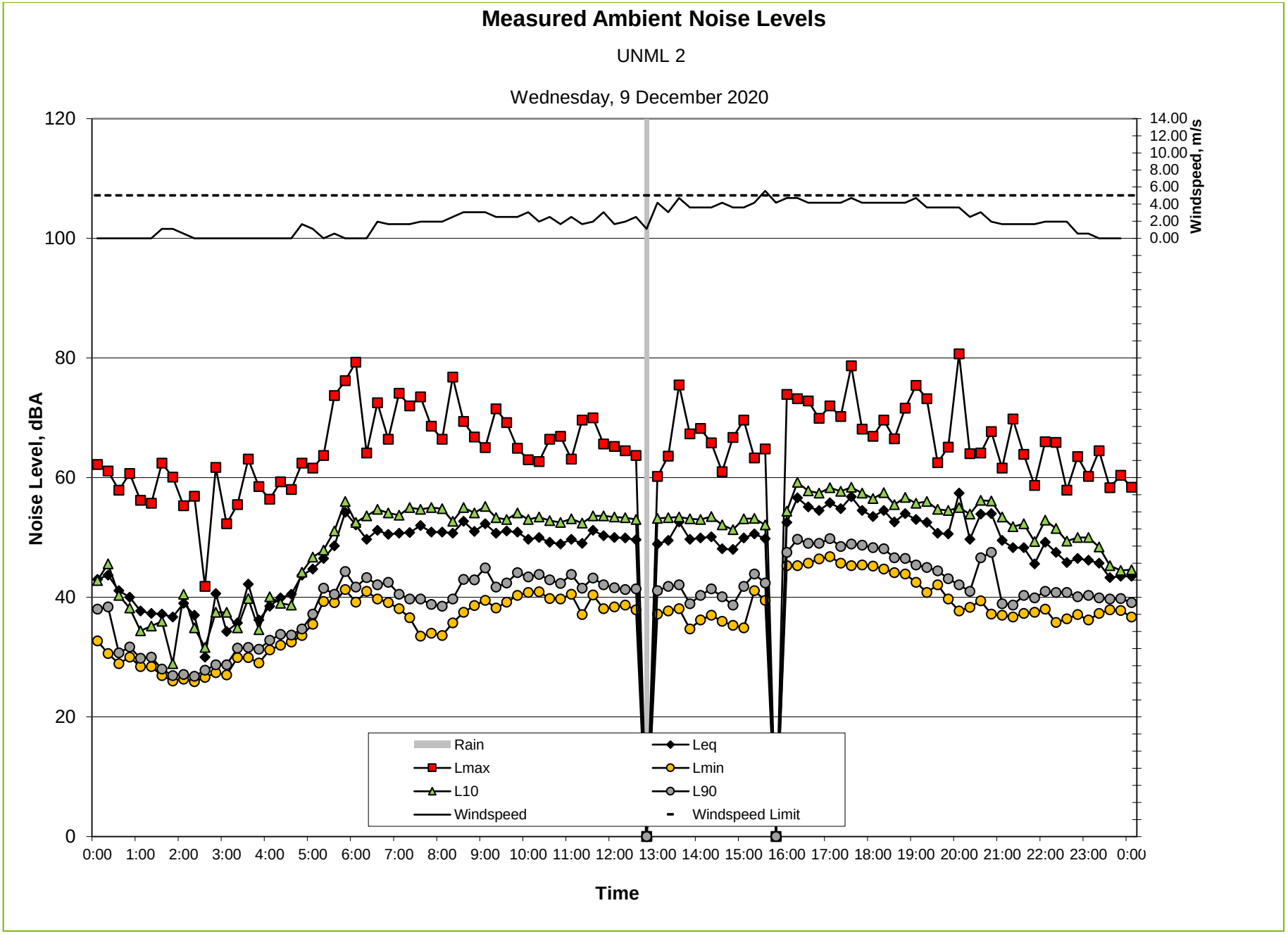
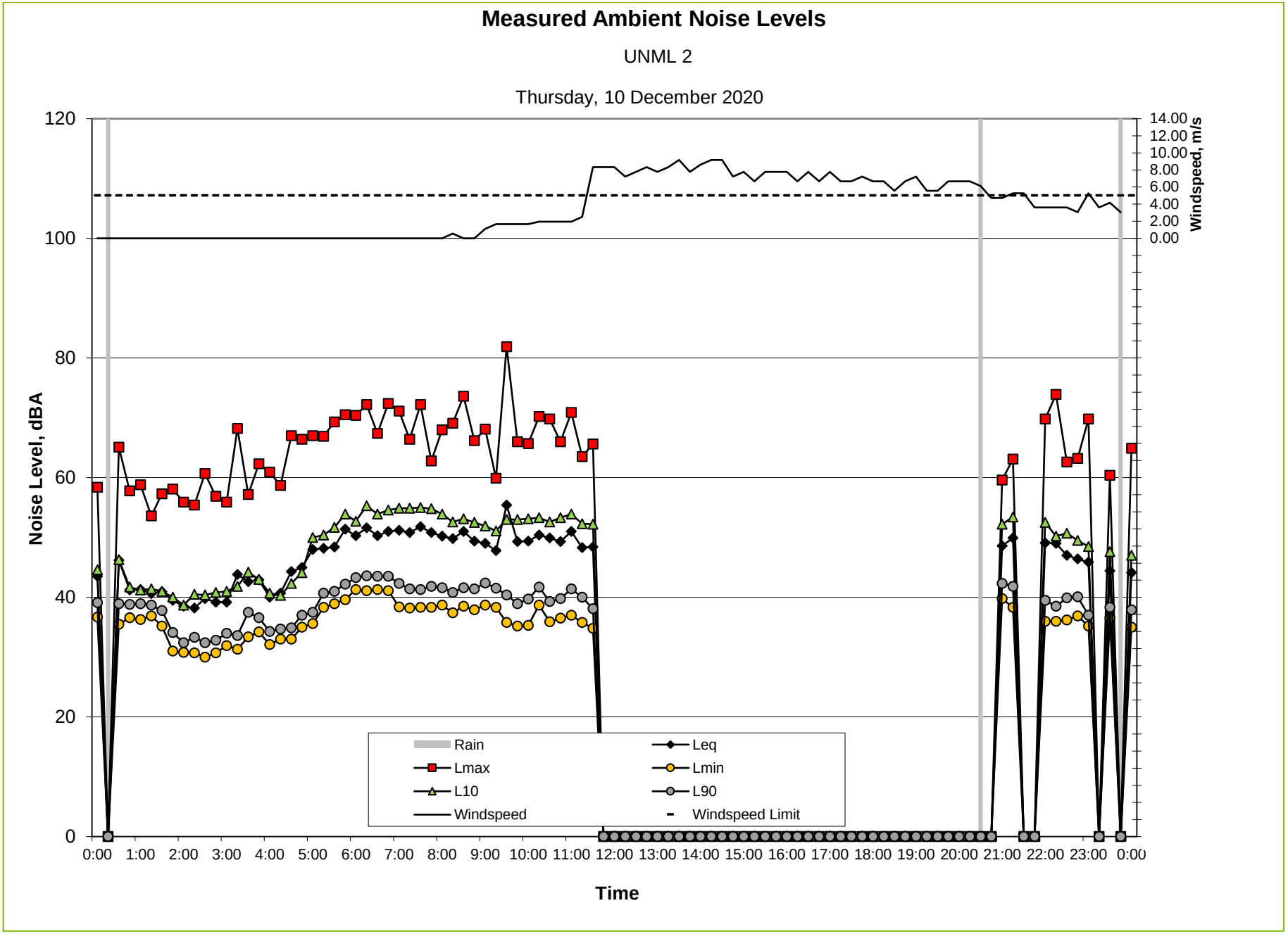
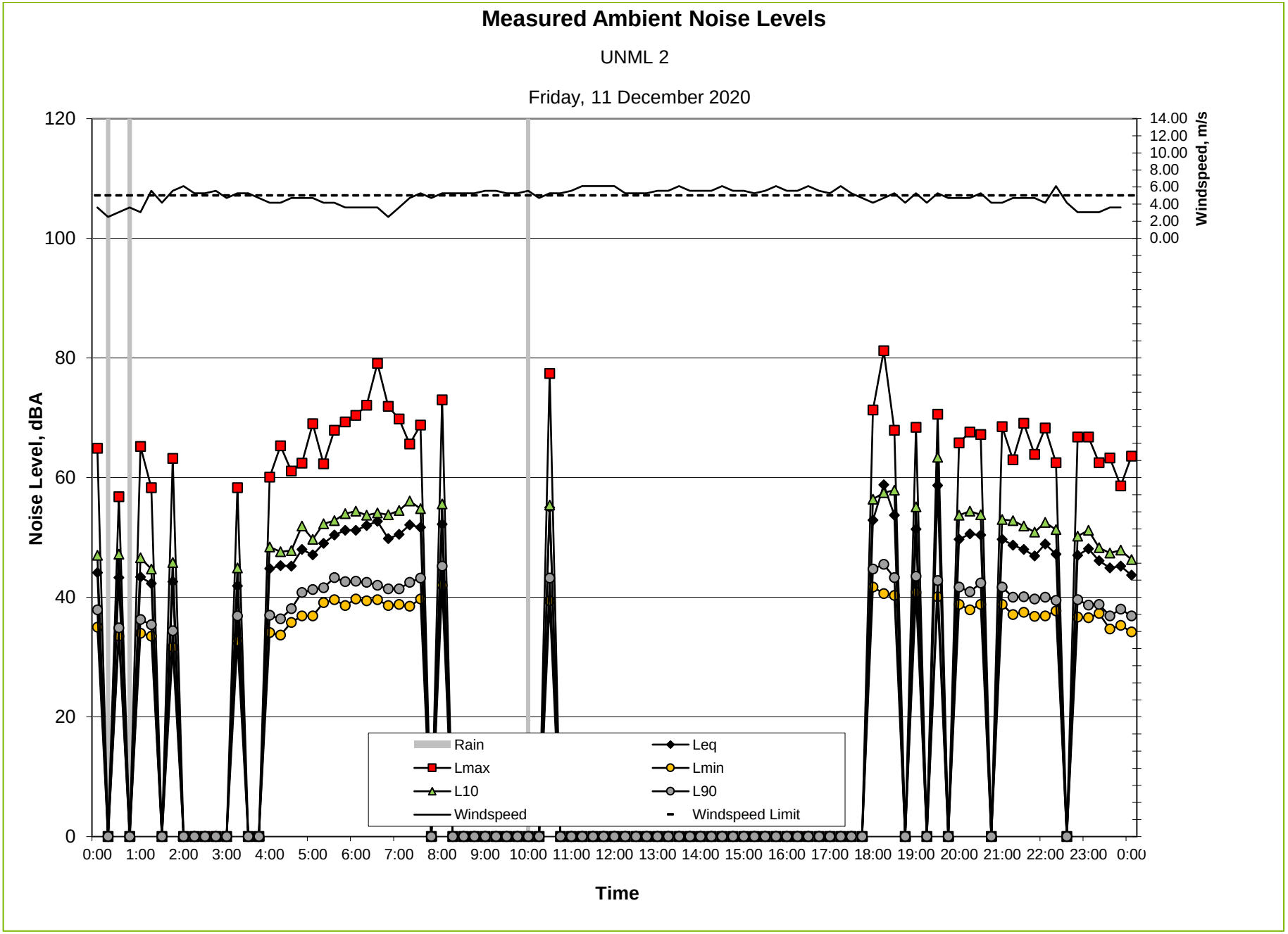
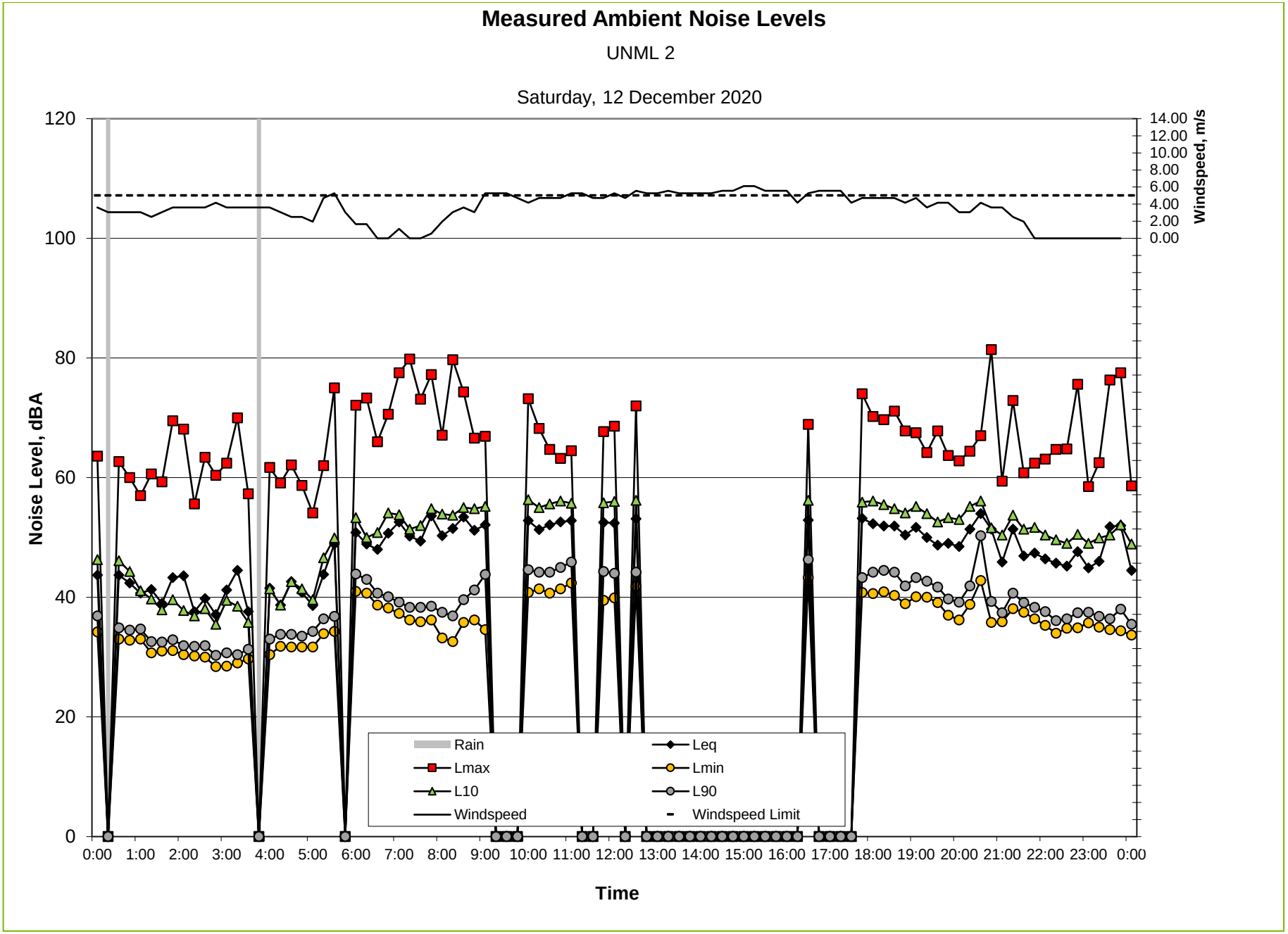
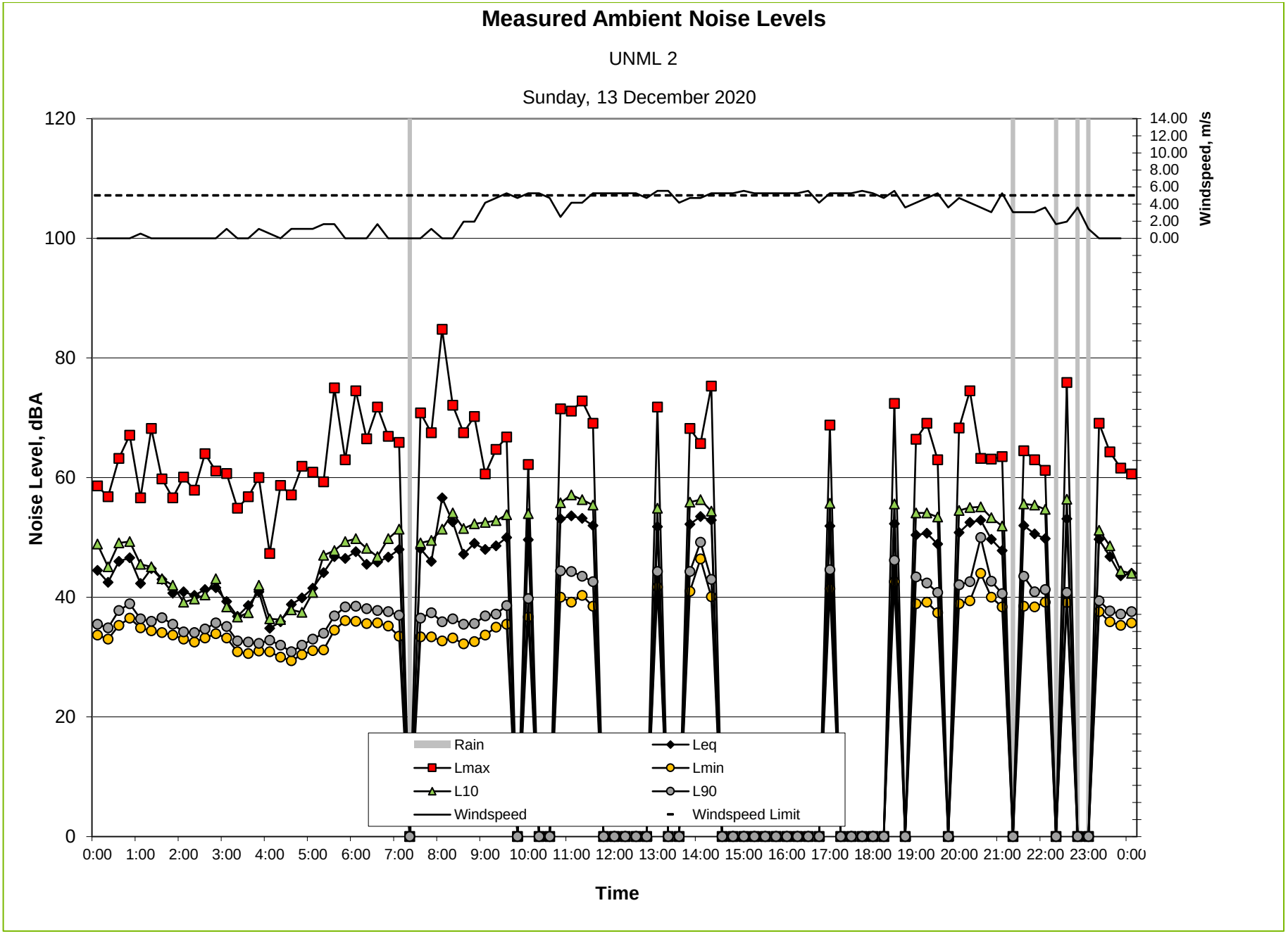

Measured Ambient Noise Levels
UNML 2
Tuesday, 8 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit

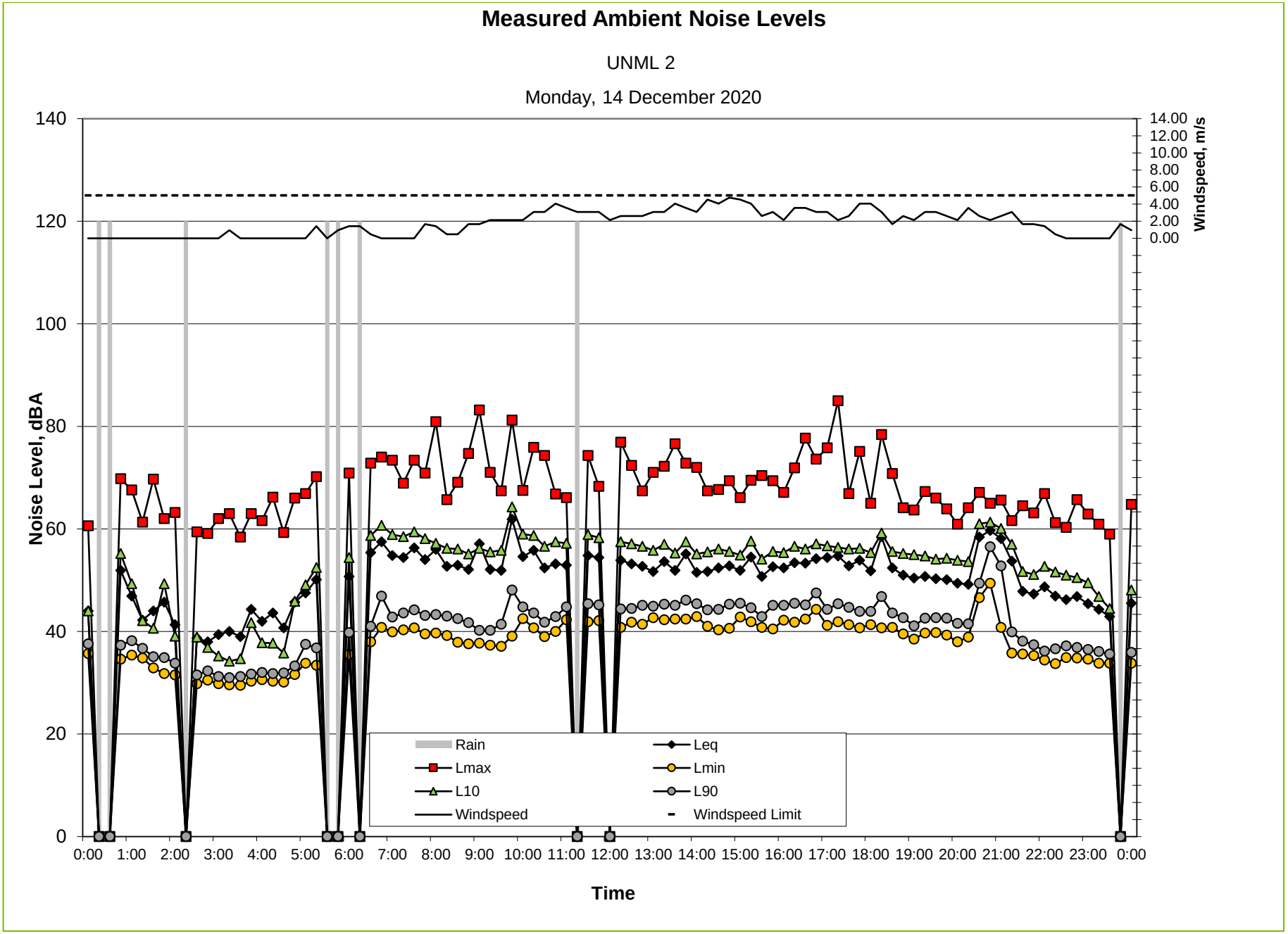

Measured Ambient Noise Levels
UNML 2
Wednesday, 9 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit

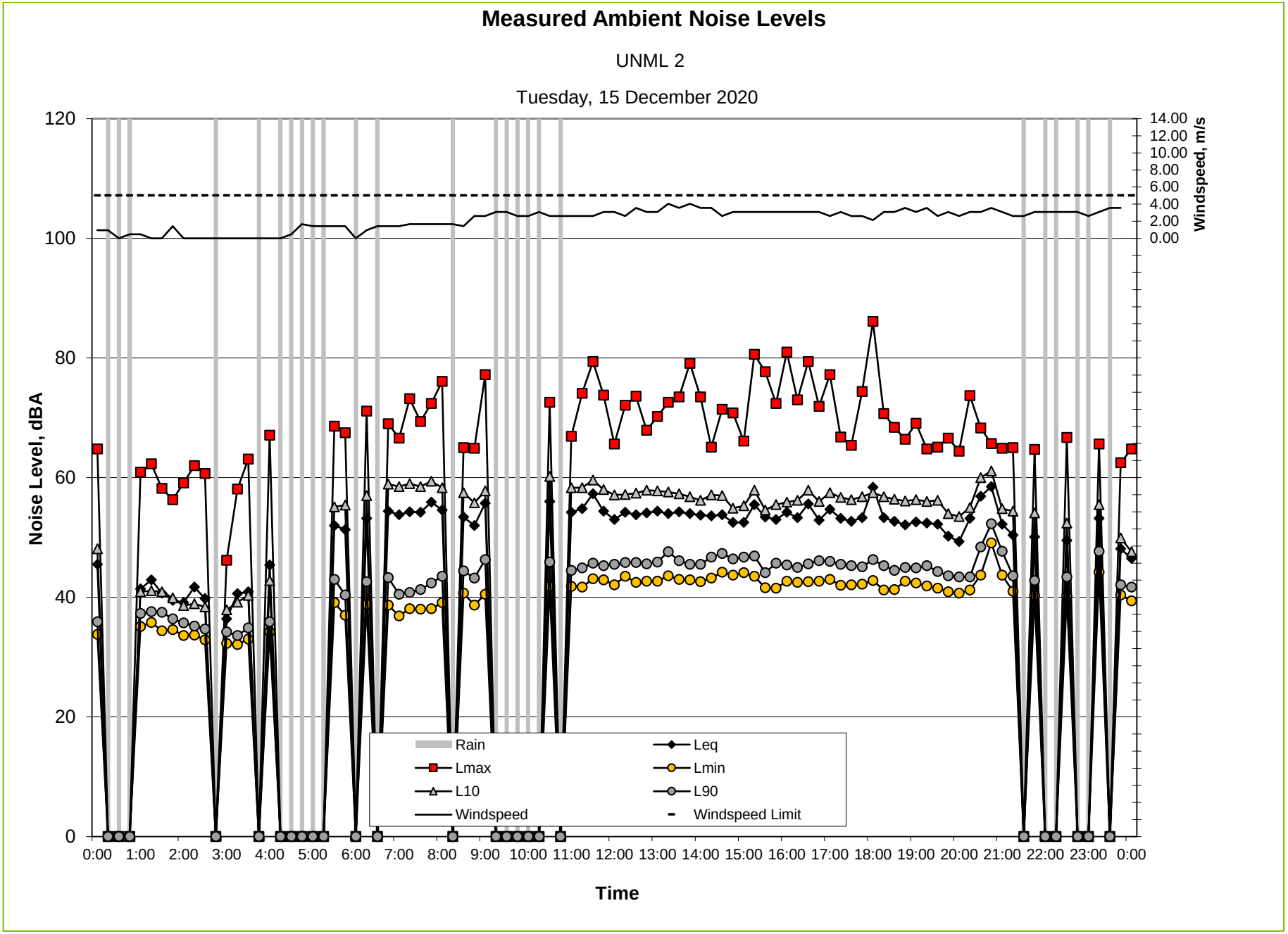

Measured Ambient Noise Levels
UNML 2
Thursday, 10 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit

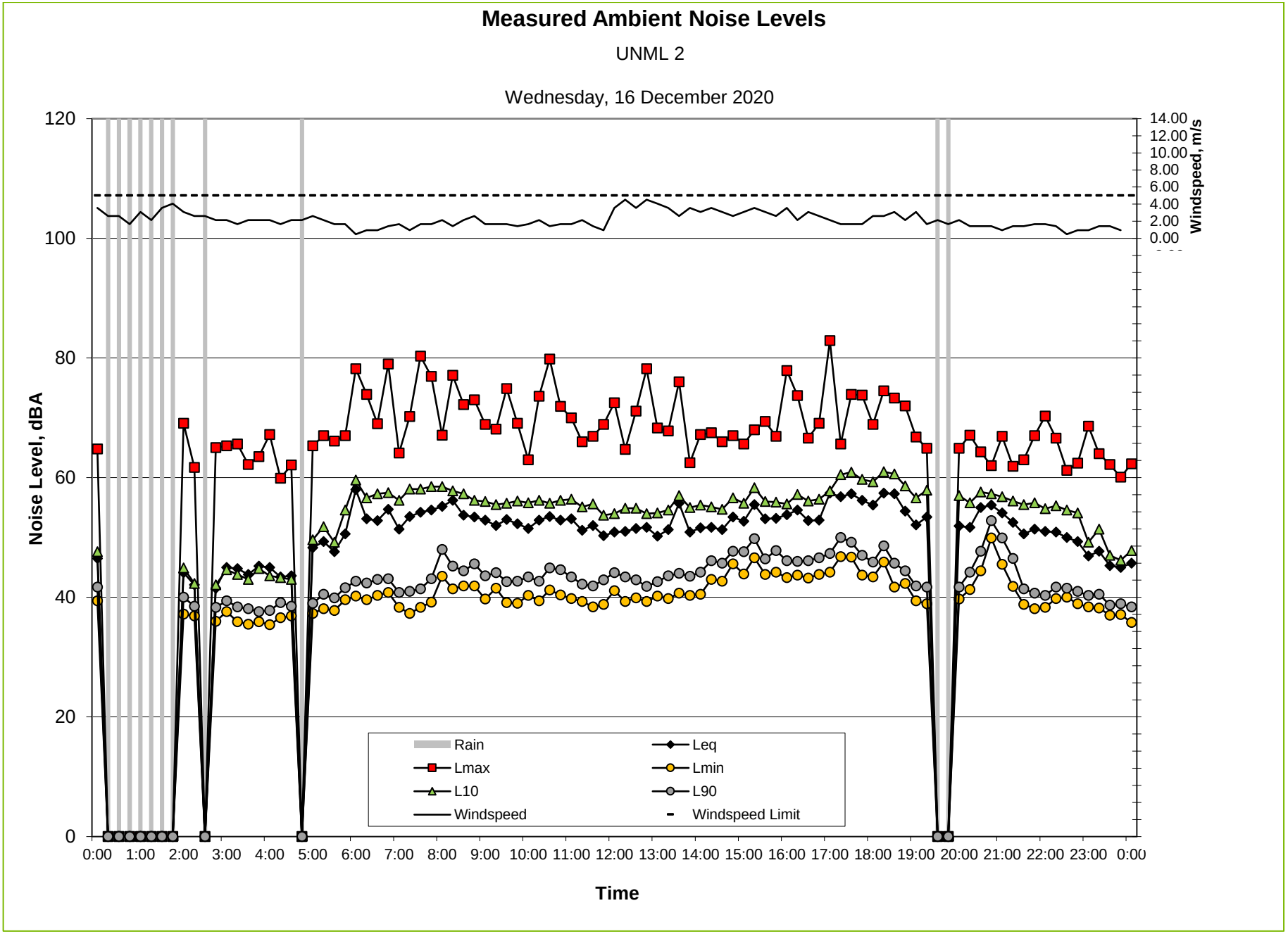

Measured Ambient Noise Levels
UNML 2
Friday, 11 December 2020
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit
0
20
40
60
80
100
120
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00

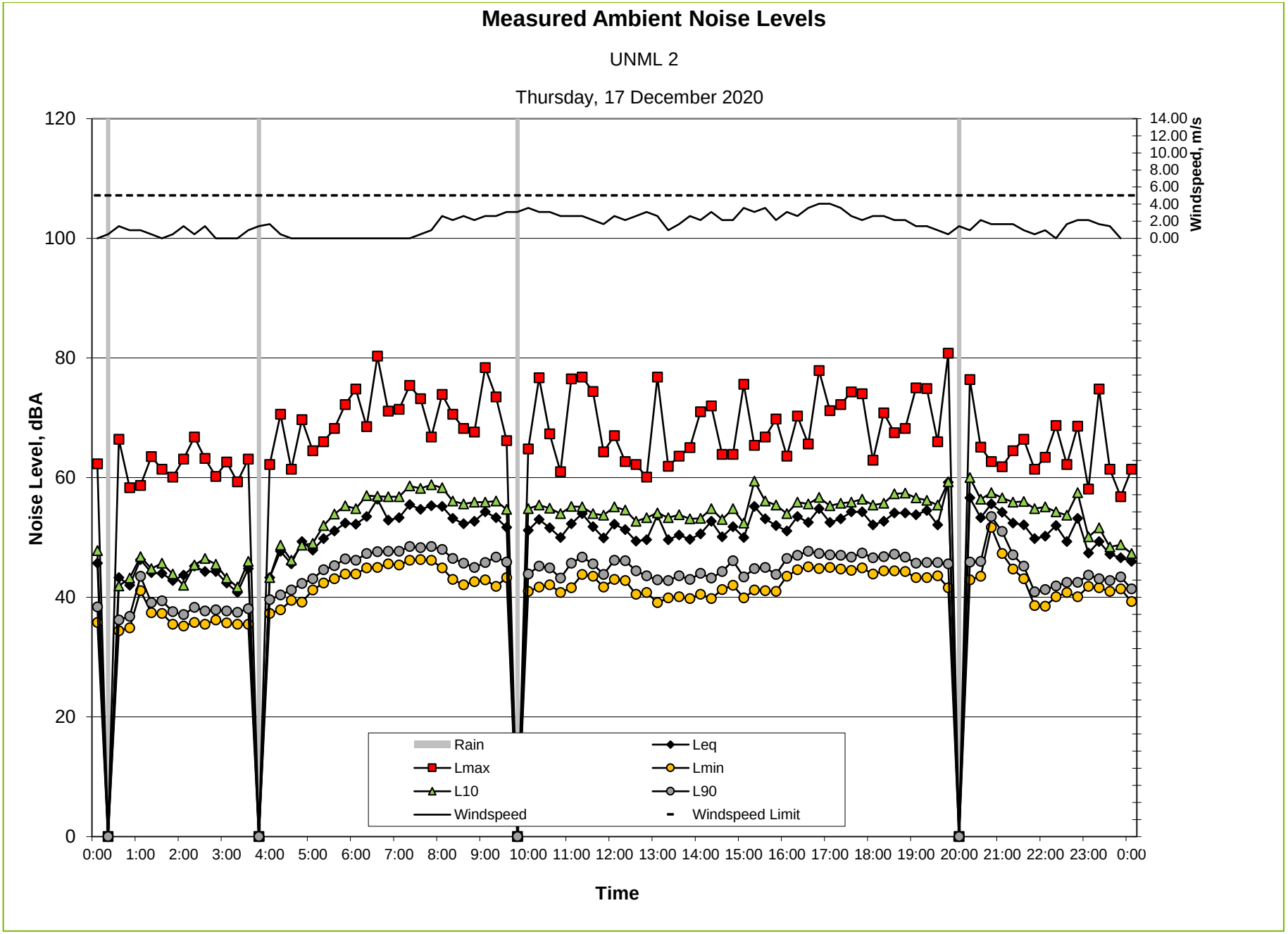

Measured Ambient Noise Levels
UNML 2
Saturday, 12 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit

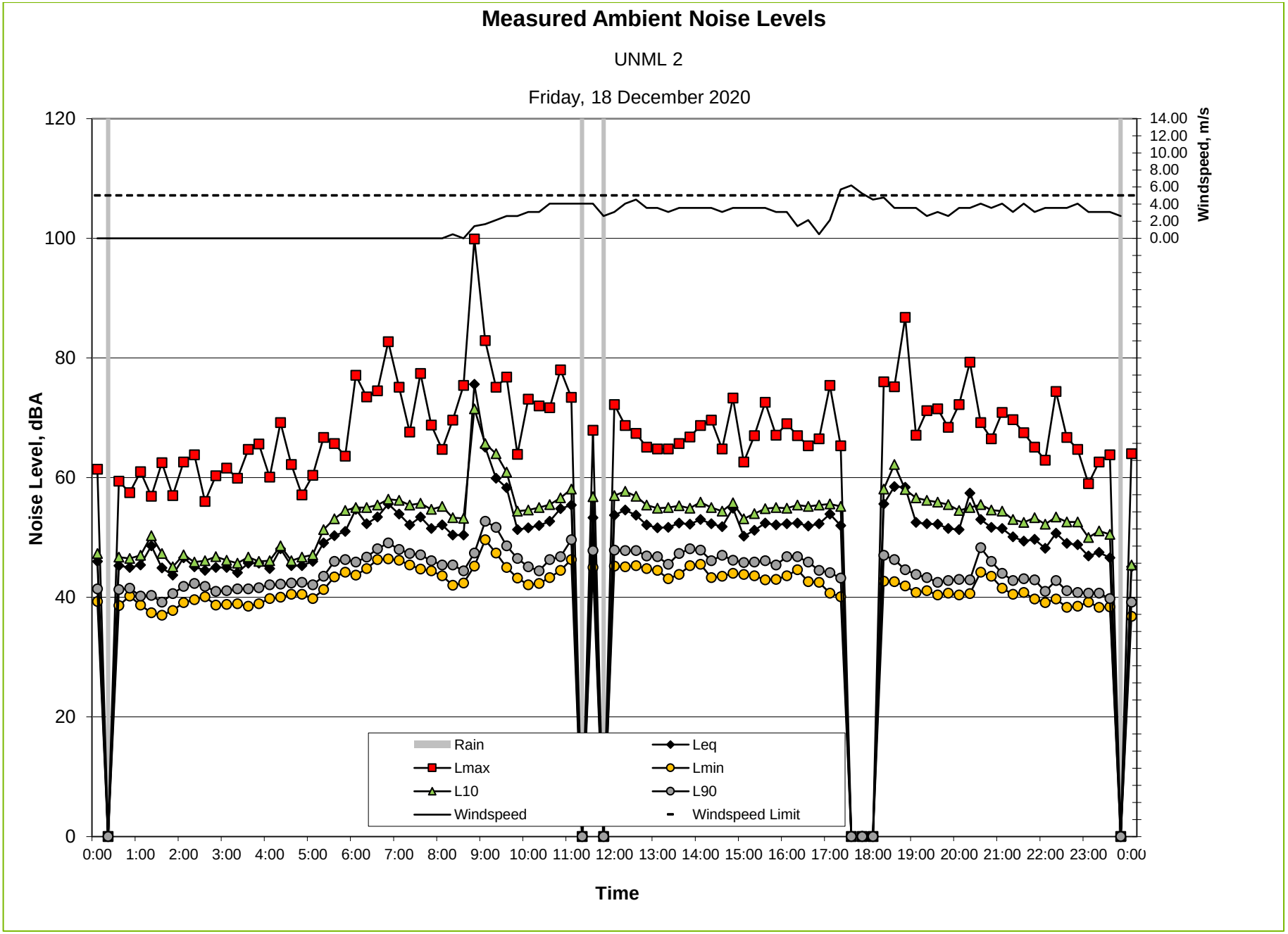

Measured Ambient Noise Levels
UNML 2
Sunday, 13 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
UNML 2
Monday, 14 December 2020
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
UNML 2
Tuesday, 15 December 2020
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
UNML 2
Wednesday, 16 December 2020
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
UNML 2
Thursday, 17 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
UNML 2
Friday, 18 December 2020
Noise Level, dBA
Windspeed, m/s
Time
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit
0
20
40
60
80
100
120
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
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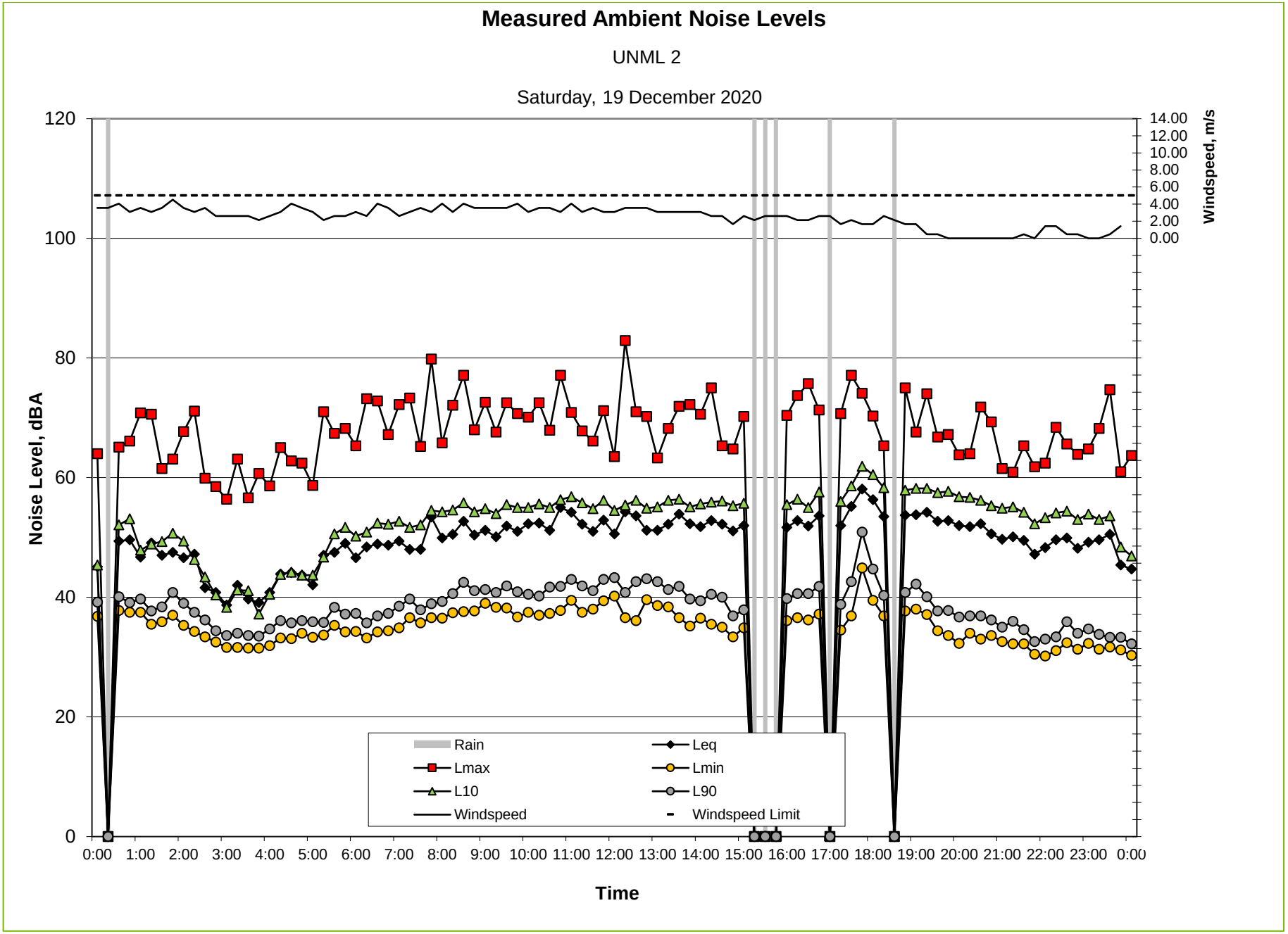
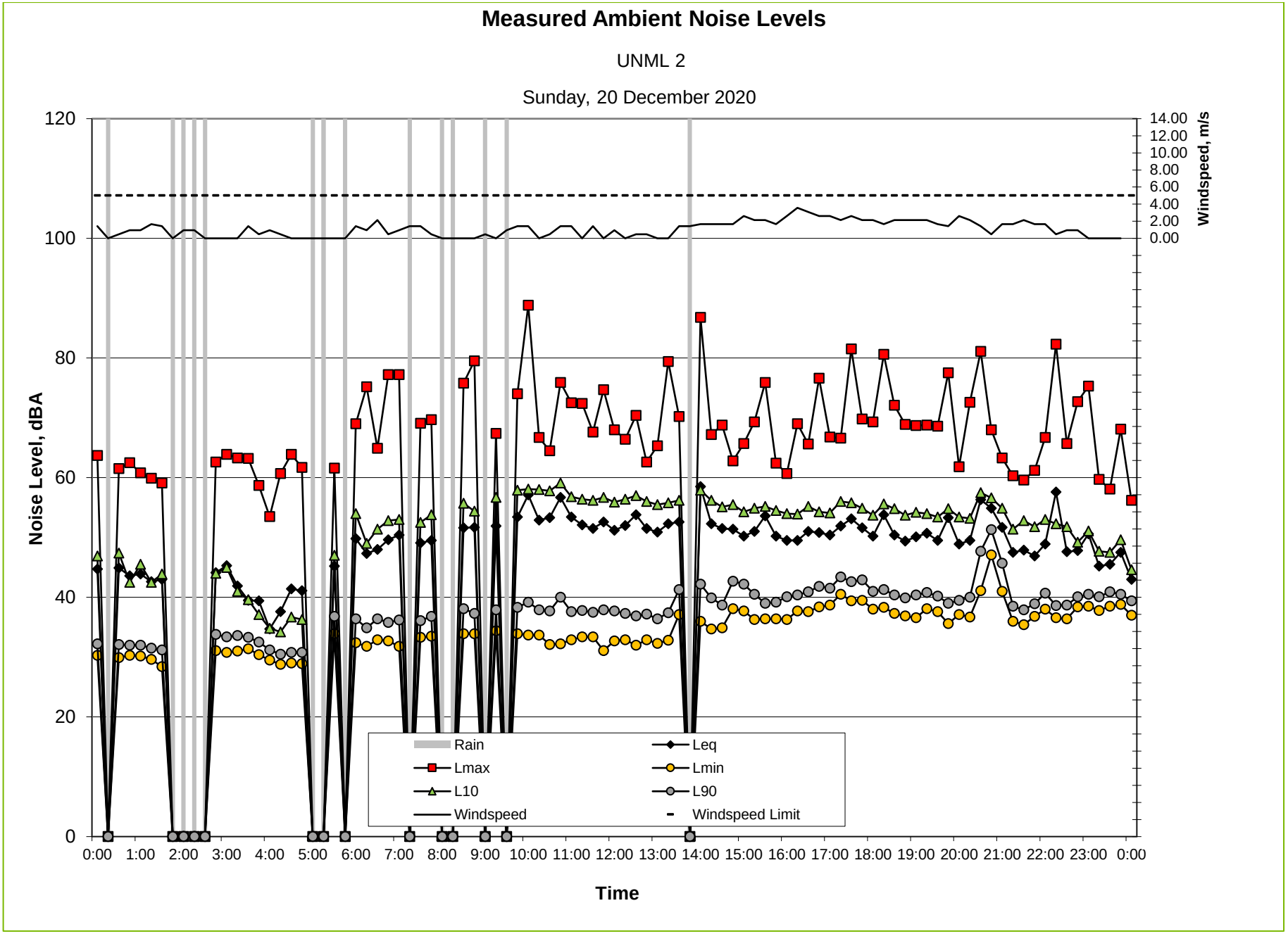
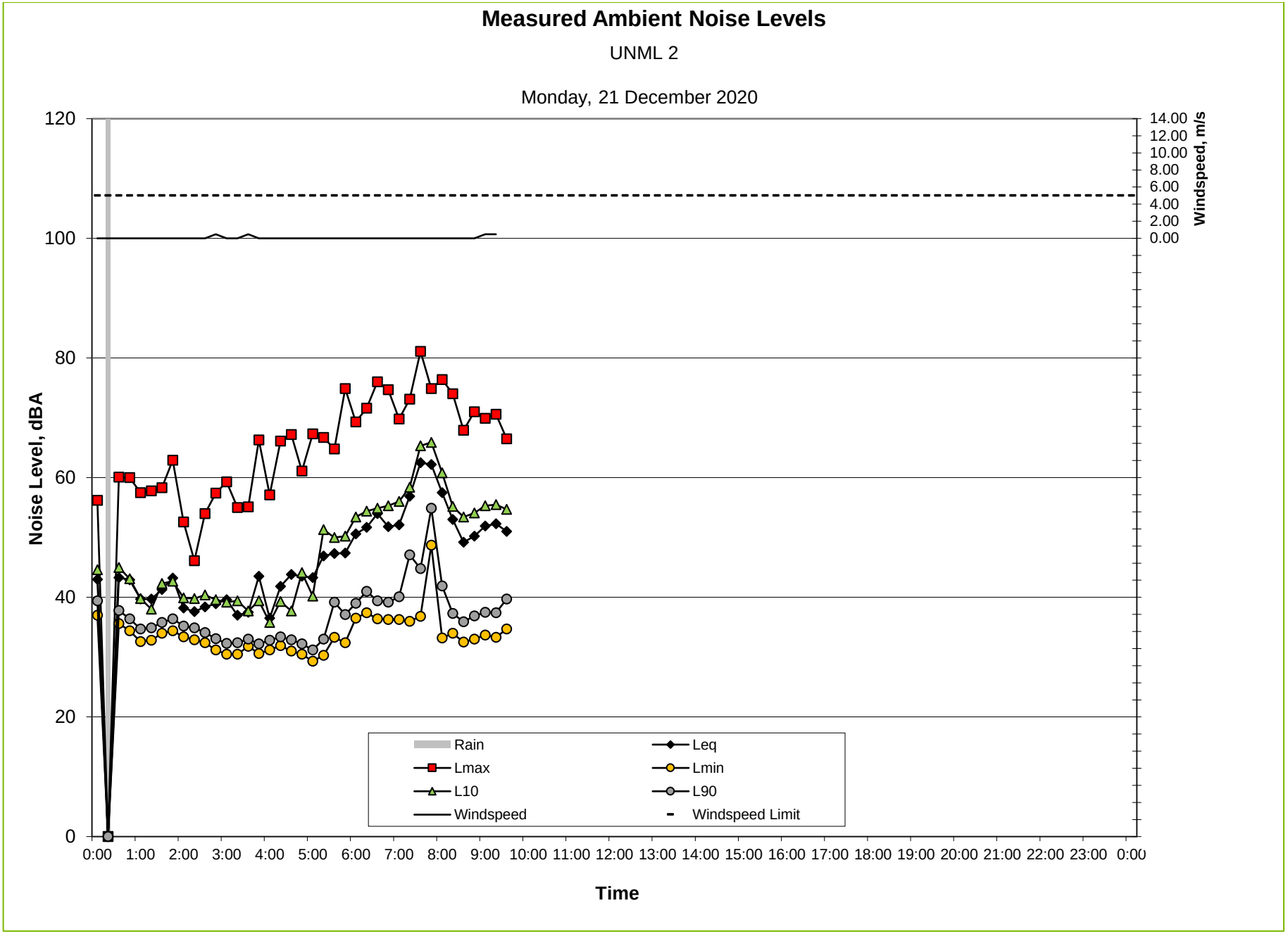
19:00
20:00
21:00
22:00
23:00
0:00


Measured Ambient Noise Levels
UNML 2
Saturday, 19 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
UNML 2
Sunday, 20 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit


Measured Ambient Noise Levels
UNML 2
Monday, 21 December 2020
Noise Level, dBA
Windspeed, m/s
Time
120
100
80
60
40
20
0
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 0:00
Rain
Leq
Lmax
Lmin
L10
L90
Windspeed
Windspeed Limit

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