Report

Acoustic Services – Secretary's Environmental Assessment Requirements (SEAR)

NEW WESTERN SYDNEY UNIVERSITY BANKSTOWN CITY CAMPUS
Western Sydney University

Report

CONFIDENTIAL

Revision: 7.0 – Reviewed Final
Issued: 12 August 2020

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1 EXECUTIVE SUMMARY

1.1 Purpose

NDY have been engaged by Western Sydney University to complete the Acoustics Report associated with the new Western Sydney University (WSU) Bankstown City Campus development in Bankstown, Sydney. This report has been prepared for submission as part of the Secretary's Environmental Assessment Requirements (SEAR) SSD9831.

This report outlines the outcomes of initial Authority consultation, to determine the capacities of existing services and utilities available for the proposed development. This document is intended to provide sufficient information to demonstrate servicing can be provided to support the proposed development.

This version of the report has been updated to address recent Department of Planning, Industry and Environment (DPIE), Canterbury Bankstown Council (Council) and Environmental Protection Authority (EPA). Additional noise monitoring was undertaken to validate the previous project specific noise levels, which were affected by wind and rain. Updated findings were largely consistent with the previous findings.

1.2 Summary of changes and clarifications

The latest submitted response to Submissions and changes included the items as per table below:

Table 1-1: Summary of changes NDY responses to Submissions

Ref. number	Matter	NDY update / response
16	The submitted Acoustic Report prepared by Norman Disney and Young must be updated to address the following matters: • background noise monitoring has not been conducted in accordance with the Noise Policy for Industry, specifically seven days of valid noise monitoring data has not been recorded when taking into consideration noise affected data. • detailed quantitative assessment of predicted construction noise impacts associated with the proposal and measures to minimise and mitigate noise impacts. • consideration of potential road traffic noise impacts and any associated mitigation measures required to attenuate the building. • an assessment of potential noise impacts associated with the use of the various external terrace areas and any associated mitigation measures.	Background noise monitoring is included in section 4.2.1 and appendix A. Loggers were left from 16.05.2019 to 24.05.2019. Additional measurements were conducted between 28 February and March 12 2020. Considerations of potential road traffic noise impacts are given in Section 5.3, we do not consider mitigation measures are required for the traffic noise impact because the only PNTL exceeded for the traffic (at full carpark occupancy) is the night time and this situation is not likely to happen, in addition Section 7.1 Road traffic noise is not predicting a noticeable impact (0.5 - 0.8 dBA), same case with section 7.2 road traffic noise during construction. Considerations to the use of various external terrace areas is given in section 5.2, the only PNTL exceeded here is the night time, however we believe that with the recommendation of limiting the use not late than 10 pm is sufficient. Details of quantitative assessment of predicted construction impacts associated with the proposal are included / updated in section 6.1

29	The EPA reviewed the Acoustic Services Report (ASR) prepared by Norman Disney and Young in Appendix V (28.08.19) and the Environmental Impact Statement prepared by Urbis (dated 24.10.19) (EIS) – Section 8.20 Acoustic Amenity for Western Sydney University Bankstown City Campus. The EPA considers that the assessment has not adequately quantified the main noise and vibration generating sources during construction and operation; and has not provided adequate information on the measures to minimise and mitigate potential noise and vibration impacts.	Please refer to updated section 6.1 of the report that addresses the noise and vibration estimation during construction
30	The ASR and EIS have not appropriately applied EPA noise and vibration policy to assess noise and vibration impacts associated with the construction and operation of the Campus. Although the ASR and EIS has identified the Noise Policy for Industry (EPA, 2017) (NPfI) and the Interim Construction Noise Guideline (DECC, 2009) (ICNG), it has not considered potential impacts from road traffic noise in accordance with the NSW Road Noise Policy (DECCW, 2011).	Please refer to updated section 6.1 of the report that addresses the noise and vibration estimation during construction (including quantitative calculations for residential and commercial receivers). Road traffic noise impacts are included in sections 5.3, 7.1 and 7.2
31	The background noise monitoring has not been undertaken in accordance with the NPfI and cannot be relied upon to derive project noise trigger levels for operational noise. Seven days of valid noise monitoring has not been provided when wind affected data is considered in the noise monitoring. Further, the receivers on Chapel Road do not appear to be residential and therefore not considered representative of noise-sensitive receivers.	Background noise monitoring is included in section 4.2.1 and appendix A. Loggers were left from 16.05.2019 to 24.05.2019. Additional measurements were conducted between 28 February and March 12 2020. 400 Chapel road is an apartment building, residential use, we consider this location a noise sensitive user
32	No quantitative operational noise assessment has been provided as required by the Secretary's environmental assessment requirements (SEARs). The proposed measures to minimise and mitigate noise are not supported by quantitative noise prediction modelling and are considered inadequate.	NDY Response 8/4 - This has been updated and addressed in the following Section 5.0, section was updated with estimations of the recommended limited SWL levels for the rooftop plant and noise propagation into the closest receiver in Rickard Rd. Information regarding mechanical equipment is necessary to include quantitative analysis, equipment selection is not yet finalized to be included in the report

33	Plant on northern side of level 18 are close to the residential receivers at 61-63 Rickard Road. No feasible and reasonable alternative consideration is provided regarding layout and options to protect these receivers by orientating the plant to the southern facing side of the building.	NDY Response 8/4 - This has been updated and addressed in the following Section 5.1, section was updated with estimations of the recommended limited SWL levels for the rooftop plant and noise propagation into the closest receiver in Rickard Rd. Noise estimations are still below the PTNL levels
34	The EIS concludes that construction work will result in significant exceedances of the Highly Noise Affected management level of 75 dB(A) for some construction work taking place during the recommended standard hours of work described in the ICNG. However, the ASR does not provide predicted construction noise levels and offers only generic noise management options. This approach is inadequate and inconsistent with the SEARs requirement to prepare a quantitative assessment of construction noise impacts and identify measures to minimise and mitigate noise impacts.	Please refer to updated section 6.1 of the report that addresses the noise and vibration estimation during construction (including quantitative calculations for residential and commercial receivers).
35	No quantitative assessment has been provided for vibration impacts from construction activities at the closest sensitive receivers, including the adjacent Bankstown Library and Knowledge Centre and residential dwellings, as required by the SEARs.	Please refer to updated section 6.1 of the report that addresses the noise and vibration estimation during construction (including quantitative calculations for residential and commercial receivers). Vibration estimations were updated to add piling operations in critical receivers
36	The assessment has not considered how construction noise and vibration will impact on the Hoyts Cinema and Council buildings located at the south western corner of Rickard Road and Jacobs Street, Bankstown.	Hoyts cinema and the council building assessment has been updated in section 6.1 and 6.2
37	No consideration has been given to potential construction and operational traffic noise impacts at the closest sensitive receivers.	Please refer to sections 7.1 and 7.2 of the report
No ref	Updated documents to be incorporated in the report	Updated Architecture plans, updated ARUP Transport Management and Accessibility Plan and updated information from mechanical plant has been incorporated in the report.
No ref	Lyons comments	All comments provided were incorporated in this version of the report

1.3 Revision History

Rev	Date Issued	Comment
1.0	05 June 2019	Initial Issue
2.0	18 July 2019	Draft Issue
3.0	22 July 2019	Final Issue
4.0	28 August 2019	Final Issue
5.0	8 April 2020	SEARS Comments - Final
6.0	24 July 2020	SEARS Comments – Reviewed
7.0	August 2020	SEARS Comments – Reviewed Final

1.4 Information Sources

- NSW Noise Policy for Industry 2017
- NSW Interim Construction Noise Guideline 2009
- NSW Road Noise Policy 2011
- Assessing Vibration: A Technical Guideline 2006
- Vibrations in Buildings, DIN4150.3-1999
- Development near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008)
- Lyons Architecture plans, Rev. 37, Issued for information, date 07.08.2020.
- ARUP Transport Management and Accessibility Plan, Rev E, dated 05.08.2020

2 PROJECT INFORMATION

2.1 Project Site

The Bankstown City Campus Development (BCCD) is a key component of Western Sydney University's Western Growth Program. The project, entailing a stand-alone vertical campus on an undeveloped site in Bankstown Central Business District, will facilitate the relocation of most programs from the existing campus at Milperra into new facilities that support new modes of working, learning and research, with scope to accommodate future growth.

The project site includes 74 Rickard Road (being Lot 15 DP1256167) and a portion of 375 Chapel Street (being part Lot 6 DP 777510). In addition, public domain works are proposed to Rickard Road, 70 Rickard Road (being part Lot 7 DP 777510) and access is proposed via 80 Rickard Road (being Lot 12 DP 566924). The site is within the Civic Precinct, located next to Council office and chambers, Bankstown Knowledge Hub and the Bryan Brown Theatre, and Paul Keating Park. On the east side of the site The Appian Way, a partially pedestrianised roadway, links from Rickard Road south to Bankstown Railway Station.

Project Description:

The building has been divided into Podium and volumes 2 to 4 with terraces in Levels 3, 8 and 14, characteristics are as noted below:

- **Basement**: There are two levels of carpark in the Bankstown City Campus development, accommodating carparking, loading & delivery, building management office, cleaners store, waste room, end of trip facilities, main switch, fire tank and building services plant (Chiller, AHU, exhaust plant, cold water plant).
- **Ground Level**: The Ground Level concept is to create a porous building, connected to its external context, drawing both landscape and visitors into the Ground Level, and continuing through to the levels above. Key entry points provided at the centre of the Rickard Road and Paul Keating Park frontages, connected by an internal 'University Street', punctuated by an atria and escalator route that provided a visual and physical connection that extends to high student use spaces above. The ground level also contains a multipurposed theatre and 2 retail tenancies which are proposed to food and beverage tenancies.
- **Levels 1 & 2**: Level 1 & 2 are the largest floor plates of the Bankstown City Campus Development with GFA of approximately 2,391 m^2 and 2,578 m^2 respectively. A greater floor to floor height has been provided to both these levels of 4.32m, offering a flexible expansive floor for range learning programmes, particularly to the north where the column spacing extends to 12m.
- **Level 3**: Situated between high occupancy levels above and below, including the Library, Level 3 has been identified as a real destination space within the building for students and visitors. It's proposed that level will accommodate the Student Hub and provide valuable breakout and study space between classes for students. This level includes a terrace.
- **Levels 4-7**: these levels are proposed to house a variety of University Workspace, Research and Learning accommodation, including the Library at Level 4, situated directly above the Student Hub below. The levels are served by escalators, was well as lifts. The large rectangular flexible floor plate allows for a range of learning accommodation, including larger rooms to the north, where the column spans are at their greatest.
- **Level 8**: Levels 8 had been designed to accommodate a conference facility for the University, catering for up to 300 persons. A generous floor to floor height in excess of 4.8m has been provided, allowing for large conference rooms with increased ceiling heights along the northern boundary. This level is not served by escalators and includes a terrace to the West.
- **Levels 9-13**: Levels 9 to 13 form the mid-tower, with access via the passenger lifts. The levels are expected to accommodate a variety of University Workspace and Learning Spaces. A series of balconies

are provided at each floor the south-west façade allowing for external study and breakout areas from the main floorplate. The stair pressurization fans room is located in Level 13 plant room.

- **Levels 14-18:** Upper tower levels form the cantilevered form of the building. These levels allow future growth opportunities for the University as the campus develops. The floors will be constructed with fit-out to accommodate University growth needs. Terraces are provided to Level 14 and Level 18 overlooking Bankstown CBD to the south, as well as Level 16 to the north. The north-east corner of the Level 18 floor plate accommodates the majority of the 'roof' services plant, including building back-up generator, hydraulics plant, and external cooling towers. Additional smaller plant rooms are located at level 15 (Air Handling unit) and 17 (air handling unit). Level 18 will accommodate the external cooling towers, air handling units, toilet exhaust fans, kitchen exhaust fans and smoke relief fans.

Figure 1 shows the Bankstown Area zoning in accordance with Bankstown Local Environmental Plan 2015, Land Zoning Map.

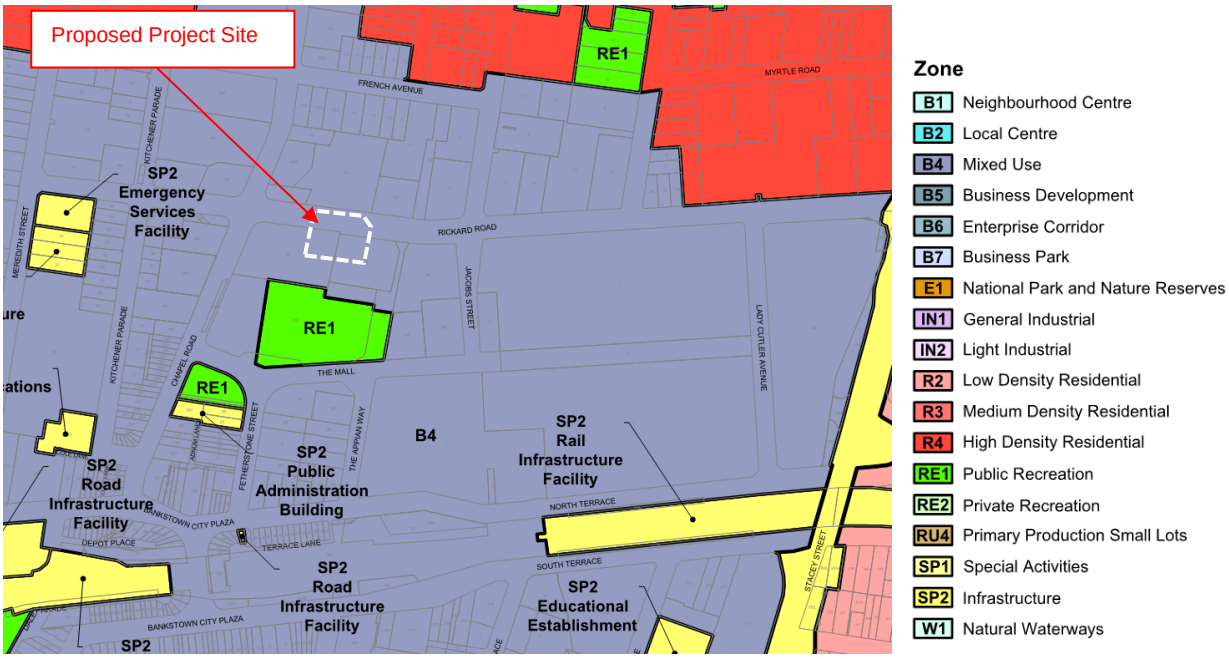


Figure 1: Bankstown Local Environmental Plan 2015 Land Zoning Map

3 ACOUSTIC SURVEY OF THE EXISTING ENVIRONMENT

3.1 Methodology

Noise survey and site inspection were conducted to determine the existing background/ ambient noise levels at the nearest sensitive receivers. The noise survey was carried out over a period of 8 days, between the 16th May and 24th May 2019. It was noted that these original measurements were affected by wind and rain over the 8-day period. Hence additional noise monitoring was conducted from 28th February 2020 to March 12, 2020, an additional 13 days. The noise measurements locations are shown in Figure 2.

These locations were selected with the following project objectives in mind:

- Logger Location 1 – 61-63 Rickard Rd consists of a multi-storey residential apartment complex, which is directly adjecent to the proposed WSU Bankstown development. Its proximity to the site was considered to be the most sensitive location. It should be noted that during followup logging in February/March 2020, this noise logger was removed/stolen from the site. While this was unforeseen, it was anticipated that given the urban envieornment the additional monotiring would have resulted in similar project specfic noise levels. As updated data was not available NDY undertook a comparitive assesment of 'weather' vs 'non weather' 15 minute periods for the May data set. Overall the difference between weather affected and non weather within 1-2 dB(A), which was within acceptable tolerances. e have retained the original project specific crtiera
- Logger Location 2 – 402 Chapel Road was in close proximity to residential apartments at 400 Chapel Road to the west of the site. It should be noted that access to these apartments was not possible, hence the nearest representative location at 402-410 Chapel Road was chosen. Additional monitoring conducted in February/March 2020 was determined to be within 1-2 dB(A) of the previous findings. Given that there are no significant variations between the two data sets, we have retained the previous May 2019 findings and criteria for this report.

Figure 2: Noise Logging and Receiver Locations

3.2 Instrumentation

The equipment calibration was checked prior to, and after the noise survey using a 94dB external calibration tone at 1 kHz. No significant drift was noted during the calibration procedure (i.e. less than 0.5dB).

The noise logger was configured to record all relevant noise parameters including background noise (L_{A90}) and equivalent continuous noise levels L_{Aeq}. Samples were recorded at 15-minute A-weighted continuous intervals. The noise monitor responses were set to *fast* response.

3.3 Meteorological Data

In order to verify that the noise data was obtained during suitable meteorological conditions, weather data such as rain and wind speed was obtained from the Bureau of Meteorology Bankstown Airport AWS weather station (Station ID 066137) as a representative site.

Noise data is excluded (as per the NSW NPFI methodology) from the results in case of:

- Rain observed during any 15-minute noise measurement period and/or.
- Wind speeds exceeded 5 m/s during any 15-minute noise measuring period.[1]

[1] The wind noise data has been corrected for the height difference between the meteorological station (33m) and the measurement position (1.5m) as per AS1170.2-1989. The procedure has been outlined and validated in *"CONVERTING BUREAU OF METEOROLOGY WIND SPEED DATA TO LOCAL WIND SPEEDS AT 1.5m ABOVE GROUND LEVEL" by Tracy Gowen, Peter Karantonis, and Tony Rofail*.

3.4 Sensitive Receivers

Table 3-1 shows the assessed sensitive receivers in close proximity to the site, please also refer to **Figure 2** for a mark-up of the receiver locations.

Table 3-1: Sensitive Receivers and zoning

Item	Receivers	Representative property for monitoring	Distance (approximate)	Zoning as per LEP 2014
R1	Residential properties on Rickard Road	61 – 63 Rickard Road Bankstown NSW	25m North of site	B4 – Mixed use with Residential
R2	Residential properties on Chapel Road	400 Chapel Road N Bankstown NSW	100m South West of site	B4 – Mixed use with Residential
R3	Passive Recreational	Paul Keating Park	20m South of site	RE1 – Public Recreation
R4	Commercial properties	Bankstown Community Services/ Bankstown Library and Knowledge Centre	10-20m West/East of site	B4 – Mixed use
R5	Hoyts Cinema	Cnr The Mall and Jacobs Streets, Bankstown, NSW	80m South-east of site	B4 – Mixed Use

4 ACOUSTIC CRITERIA

4.1 SEARS Requirements

Critical State significant infrastructure (CSSI) projects are high priority infrastructure projects that are essential to the State for economic, social or environmental reasons. The CSSI process involves a declaration by the Minister for Planning that a State significant infrastructure project is critical.

When an application for approval of a declared CSSI project is made, the Secretary of the Department of Planning and Environment is required to issue environmental assessment requirements (SEARs). The Secretary is also required to consult with relevant government agencies in preparing the SEARs. Community consultation during preparation of the SEARs may also be undertaken if deemed necessary by Minister.

Project-specific SEARs was prepared to deal with specific issues associated with a project that are not adequately covered in the standard SEARs. Below is extract from the project specific SEARs for this project.

10. Noise and Vibration

Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction and operation. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land, particularly the Bankstown Library and Knowledge Centre and residential dwellings.

4.2 Operational Noise Criteria

4.2.1 NSW Noise Policy for Industry 2017

For the purpose of the assessment, the measured noise data was processed into the following time periods:

- Daytime: 0700 to 1800 hrs.
- Evening: 1800 to 2200 hrs.
- Night-time: 2200 to 0700 hrs.

The measured background (L_{A90}) and equivalent continuous (L_{Aeq}) noise levels during these defined time periods are presented in Table 4-1.

The L_{A90} noise levels presented are *Rating Background Levels* (RBLs), being the median of the background L_{A90} (i.e. of the lowest 10th percentile of samples) in each daytime, evening and night-time measurement period, for each 24-hour period during the noise survey.

The L_{Aeq} noise levels presented are the logarithmic average of all the L_{Aeq} samples taken in each of the daytime, evening and night-time periods.

Table 4-1 shows the existing ambient and background noise levels at the closest residential boundary (Location 1 in Figure 2), measured from 16.05.2019 to 24.05.2019. Appendix A shows the graphical data results for the monitoring location.

Note that additional background noise measurements were conducted between 28 February and March 12th 2020.

Table 4-1: Existing Ambient Noise Levels, dBA*

Location	Noise Index	Noise Level, dB re 20 µPa		
		Daytime 0700 to 1800	Evening 1800 to 2200	Night-time 2200 to 0700
L1 – 1-5 Jacobs Street, Bankstown NSW	L_{A90} (RBL)	54	54	41
	$L_{Aeq,period}$	65	65	60
L2 – 402-410 Chapel Road Bankstown NSW	L_{A90} (RBL)	54	51	42
	$L_{Aeq,period}$	64	63	61

4.2.1.1 Amenity and Intrusiveness Criteria

Based on the unattended noise survey discussed in Section 3 of this report, the external noise level criteria for the receiver location has been derived in accordance with the NSW Noise Policy for Industry (NSW NPfI).

The NSW NPfI provides assessment methodologies, criteria and detailed information on the assessment of environmental noise emissions in NSW. The NSW NPfI criteria for noise sources consider two (2) components:

- Controlling **intrusive** noise impacts for residential receivers. Assessing intrusiveness generally requires noise measurements to quantify background (L_{A90}) noise levels at a location considered representative of the most potentially affected residential receiver(s). The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source(s) under consideration should be controlled to not exceed background noise levels by more than 5 dB.

- Maintaining noise **amenity** for various categories of land use (including residential receivers and other sensitive receivers). The amenity criterion is based on the sensitivity of a particular land use to industrial-type noise. The recommended amenity noise levels detailed in Table 2.2 of NSW NPfI represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. This is to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area. The project amenity criteria for each new source of industrial noise is equalled to recommended amenity noise level minus 5dB(A). A +3dB(A) to be added to project amenity noise level for conversion from a period level to a 15-minutes level. Where the resultant project amenity noise level is 10dB or more below the existing industrial noise level, the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

The closest *residential* receivers are located on Rickard Road and Chapel Road which has been assessed based on the urban noise criteria given in the NPfI.

The NPfI recommends “Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2, only the amenity levels apply.” The project amenity and intrusive noise levels are listed in Table 4-2.

Table 4-2: NPfI Project Intrusiveness and Amenity Noise Criteria – Operational Noise

Type of Receiver	Noise Level $L_{eq,15min}$ [dBA]		
	Daytime 0700 to 1800	Evening 1800 to 2200	Night-time 2200 to 0700
Commercial premises/Council Building/Library/Hoyts	**Project Amenity Assessment**		
	63 (when in use)		
Passive recreational (Southern boundary, Paul Keating Park)	**Project Amenity Assessment**		
	55 (when in use)		
Residential properties (on Rickard Road)	**Project Intrusiveness Assessment**		
	59	59	46
	Project Amenity Assessment		
	58	55	50
Residential properties (on Chapel Road)	**Project Intrusiveness Assessment**		
	59	56	47
	Project Amenity Assessment		
	58	53	51

4.2.1.2 'Modifying factor' Adjustments

Penalties may be applied if the noise from the development "... contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."

To take into account the potential annoying character of the noise an adjustment of +2dB(A) or +5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), may be added to the measured value to penalise the noise for its potential greater annoyance aspect.

Table C1 of the NSW NPfI provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

4.2.2 Project Trigger Noise Levels for Operational Noise Sources

The project trigger noise levels are the most stringent noise levels of the NSW NPfI project intrusiveness and project amenity noise levels for day, evening and night-time periods and are project specific. Table 4-3 below presents the project trigger noise level (PTNL) for the closest receivers.

Table 4-3: External Project Trigger Noise Levels (PTNL) operation noise

Location	Time	Descriptor	External PTNL [dBA]
Commercial premises/Council Building/Library/Hoyts	When in use	$L_{eq, 15min}$	63
Passive Recreational (Southern boundary, Paul Keating Park)	When in use	$L_{eq, 15min}$	55
Residential properties (on Rickard Road)	0700 to 1800	$L_{eq, 15min, day}$	58
	1800 to 2200	$L_{eq, 15min, evening}$	55
	2200 to 0700	$L_{eq, 15min, night}$	46
Residential properties (on Chapel Road)*	0700 to 1800	$L_{eq, 15min, day}$	58
	1800 to 2200	$L_{eq, 15min, evening}$	53
	2200 to 0700	$L_{eq, 15min, night}$	47
*Additional monitoring conducted in February-March determined PNTL of 1-2dB(A): Day 58dB(A), Evening 55dB(A), Night 46 dB(A).			

4.2.3 Project Trigger Noise Levels for Emergency Equipment

There is no specific guideline related to noise criteria specific to emergency equipment (e.g. Generators, fore pumps, etc.). State Environment Protection Policy (SEPP), VIC 1989, have specific noise guidelines for standby generators[2] which states that noise limit shall be increased by 10dB for a day period and by 5 dB for all other periods. Based on the best practice for state of Victoria, we have developed external noise criteria for emergency equipment which is to increase the PTNL by 10 dB for all periods. Table 4-4 summarises the noise criteria for emergency equipment.

Table 4-4: External Project Trigger Noise Levels (PTNL) for emergency equipment.

Location	Time	Descriptor	External PTNL [dBA]
Commercial premises/Council Building/Library/Hoyts	When in use	$L_{eq, 15min}$	73
Passive Recreational (Southern boundary, Paul Keating Park)	When in use	$L_{eq, 15min}$	65
Residential properties (on Rickard Road)	0700 to 1800	$L_{eq, 15min, day}$	68
	1800 to 2200	$L_{eq, 15min, evening}$	65
	2200 to 0700	$L_{eq, 15min, night}$	56
Residential properties (on Chapel Road)	0700 to 1800	$L_{eq, 15min, day}$	68
	1800 to 2200	$L_{eq, 15min, evening}$	63
	2200 to 0700	$L_{eq, 15min, night}$	57

[2] A standby generator means a generator of electrical power used as an alternative to the main supply in emergencies or for a maximum period of 4 hours per month for maintenance purposes.

4.2.3.1 Sleep Disturbance Noise Limits

In accordance with NSW NPfI 2017, the potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is both awakenings and disturbance to sleep stages.

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

- *$L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is the greater, and/or*
- *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*

a detailed maximum noise level event assessment should be undertaken."

Table 4-5 details the sleep disturbance noise limits for the nearest residential receivers adjacent to the proposed development.

Table 4-5: Sleep Disturbance Noise Limits

Location	Descriptor	Given Noise Limits [dBA]	Limits based on RBL* [dBA]	Project Noise Levels [dBA]
Residential properties (on Rickard Road)	$L_{eq,15mins,\ night}$	40	46	46
	$L_{Fmax,\ night}$	52	56	56
Residential properties (on Chapel Road)	$L_{eq,15mins,\ night}$	40	47	47
	$L_{Fmax,\ night}$	52	57	57

4.3 Construction Noise and Vibration Criteria

4.3.1 Interim Construction Noise Guideline

The NSW Interim Construction Noise Guideline was developed by the NSW-Department of Environment & Climate Change DECC, NSW which incorporates the EPA. The Guideline contains detailed procedures for the assessment and management of construction noise impacts.

The guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer term construction works and the qualitative method, which is generally suited to short term works (usually not more than 3 weeks) such as infrastructure maintenance.

It is expected that the length of the construction works associated with the development would be more than 3 weeks and therefore a quantitative method has been used for this assessment.

Table 4-6 and Table 4-7 set out the management levels for noise at residence and sensitive land uses, respectively. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected management level' which is >75dBA. Affected properties above 75 dBA will require community consultation and a Construction Noise & Vibration Management Plan (CNVMP).

Table 4-6: Noise at Residence using Quantitative Assessment

Recommended Hours	Time of Day	External Management Level $L_{eq,15min}$ [dBA]
Recommended Standard Hours	Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise Affected RBL + 10
		Highly noise affected 75
Outside recommended standard hours	Any time other than the recommended standard hours	Noise Affected RBL + 5
Note: Noise Levels apply at the boundary that is most exposed to construction noise and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most affected point within 30m of the residence.		

Table 4-7: Noise at Sensitive Land Use (other than residence)

Land Use	External Management Level, $L_{eq,15min}$ [dBA] (applies when properties are being used)
Commercial premises	70
Passive Recreation area (Paul Keating Park)	60

4.3.2 Noise Management Level

Noise Management Levels (NML) associated with the construction works on the project site are presented in Table 4-8.

Table 4-8: Construction Noise Management Levels

Receivers	Recommended Hours	Period	RBL $L_{A90,15mins}$ [dBA]	External Noise Management Level [dBA]
Commercial premises/Council Building/Library/Hoyts	All Hours (Standard Construction Hours + Outside Standard Construction Hours)	When in use	n/a	70 $L_{eq,15mins}$
Passive Recreation area (Paul Keating Park)	All Hours (Standard Construction Hours + Outside Standard Construction Hours)	When in use	n/a	60 $L_{eq,15mins}$
Residential properties on Rickard Road (North of the site boundary)	Standard Construction Hours	Day	54	64 $L_{eq,15mins}$
	Outside Standard Construction Hours	Day	54	59 $L_{eq,15mins}$
		Evening	54	59 $L_{eq,15mins}$
		Night	41	46 $L_{eq,15mins}$
Residential properties on Chapel Road (West of the site)	Standard Construction Hours	Day	54	64 $L_{eq,15mins}$
	Outside Standard Construction Hours	Day	54	59 $L_{eq,15mins}$
		Evening	51	56 $L_{eq,15mins}$
		Night	42	47 $L_{eq,15mins}$

4.3.3 Construction Vibration Criteria

The effects of construction vibration upon buildings can be separated into three main categories:

1. Perceptibility of the occupants to the vibration and the possibility of them being disturbed or annoyed.
2. Vulnerability of the building structures to vibration induced damaged.
3. Vulnerability of the contents of the building that includes types of equipment, activities and processes.

4.3.3.1 Human Response to Vibration

Humans are very sensitive to vibration, and they can be disturbed, annoyed and have their work activities interfered with if the levels are too high. The Interim Construction Noise Guideline references *"Assessing Vibration: a technical guideline"* (Vibration Guideline) issued by the Department of Environment and Conservation NSW for measurement and assessment of vibration. The Vibration Guideline provides vibration criteria for continuous, impulsive and intermittent vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

The criteria are discussed in more detail in the following sections.

4.3.3.2 Continuous and impulsive vibration (1-80 Hz)

According to the Vibration Guideline for continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted root-mean-square acceleration values and results are to be compared against the following preferred and maximum values given for each orthogonal axis. The frequency weightings as per BS6841:1987 (reproduced in Appendix B3 of the guideline) are to be applied to the RMS measurement values (1-80Hz). The criteria in the Vibration Guideline are derived from the limiting values of the assessment curves and multiplying factors from BS 6472:1992 (the curves are no longer referenced in the superseded version of the standard BS 6472:2008). We have assumed hotels will be assessed as per the criteria for residences.

Table 2.2 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s²) 1–80 Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am

2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992

The Vibration Guideline notes "*Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short-term duration. An example is a construction or excavation project.*"

4.3.3.3 Intermittent vibration (1-80 Hz)

According to the Vibration Guideline for intermittent vibration, assessment of impact should be considered on the basis of vibration dose values (VDV). Acceptable values of vibration dose are given as follows. We have assumed hotels will be assessed as per the criteria for residences.

Table 2.4 Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.
Source: BS 6472–1992

4.3.3.4 Structural Response to Vibration - German Standard DIN 4150-3:1999

The German Standard DIN 4150-3 Structural Vibration Part 3: Effects on building and structures is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

The response of a building to vibration is affected by several factors that include its type of foundation, the underlying ground conditions, its construction and the state of the building. Please note the construction vibration limits are designed to ensure the structural integrity of nearby buildings and are not for human comfort. the limits are well above perceptibility.

According to DIN 4150 short term vibration refers to vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated. Long-term vibration refers to all types of vibration not covered by the definition of ‘short-term vibration’. The criteria for short-term and long-term vibration are listed in the following.

4.3.3.5 Guideline Values for evaluation of short-term vibration - DIN 4150-3:1999

The vibration limits of table 1 in DIN 4150-3:1999 (replicated in Table 4-9 below refer to the evaluation of the effects of short-term vibration on structures.

The criteria are the peak particle velocities (pp.) measured on any foundation or uppermost full storey of any building not related to the site and are listed in the Table 4-9 below.

It should however be noted that compliance with the vibration limits to avoid structural damage of buildings, cannot provide certainty. If damage occurs despite compliance with the standard, it is to be assumed that other causes are responsible, however, further investigations are necessary. And on the other hand, exceeding the limits does not necessarily lead to damage.

Table 4-9: DIN 4150-3 Construction Vibration Limits – Short Term

Type of Structures	Guideline values for vibration velocity (mm/s)			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50 Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, **Industrial building** and building of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

4.3.3.6 Guideline Values for evaluation of long-term vibration - DIN 4150-3:1999

The vibration limits of table 3 in DIN 4150-3:1999 refer to the evaluation of the effects of long-term vibration on structures.

The criteria are the peak particle velocities measured on the uppermost full storey of any building not related to the site and are listed in Table 4-10 below.

According to the standard, *exceeding the values listed below does not necessarily lead to damage*.

If a building is subject to harmonic vibration, then maximum values can occur in floors other than the top floor, or in the foundation. The values given also apply in these cases.

Table 4-10: DIN 4150-3 Construction Vibration Limits – Long Term

Type of Structures	Guideline values for velocity, vi, in mm/s of vibration in horizontal plane of highest floor, at all frequencies
Buildings for commercial purposes, Industrial building and building of similar design	10
Dwellings and buildings of similar design and/or occupancy	5
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	2.5

5 OPERATIONAL NOISE IMPACT ASSESSMENT

5.1 Building Services Plant Noise

It is understood that the development will include mechanical plant and HVAC equipment including provision for 3 rooftop level cooling towers. At this stage, the detailed design and selection of mechanical plant is still underway. Preliminary assessment based on initial equipment selection is summarised below,

For other HVAC equipment, these can be treated using a combination of any of the following options:

- Selection of low noise units.
- Strategic location of equipment away from most sensitive receivers.
- Duct internal acoustic lining (where appropriate).
- Acoustic attenuators (where appropriate).
- Acoustic louvres.
- Acoustic barriers (if exceed the above recommendations).
- For preliminary purposes a limiting aggregate sound power level of Lw 80dB(A) is recommended to achieve the NPfI requirements at the nearest affected residential locations at night.

Note: Information regarding mechanical equipment is necessary to include a quantitative analysis, mechanical equipment selection is not yet finalized to be included in the report.

Closest sensitive receivers (residential) to the building services plant would probably be 61 – 63 Rickard Rd. the façade of 61 Rickard Rd. is at approximately 27 m from the new buildings edge.

With equipment plant limiting the total SWL of Lw 80dB(A) the propagated noise in the closest receiver is still compliant with PTNL for Day, Evening and Night. This do not consider the effect of louvers or acoustic barriers and the fact that the operation might be less noisy during the night when the equipment will be working on a less onerous condition depending on the heat load.

5.1.1 Load Bank

Based on the preliminary design of load bank, it is understood that 1 x Load Bank (Model BL12V1200MC, with 1200KW) with Sound Pressure Level of 91 dBA at 1m is proposed at Level 18 on the northern side. We have assumed a solid noise barrier on the northern façade to reduce the noise from the load bank reaching the apartments on Rickard Road. Load Bank will be used during an emergency scenario or during testing of a generator (once in 3 months). Worst case noise during night-time (with attenuation from noise barrier) will comply with the project specific noise levels for emergency scenario of 56 dBA at the boundary of nearest residential apartments on Rickard Road.

5.1.2 Emergency Generator Assessment

The detailed design of the generator rooms and selection of the plant will still need to be confirmed. Refer to Table 4-4 for external noise criteria specific to emergency generators. Based on preliminary selection it is understood that CAT C32 Diesel Generator set (1500 KVA) will be installed inside the generator room on Level 18 with Sound Pressure Levels of 80dBA at 1m. It is expected to require the following acoustic treatment to achieve boundary noise compliance:

- Heavy construction to acoustic enclosure walls and ceiling
- Acoustic attenuators to intake, outlet and exhaust

The emergency generator noise emissions from the development will be designed to satisfy the boundary noise requirements. Treatment requirements will be reviewed in detail as the design of the development progresses.

Based on the information provided the emergency generator will comply with the project specific noise levels for emergency scenario of 56 dBA at the boundary of nearest residential apartments on Rickard Road.

All mechanical services noise emissions from the development will be designed to satisfy the boundary noise requirements. These will be reviewed in detail as the design of the development progresses.

5.1.3 Operational Vibration Impact

All operational activities expected to occur on this site are likely to have negligible impact on the surrounding buildings with respect to vibration and are expected to comply with the stipulated vibration limits. All vibrating plant has been assessed in accordance with ASHRAE Chapter 47, which specifies relevant vibration isolation for plant and machinery.

5.1.4 Building envelope

The building envelope, internal partitions and building services equipment will be designed in general accordance with recommended internal design sound levels as per AS/NZS2107:2016 and Development Near Rail Corridors and Busy Roads – Interim Guideline. Based upon current assessment for the project it is recommended that 6mm monolithic glazing/12mm Airgap/10mm monolithic curtain wall glazing, with a minimum transmission loss of Rw37, will be suitable for the acoustic requirements of this project.

5.2 Outdoor Balcony Use

We note that the use of the outdoor balconies could have the potential for functions and/or outdoor congregation space. For preliminary planning purposes we have assumed a typical worst-case social event using the following assumptions:

- 100 persons on the outdoor balcony, with 50% (or 50 persons) speaking in raised voice at any given time;
- Assumed staged voice sound power level of L_w=74 dB(A) (as per AS2822-1985 Staged Vocal Effort, 66 dB(A) at 1m);
- Total crowd sound power level of Lw91 dB(A) (or 74dB(A) +10 x log (50) persons);
- Typical distances of 35m to the nearest affected residential apartments in Rickard Road;

Predicted Noise levels are summarised below in Table 5.1.

Table 5-1: Predicted Balcony Noise Levels, dB(A) at the nearest affected receivers.

Location	Predicted Traffic Noise	PNTL	Complies Yes/No
Day	50	58	Yes
Evening		53	Yes
Night		47	No

Based upon these preliminary findings, the use of the balcony spaces for open air use should be limited the day and evening periods only. It is not recommended that these spaces on the northern façade are used past 10pm. For general management it is recommended that the number of people accessing the balcony is limited to smaller gatherings where possible.

5.3 Operational Car Park Noise

Based upon the data provided in the ARUP TMAP Traffic report (dated August,2020), it is stated that provision for 87 car parking spaces, which will be provided on site to staff only parking. No parking will be provided for students and hence traffic movements will be relatively limited.

To assess the noise impacts of site related noise emissions the following assumptions were made:

- It was conservatively assumed that all 87 car spaces would be full during a typical peak hour period, - hence for a typical 15-minute assessment period, 25% of on-site car movements will occur i.e. 21.75 car movements in 15 minutes;
- Entry and exit points are via on the western side of the site, at typical distances of 75m to the nearest affected residential locations on Rickard Road;
- Typical traverse of 30m from the carpark portal carpark to/from Rickard Road;
- Estimated distances of 47-55m to the nearest affected residential receivers;
- Typical event time of 7 seconds, assuming 30m traverse at 15km/h;
- Using a typical vehicle L_{Amax} of 65 dB(A) measured at 8m traversing a carpark

  where: SEL = L_{Amax} + 10 log ((0.5 x (t2-t1)) / t_{ref}) and:

  - *tref = 1 second;*
  - *N = no. events and in period T;*
  - *T = total time period under consideration in seconds which is 15 minutes, or 900 seconds;*
  - *(t2-t1) = duration of single event in seconds (t=7)*

As shown in Table 5-2: Predicted on site traffic noise emissions to the nearest affected residential locations – Rickard Rd. during a typical peak usage for the car park during the Day, Evening and Night periods, predicted on site noise levels of 53-55 dB(A) which are predicted to comply with the NSW NPfI for Day and Evening.

Table 5-2: Predicted on site traffic noise emissions to the nearest affected residential locations – Rickard Rd.

Location	Predicted Traffic Noise	PNTL	Complies Yes/No
Day	53-55	58	**Yes**
Evening		53	**Yes**
Night		47	**No***

The only time where the peak usage of the carpark is predicted to exceed the Project Noise trigger levels is during the night, but we believe this scenario is not typical. Therefore we believe no mitigation measures are required for traffic Nosie impact of this particular building.

Note*: Further to the above, section 5.5.1 of the ARUP TMAP Traffic report, states that it is estimated that the car park will generate a total of 48 vehicular trips in the AM peak and 45 in the PM peak hour and not the estimated critical 100% of use as stated above, therefore we expect that the noise estimations will be complying with the PTNL at all times. Also Section 5.9.1 estimates that the demand for the carpark will considerably decrease after 18 hours and before 7 hours.

6 CONSTRUCTION ASSESSMENT

6.1 Preliminary Noise Assessment

The following has been assumed in regards to noise intensive equipment/activities:

- Construction will be undertaken in standard construction hours
- Excavations may be undertaken including Rock breaking to be undertaken
- Main structural works and building erection.

For the assessment reference sound levels for representative equipment have been taken from the BS5228 databases. The documents include extensive databases of sound data covering trucks, excavators, hand tools and all manner of other construction equipment and activities. The ratings listed are for individual pieces of equipment at constant operation.

Table 6-1: Typical External Noise Levels of Demolition and Construction Machinery/Activity

Item #	Activity /Machinery	BS 5228 – 1:2009 reference number	Leq Sound Pressure Level at 10m (dBA)
Excavation and Demolition			
1	Tracked excavator, 30 t, 170kW	Table C2 Ref 16	75
2	Excavator with mounted rock breaker 23 t, 102 kW	Table C9 Ref 12	82
3	Articulated dump truck 23 t, 187 kW	Table C4 Ref 2	78
4	Dozer 28 t	Table C2 Ref 11	79
5	Tracked mobile crane 132 Kw / 55 t	Table C3 Ref 29	70
Structural / Piling Works			
6	Tracked excavator, 30 t, 170kW	Table C2 Ref 16	75
7	Articulated dump truck 23 t, 187 kW	Table C4 Ref 2	78
8	Large Piling rig 110 t / 20 m deep / 1.2 m diameter	Table C3 Ref 17	84
9	Concrete mixer discharging with concrete Pump 26 Ton / 7 m3 + 22m boom	Table C4 Ref 28	75
10	Tracked mobile crane 132 Kw / 55 Ton	Table C3 Ref 29	70
Fit out Works			
11	Handheld cordless nail gun (15 to 50 mm nails)	Table C4 Ref 95	73
12	Diesel Generator	Table C4 Ref 78	66
13	Tower Crane 88 Kw / 22 t	Table C4 Ref 48	76
14	Diesel scissor lift 24 Kw / 6 t	Table C4 Ref 59	78
15	Dust suppression unit trailer	Table C4 Ref 91	57

6.2 Preliminary Vibration Assessment

Based on the information available at this stage, the construction activities expected to occur on the site are likely to have little to no impact on the surrounding buildings on a vibration basis. Compliance with vibration limits is expected based on ensuring ground compacting equipment is selected to adherer to minimum safe working distances.

It is important to note that construction vibration levels depend on several factors. These include the activity, the machine, the geology of the ground and the distance between the building and the source. Surface works are expected to have a lower vibration impact than ground compacting/breaking works.

NSW RMS provides safe operating distances as per the *CNVG* for cosmetic damage to the building and for human response to vibration which has been used as a guideline at this stage. Table 6-2 below lists minimum safe working distances for critical equipment. Based upon current work distance to the nearest affected receivers, with minimum working distances of 12m near the library site, it is recommended that the use smaller hydraulic hammers is used at these working distances.

Based upon initial estimates vibration propagation formula, which have been provided in the now superseded RTA Environmental Noise Management Manual (2001), based upon vibration levels at 10m distance, where vibration propagation is d^{-1} predicted vibration levels from the proposed works, based upon the proposed plant items provided in Table 6-2 were, a typical worst case operating distances of 12m predicted vibration velocity values are as follows:

- Small Jackhammer (Handheld) 0.2mm/s at 12m distance;
- Small excavator with hydraulic hammer 0.8mm/s at 12m distance;
- Large excavator with hydraulic hammer 7mm/s at 12m distance.

While these magnitudes do not predict cosmetic/structural damage, it is anticipated that human response/comfort would be impacted at these distances. The current RMS Construction Noise and Vibration Guideline sets safe working distances for vibrating plant and equipment. These are summarised below in Table 6-2. As shown the use of large hydraulic hammers would not be recommended at working distances of <22m. Hence it is recommended that the use of smaller rock breakers are used for excavation works and activity close to the Bankstown Library and Council Buildings.

Table 6-2: RMS Safe Operating Distances - *Construction Noise and Vibration Guideline 2016*

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration Guideline - AVaTG)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	2 m

In addition to the above, one of the most onerous activities regarding construction site vibration generation is Piling. The typical case of percussive piling and worst-case scenario of vibratory Piling vibration estimations are included below, using Table E.1 Empirical Predictors for groundborne vibration arising from mechanized construction works of the BS 5228 – 2.2009 part II Vibration

Table 6-3: *Vibratory Piling estimated vibration levels as per Table E.1 of the BS 5228 – 2.2009*

Equipment	Vibration level PPV (mm/s)	Source
Percussive Piling (extraction of casing) Critical cases, located at 27 m from dwellings (Rickard Rd) and piles at 9 m depth	W= 85 Kj V = 0.4 PPV (very stiff soils) V = 0.2 PPV (very cohesive soils)	Table E1. BS 5228-2:2009
Vibratory Piling (extraction of casing) Critical cases, located at 27 m from dwellings (Rickard Rd) and piles at 9 m depth	kv=50% / δ = 1.3 V = 0.8 PPV	
Percussive Piling (extraction of casing) Critical cases, located at 23 m from Council Building (Crn Rickard Rd / Jacobs St) and piles at 9 m depth	W= 85 Kj V = 0.4 PPV (very stiff soils) V = 0.2 PPV (very cohesive soils)	
Vibratory Piling (extraction of casing) Critical cases, located at 23 m from Council Building (Crn Rickard Rd / Jacobs St) and piles at 9 m depth	kv=50% / δ = 1.3 V = 1.1 PPV	

BS 5228:2009 recommends that for vibrations over 1.0mm/s affected residents should be given prior warning and explanation as to the cause of the vibration.

Note that Hoyts Cinema located at the South western Corner or Rickard Rd and Jacobs street is at 25 m from the construction site, therefore the vibration levels are below the estimations shown in tables above.

6.3 Predicted Construction Noise Impacts

Residential properties are estimated to be located between 30 m – 60 m from the construction boundary and non-residential buildings are located between 15 m – 70 m from the construction boundary.

Based upon the above plant sound power levels, which represent the worst case scenario, predicted construction noise levels for the various works phases are presented below in Table 6-4. As shown construction noise levels during both excavation and structural works phases were predicted to exceed 75 dB(A). Under the ICNG, this would support the requirements for construction noise to be managed as part of a construction noise and vibration management plan.

Table 6-4: Predicted construction noise $L_{eq,15min}$

Receivers	Recommended Hours	Period	Predicted Construction Noise Level	External Noise Management Level.
Excavation Phase				
Residential properties	Monday Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Day	72 - 73 dB(A)	48 dB(A)(noise affected) 75dB(A) (highly noise affected)
Non residential properties			70 dB(A)	70 dBA commercial properties
Structural Works Phase				
Residential properties	Monday Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Day	67 - 72 dB(A)	48 dB(A)(noise affected) 75dB(A) (highly noise affected)
Non residential properties			70 dB(A)	70 dBA commercial properties
Fit out Phase				
Residential properties	Monday Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Day	61 - 64dB(A)	48 dB(A)(noise affected) 75dB(A) (highly noise affected)
Non residential properties			64 - 67 dB(A)	70 dBA commercial properties
NB: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.				

Noise predictions in the report were made in a conservative approach, considering all the sources will be located at the critical distance to the receivers (while they are usually distributed within the construction site) and considering all noise sources working simultaneously per each phase, which is a rare case.

Further to this, acoustic modelling has been done at surface level, and does not account for reduction in noise as the depth of works progress, however based upon geotechnical information, the surface material is relatively soft clays resulting in minimised excavator and related earthworks equipment noise.

During fit out works it is anticipated that noise levels will have less noise impact.

The findings in our report show that construction works undertaken during standard hours will not exceed the Highly Noise Affected criteria of 75dBA. A formal Noise and Vibration Management Plan is therefore not anticipated to be required on the basis that the site is managed through feasible and reasonable noise mitigation methods as outlined in the NSW Interim Construction Noise Guidelines and Australian Standards 2436-2010.

In the scenario that noise mitigation and attenuation measures are implemented by the contractor to reduce further below the Australian standards, a combination of the following measures may be utilised but are not considered necessary;

- Reducing operation or noisier types of machinery (time management)
- Substituting with alternative (quieter) machinery
- Acoustic barrier and / or partial enclosures

These notes were further considered and included in Appendix B. Special consideration of feasible and reasonable will be required to manage construction noise impacts at this site during construction, due to its close proximity to the works.

As per the Interim Guideline for Construction Noise, it is recommended that investigation of all feasible and reasonable noise mitigation measures is considered, as outlined in this report. It is not anticipated that a Construction Noise and Vibration Management Plan will be required, based upon these findings.

7 TRAFFIC NOISE IMPACTS

7.1 Road Traffic Noise

For the calculation of changes in traffic noise levels, the NSW EPA has proposed the use of the L_{Aeq} for the assessment of significance of changes to road traffic noise. The L_{eq} noise level generated by traffic movement is calculated from the Calculation of Road Traffic Noise (CoRTN) algorithm following general relationship:

$L_{eq} = 10\ Log\ (N) + K$ where N is the traffic flow volume and K is a Site Constant

The site constant (K) is calculated from the actual site conditions, including distance from the road edge, the speed of traffic flow, and any unique factors such as shielding by fences etc.

Providing the site factors remain constant, therefore, it is possible to calculate the change to road traffic noise levels as:

L_{eq} change = $10\ log\ (N2/N1)$ where $N1$ is the initial traffic flow and
$N2$ is the future traffic flow

Based upon NDY's assessment of the ARUP TMAP Traffic report (dated August,2020), existing traffic levels for the site were surveyed with Rickard Road being the most relevant route future development traffic conditions were determined for the project. As shown in Table 7-1, due to current proposed changes associated with the development, it is anticipated that increased traffic flow is predicted to occur on the western side of Rickard Road, with changes up to 0.8 dB(A), while overall increases are predicted to increase by only 0.5 dB(A). Overall, it is predicted that there will be no significant increase in traffic noise on Rickard Road, from the proposed WSU development.

Table 7-1: Predicted changes in traffic noise levels, dB(A),

	AM	PM	Total
Existing peak vph			
East Rickard Rd	843	961	1804
West Rickard Rd	729	591	1320
Future peak vph			
East Rickard Rd	612	1024	1636
West Rickard Rd	884	591	1475
Predicted Changes in Traffic Noise			
East Rickard Rd	-1.4dB(A)	+0.3dB(A)	-0.4dB(A)
West Rickard Rd	+0.8dB(A)	0.0dB(A)	+0.5dB(A)

7.2 Construction Traffic Noise

As per section 3.4 of the ARUP TMAP Traffic report (dated August,2020), it is anticipated that the site will generate approximately 75 trucks per day during peak activity which is similar to have 8 heavy vehicles per hour over the course of a day, including peak times. During other construction stages the vehicle generation is expected to be approximately 50 trucks per day.

Based upon the peak hour traffic figures presented in Table 7-1, we would anticipate that additional truck movements will result only in only marginal increases in traffic noise, typically +0.02 dBA. Based upon these findings and due to existing traffic volumes, it is anticipated that constriction related traffic will not cause significant impacts during the works phase. These findings would be subject to confirmation by the works contractor, however given existing traffic flows are high, there are no significant changes in traffic noise anticipated.

8 CONCLUSIONS

The following conclusions are based on the noise data and assumptions outlined in in this report.

8.1 Noise and vibration criteria

Noise and vibration criteria have been developed in accordance with the Australian Standards and stipulated NSW guidelines. Background and Ambient noise monitoring were conducted near the site and results summarised in this report. Following additional noise monitoring conducted for a 13-day period it was determined that the site-specific noise levels were within acceptable tolerances with the previous findings, and hence we have validated adopted the original noise monitoring.

8.2 Operational Noise

All mechanical services noise emissions from the development will be designed to satisfy the boundary noise requirements of the NPfI e.g. using internally lined ductwork, attenuators and/or barriers where required. These will be reviewed in detail as the design of the development progresses. To achieve requirements under the Noise Policy for Industry, a limiting aggregate sound power level of 80dB(A).

Use of the balconies for after-hours functions is not recommended for intensive use past 10pm. As shown typical large gatherings would result in exceedances of the Night-time criteria.

Operational traffic noise was assessed against proposed parking spaces for the facility. Operational traffic on the site will not result in exceedances of the project specific trigger levels.

8.3 Building Envelope

Minimum transmission loss values have been presented in this report to meet internal noise level requirements for an educational facility. It should be noted that these recommendations are to meet the acoustic requirements only, and be subject to potentially more stringent structural, thermal and façade requirements.

8.4 Construction Noise and Vibration

The findings of this assessment have determined that construction works, which is undertaken during standard hours will not exceed the Highly Noise Affected criteria of 75dB(A) or greater during construction works. Hence it is not anticipated that a construction noise and vibration management plan will be required for these works. The findings have proposed that construction noise is managed through feasible and reasonable noise mitigation measures, outlined in the NSW Interim Construction Noise Guideline and Australian Standards 2436-2010. Additional site and noise management practices have been provided in Appendix B of this report for guidance purposes only.

Construction vibration estimations are not considered to cause any damage of the closer receiver buildings during the most onerous activity (Piling).

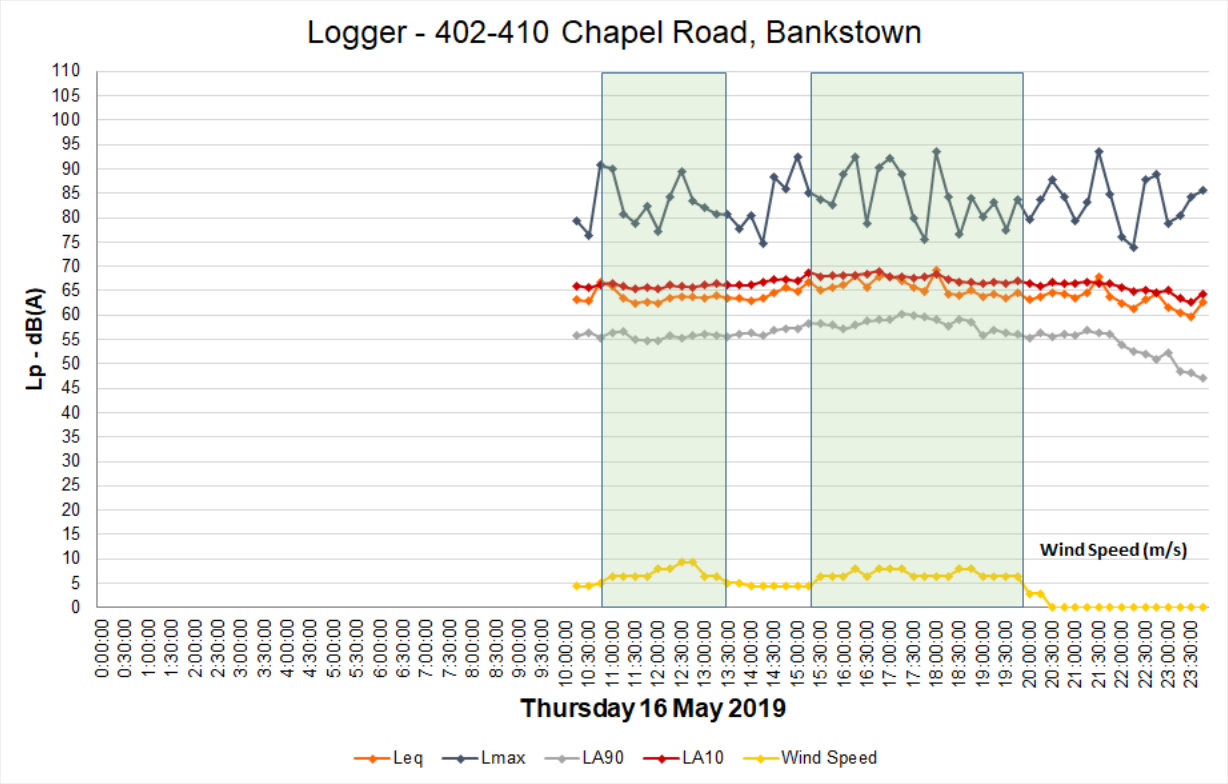
Additional findings of this report have determined that construction works during non-standard hours will exceed Construction Noise Management Levels and that any proposed work outside Standard construction hours would require additional approval by the NSW EPA.

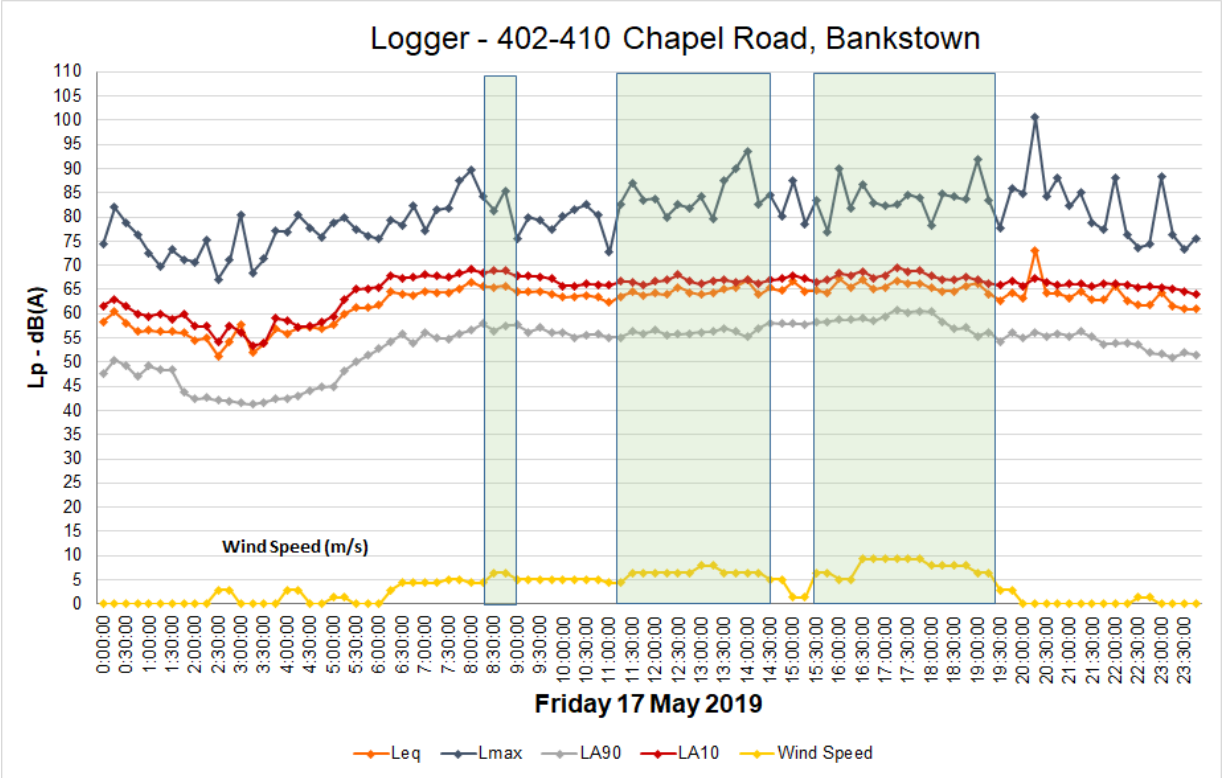
8.5 Road Traffic Noise

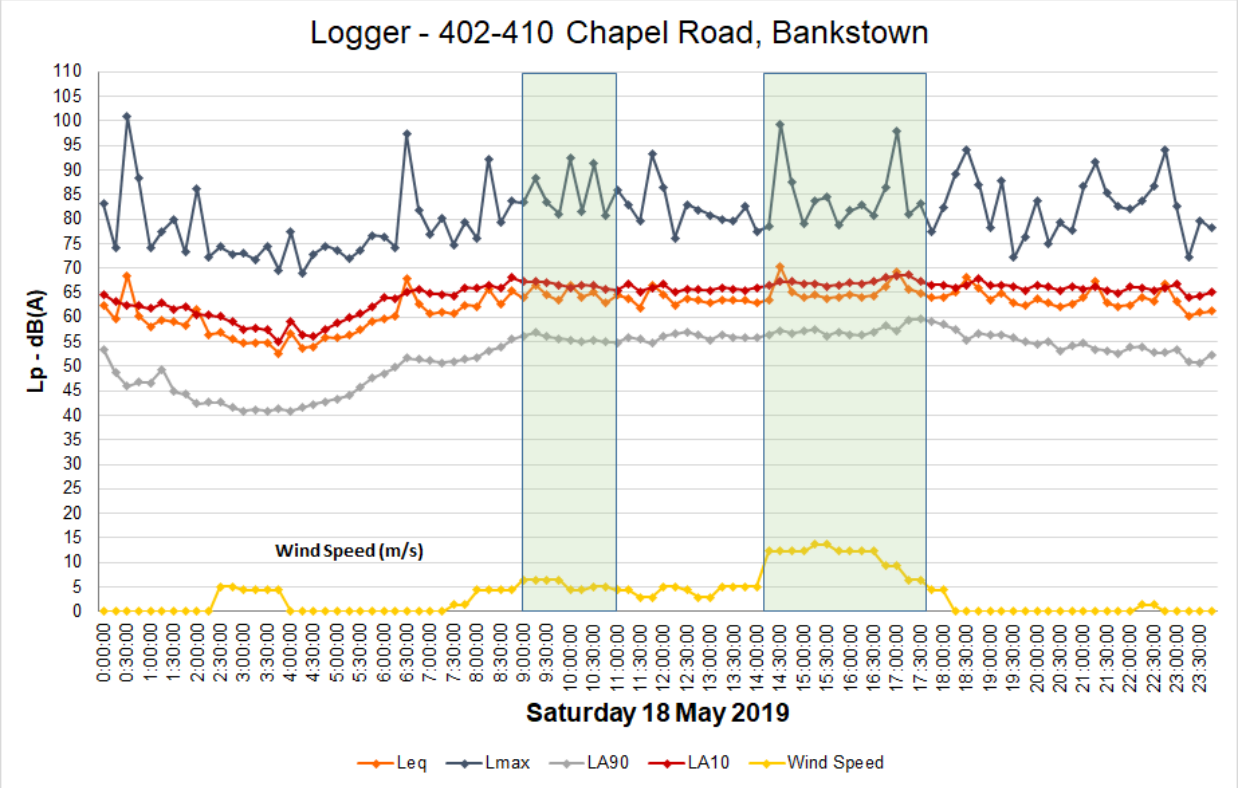
Predicted changes in traffic noise were determined not to result in significant increase in traffic noise on Rickard Road. It is anticipated that future traffic flows as post completion will result in worst-case increases of up to +0.5 dB(A) overall. Hence the proposed development is predicted to comply with the NSW RNP criteria. Due

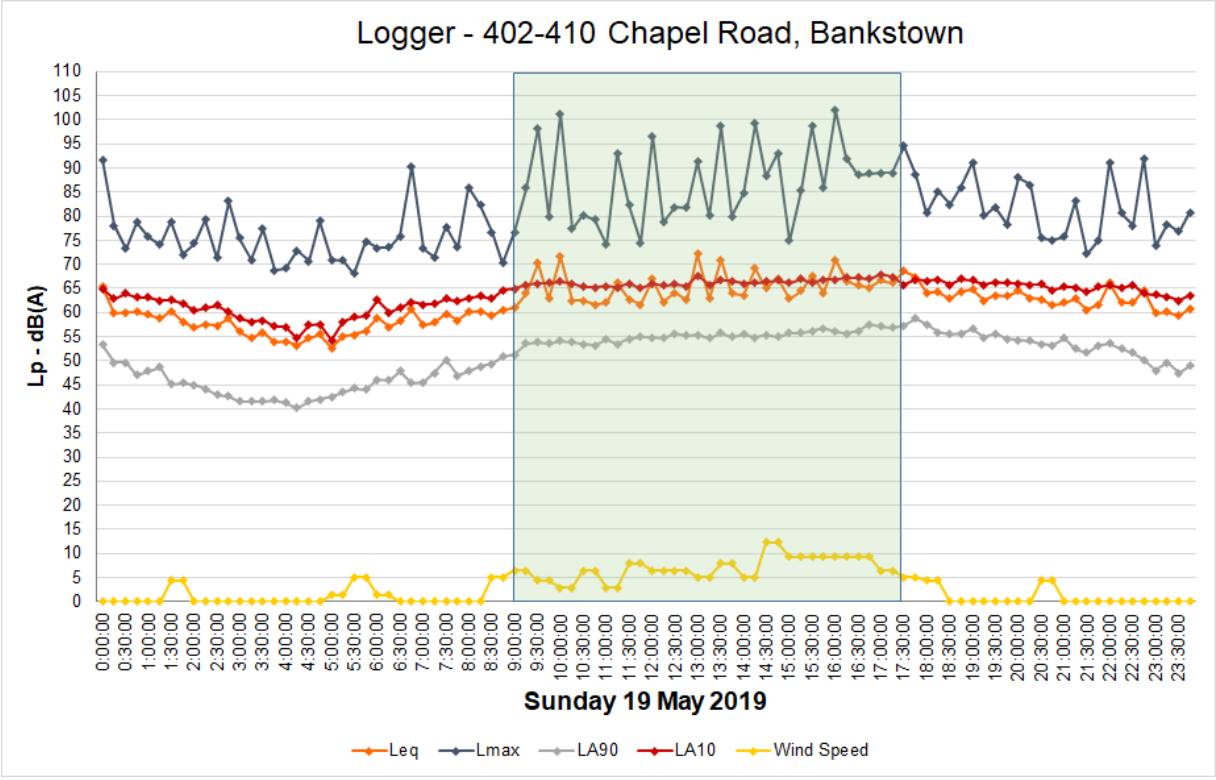
to existing traffic flows, it is anticipated that increased traffic noise during construction, will be largely negligible during site related activity, with only marginal increases in traffic noise predicted.

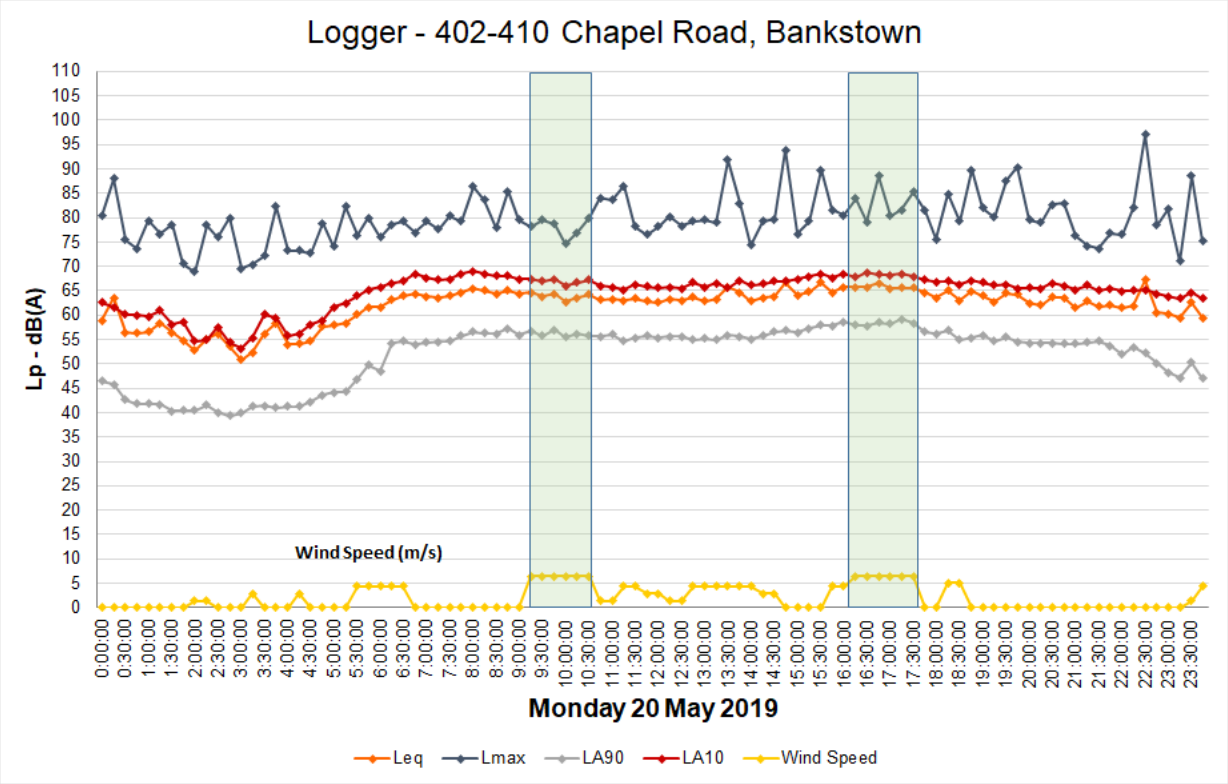
APPENDIX A - GRAPHICAL DATA FOR NOISE MONITORING LOCATIONS

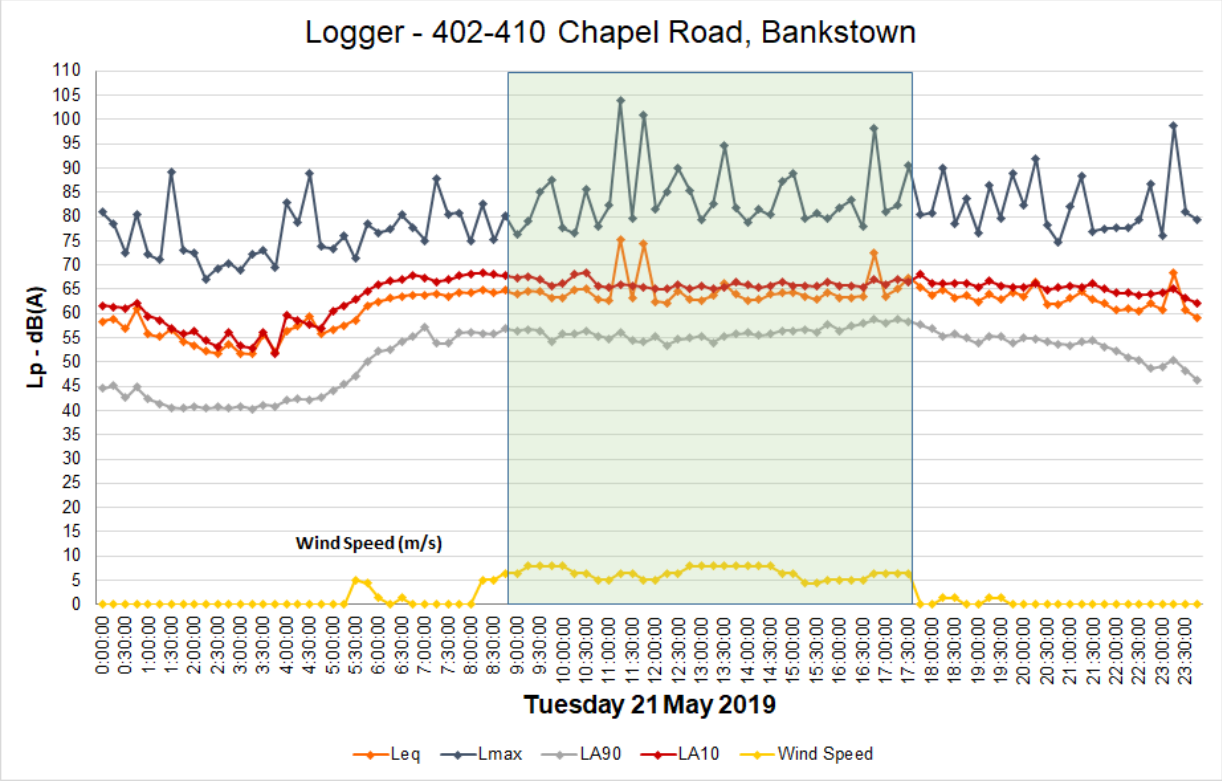


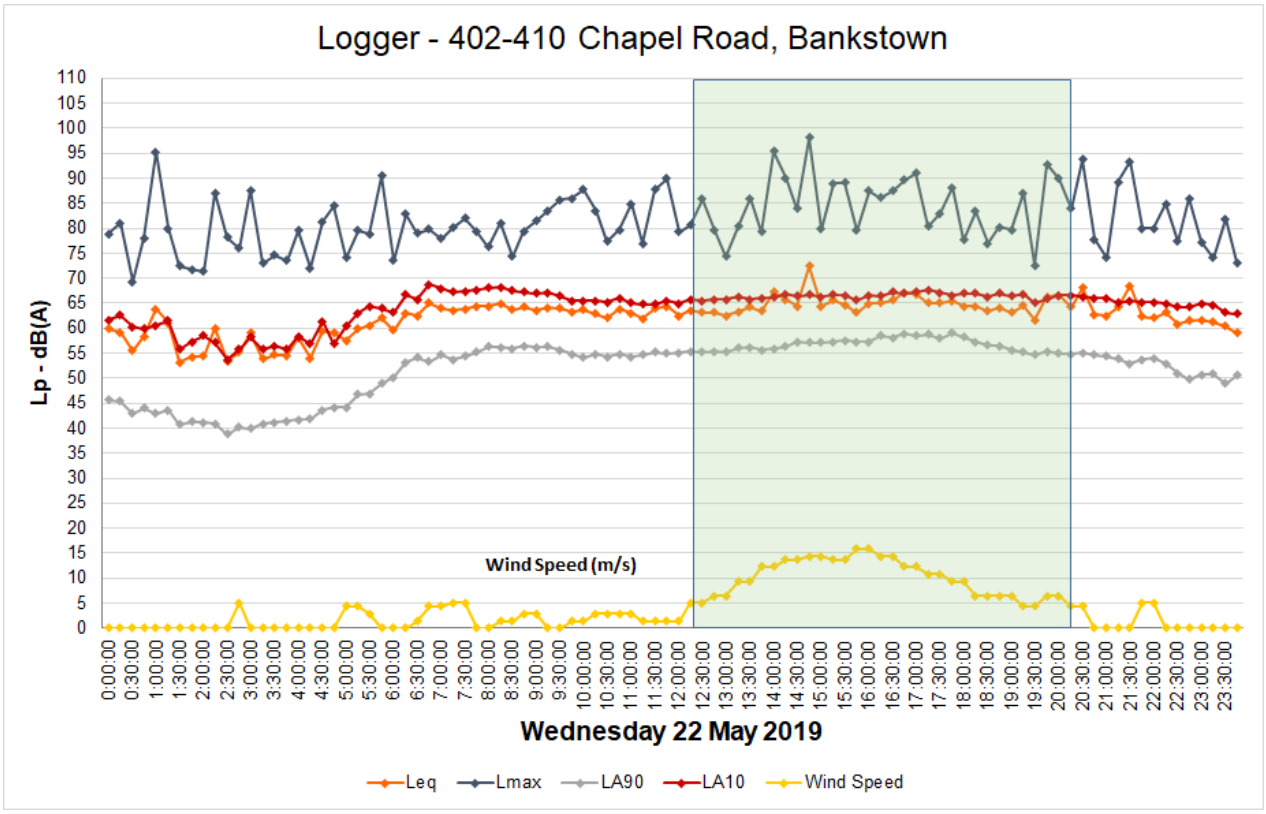



Logger - 402-410 Chapel Road, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Saturday 18 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


Logger - 402-410 Chapel Road, Bankstown
Lp - dB(A)
Sunday 19 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


Logger - 402-410 Chapel Road, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Monday 20 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


Logger - 402-410 Chapel Road, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Tuesday 21 May 2019
Leq
Lmax
LA90
LA10
Wind Speed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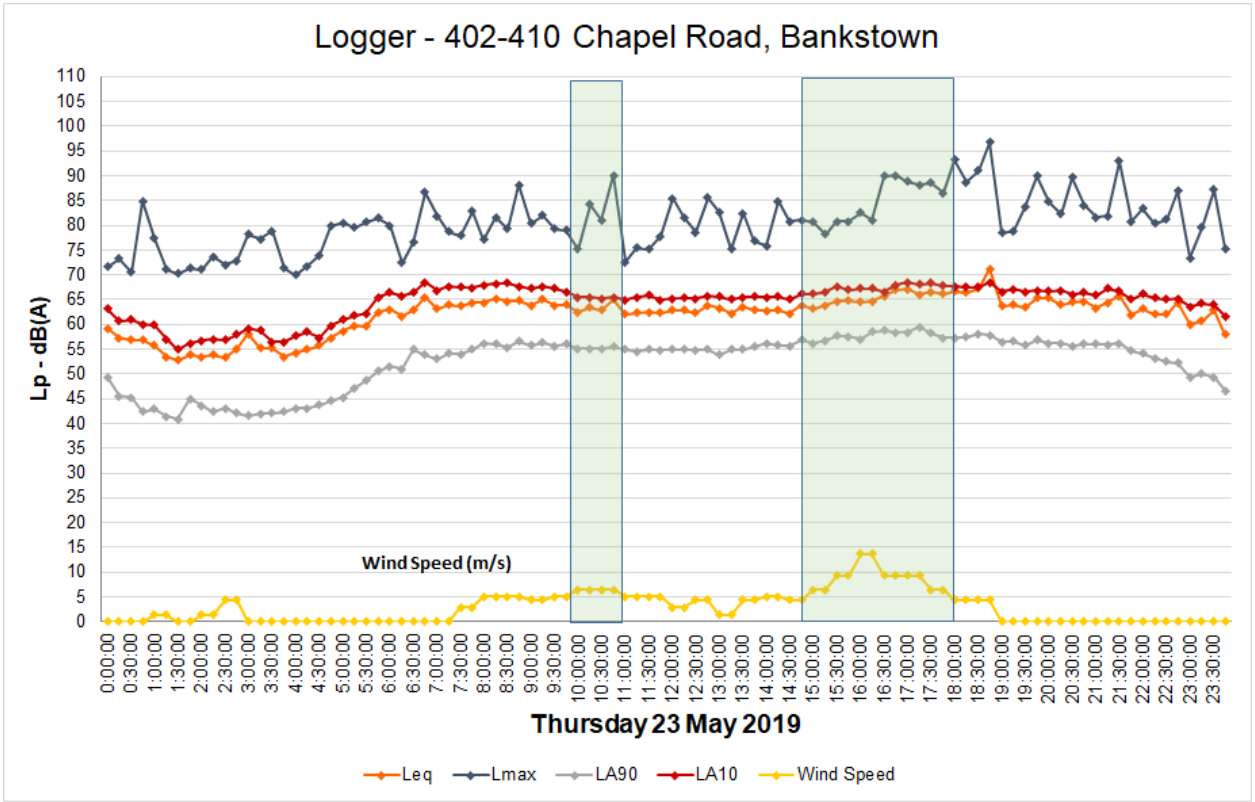
Lp - dB(A)
Wind Speed (m/s)
Wednesday 22 May 2019
Leq
Lmax
LA90
LA10
Wind Speed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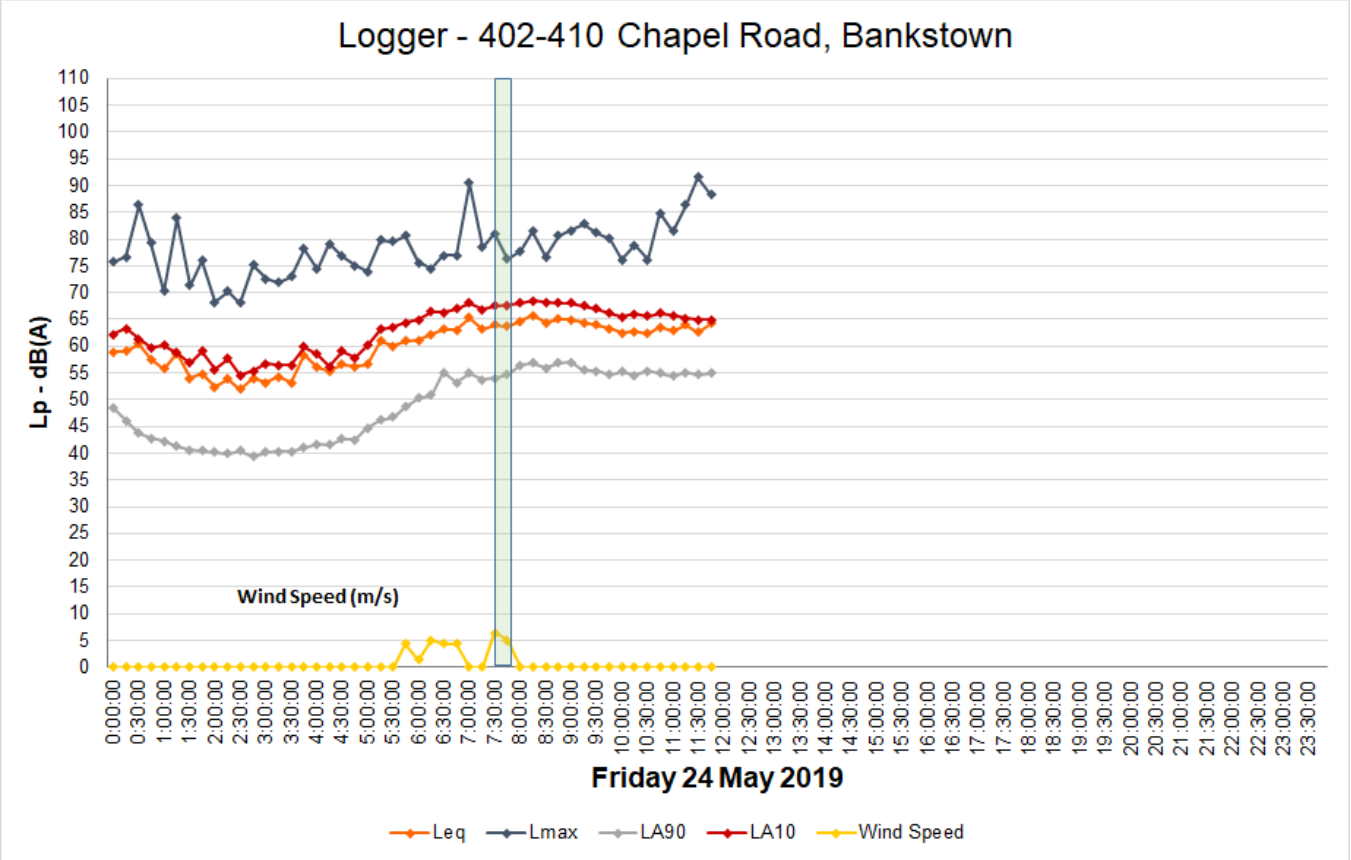
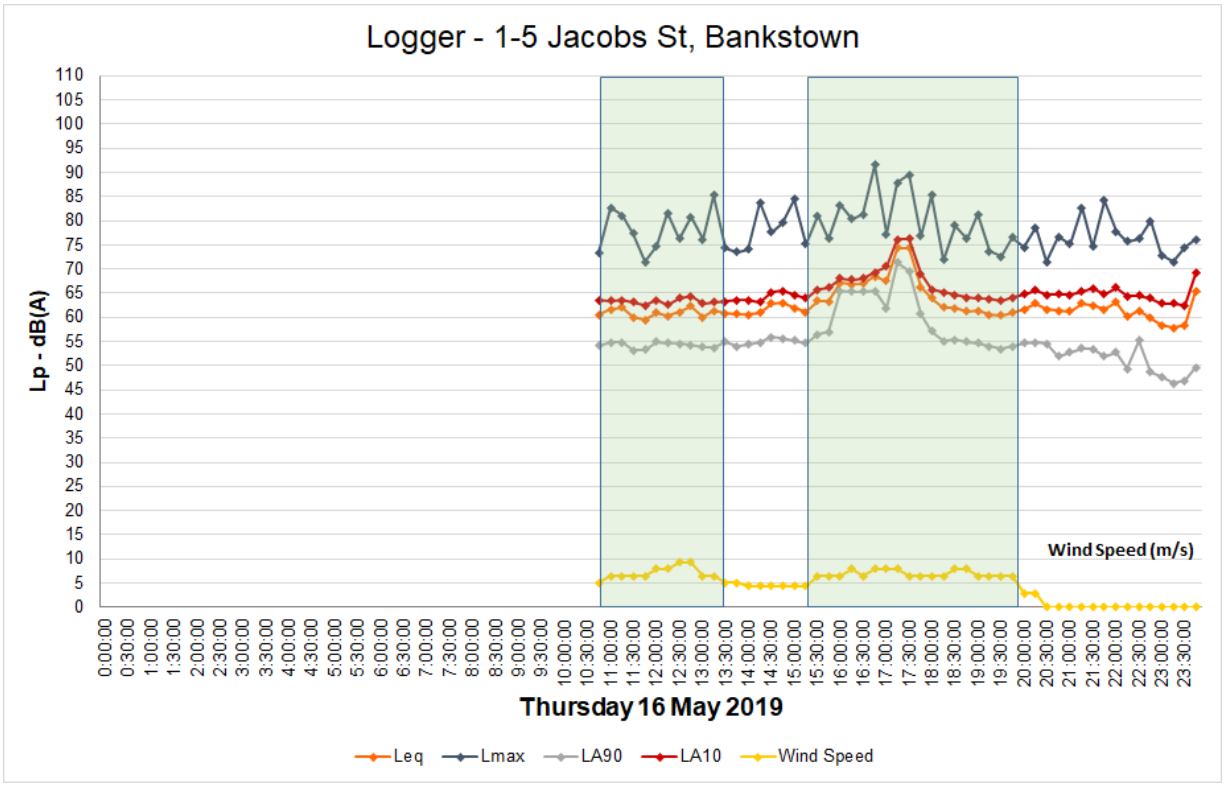
Lp - dB(A)
Wind Speed (m/s)
Thursday 23 May 2019
Leq
Lmax
LA90
LA10
Wind Speed



Note: 1-5 Jacobs Street Bankstown NSW - unattended measured noise levels, Wednesday 16 May to Thursday 24 May 2019. NB: There was no rain during the monitoring period and the bands indicate wind speeds in excess of 5 m/s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Wind Speed (m/s)
Thursday 16 May 2019
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Lmax
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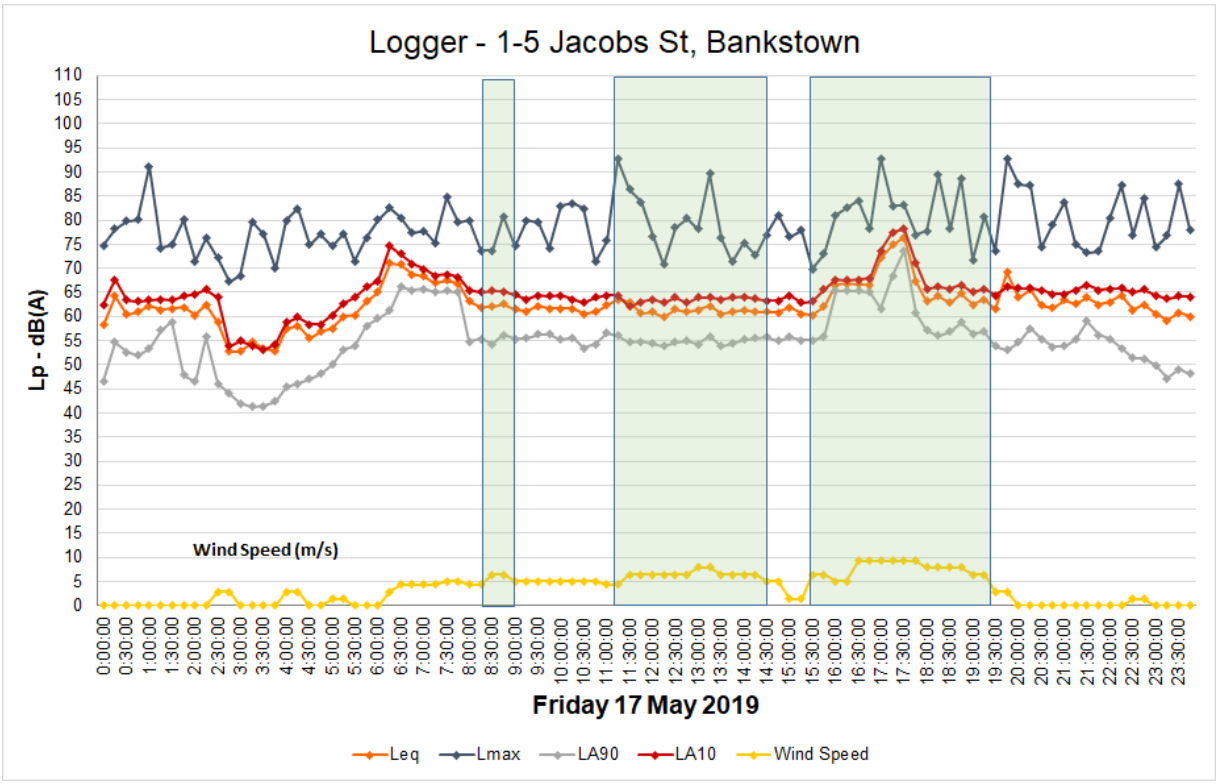
LA10
Wind Speed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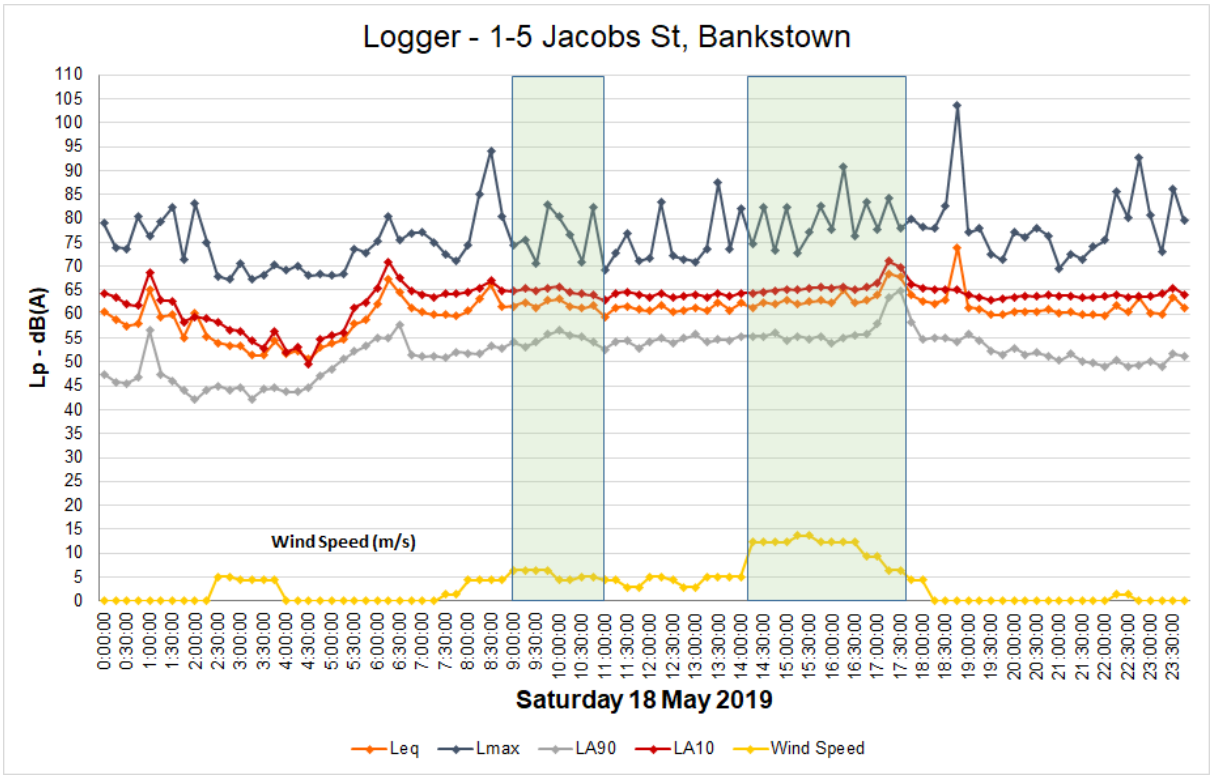
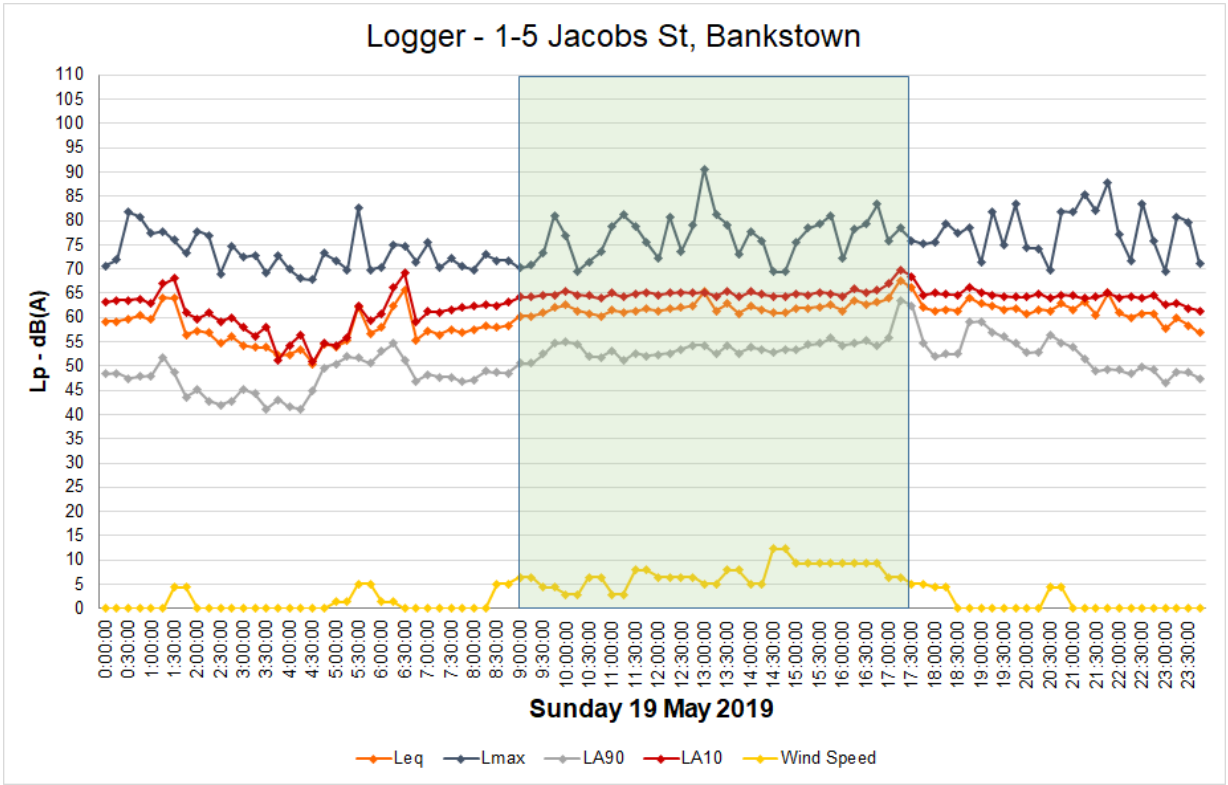
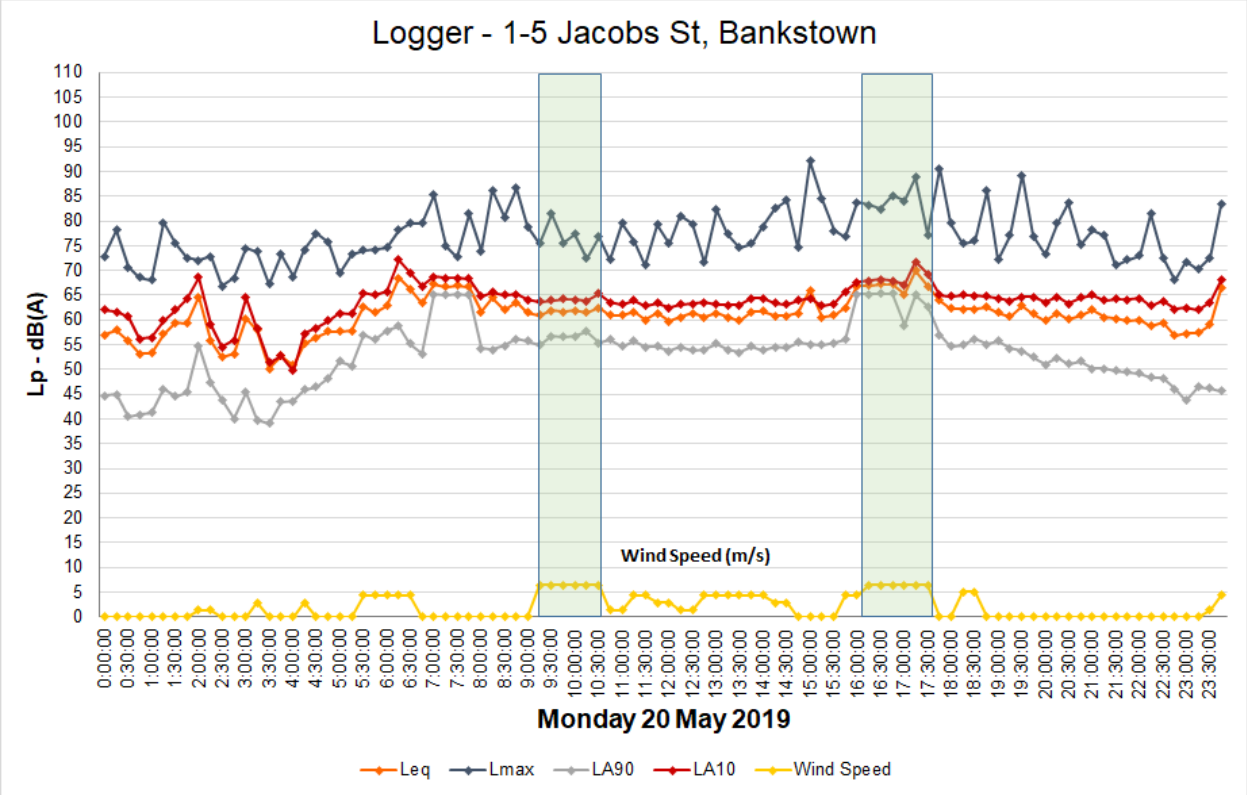
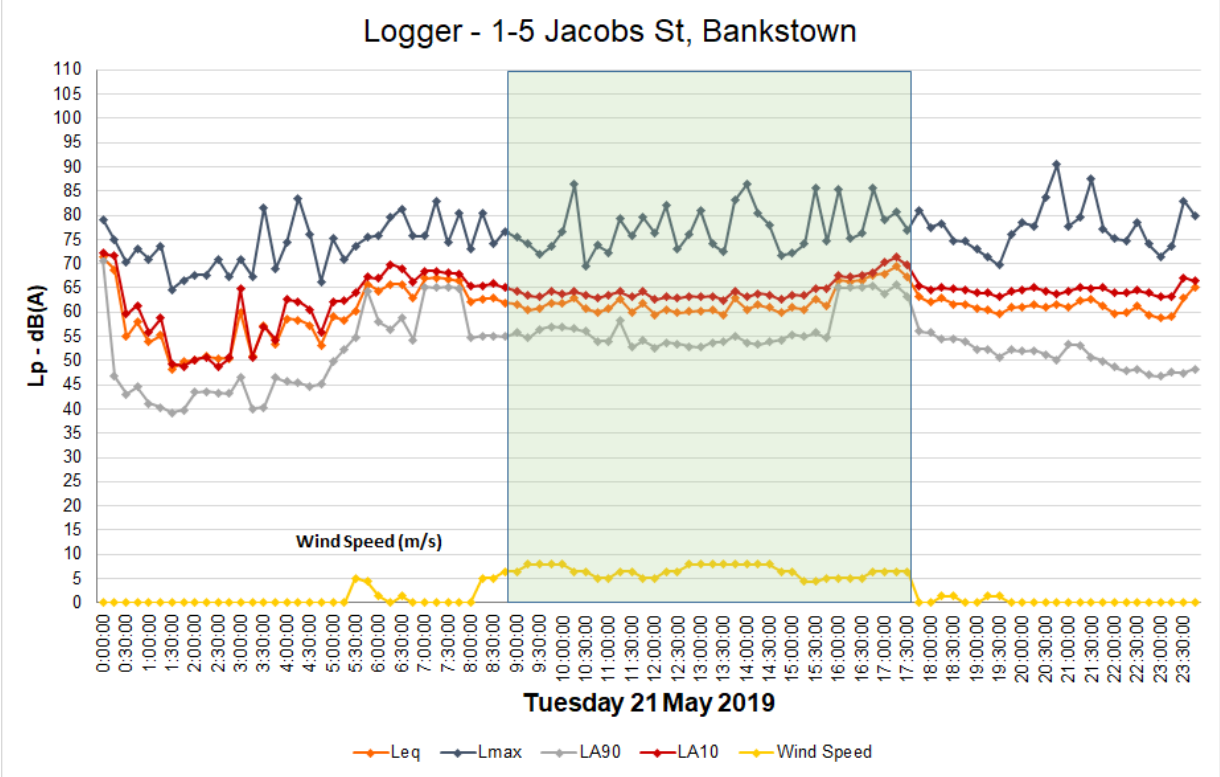
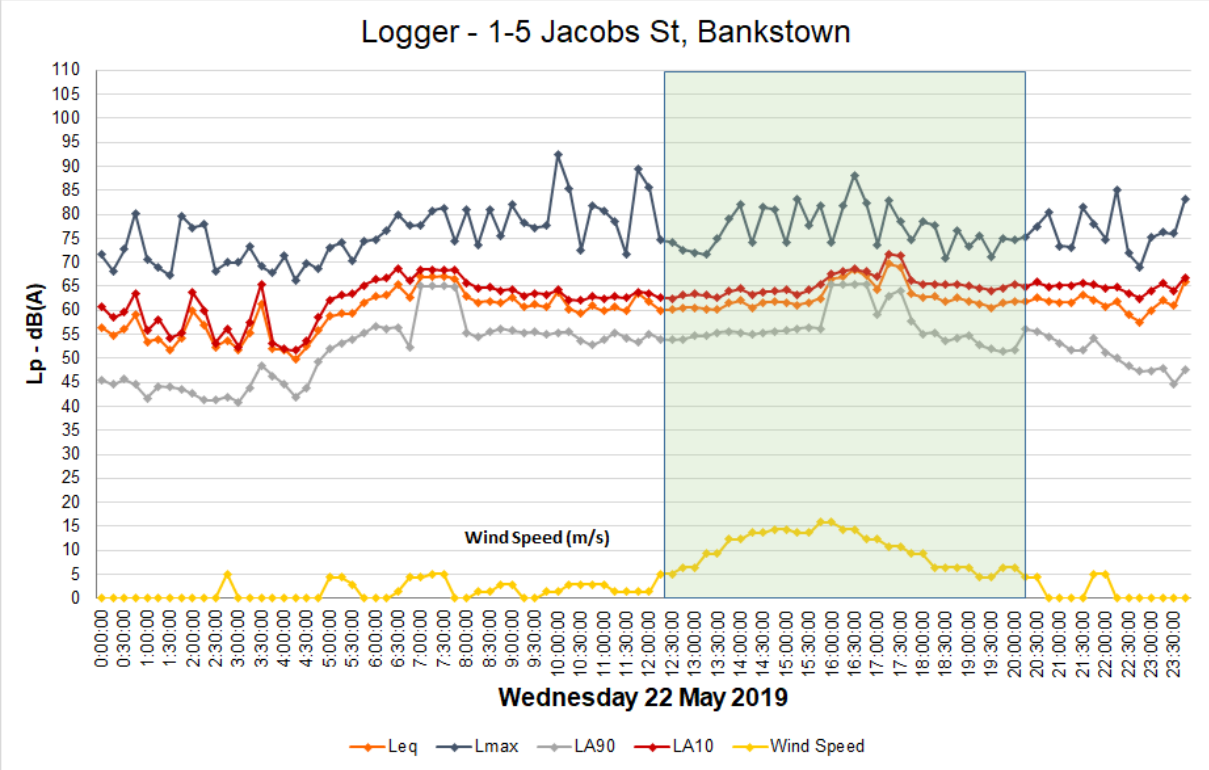
Lp - dB(A)
Wind Speed (m/s)
Friday 17 May 2019
Leq
Lmax
LA90
LA10
Wind Speed

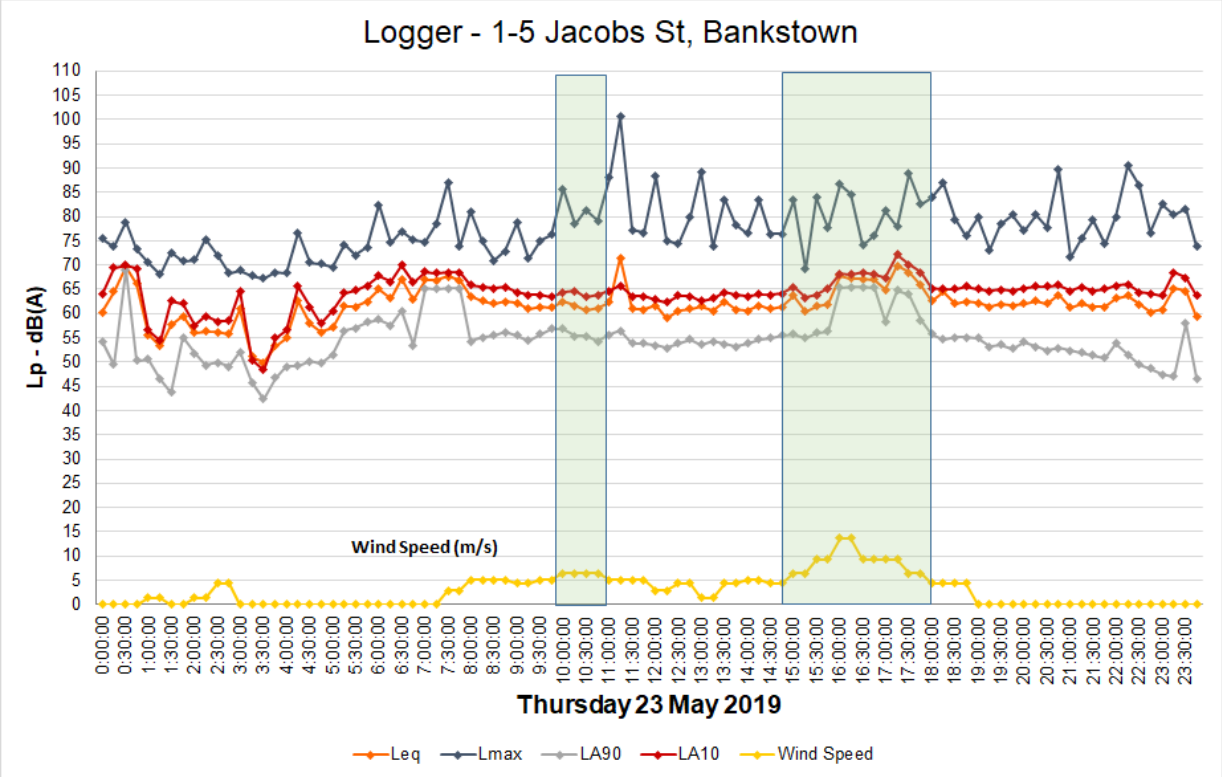

Logger - 1-5 Jacobs St, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Saturday 18 May 2019
Leq
Lmax
LA90
LA10
Wind Speed

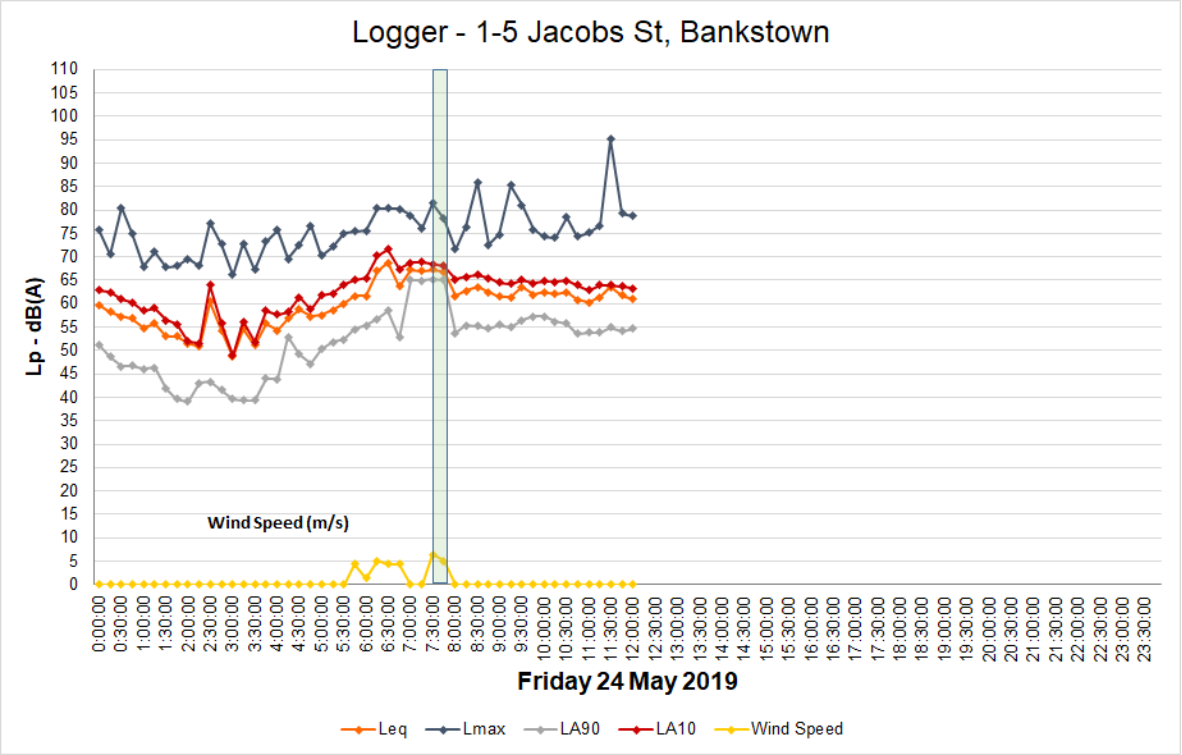

Logger - 1-5 Jacobs St, Bankstown
Lp - dB(A)
Sunday 19 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


Logger - 1-5 Jacobs St, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Monday 20 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


Logger - 1-5 Jacobs St, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Tuesday 21 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


Logger - 1-5 Jacobs St, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Wednesday 22 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


Logger - 1-5 Jacobs St, Bankstown
Lp - dB(A)
Wind Speed (m/s)
Thursday 23 May 2019
Leq
Lmax
LA90
LA10
Wind Speed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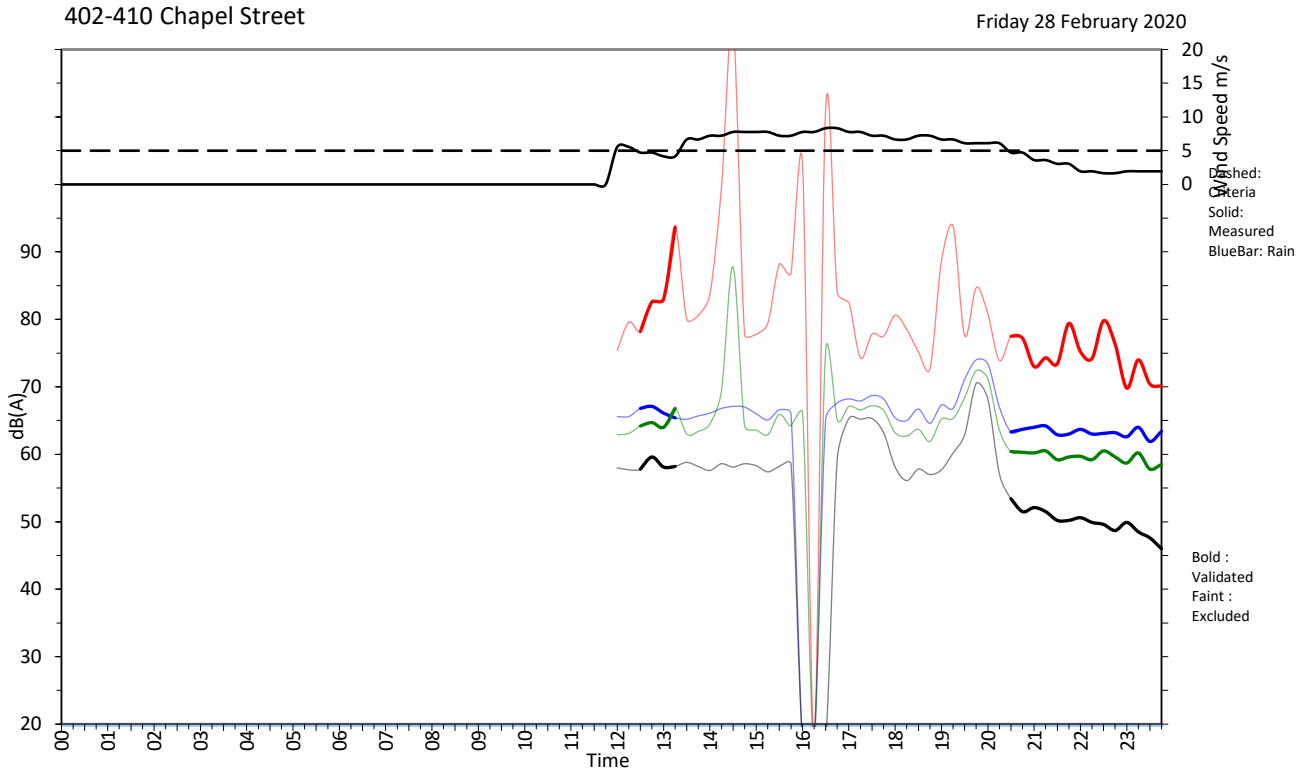
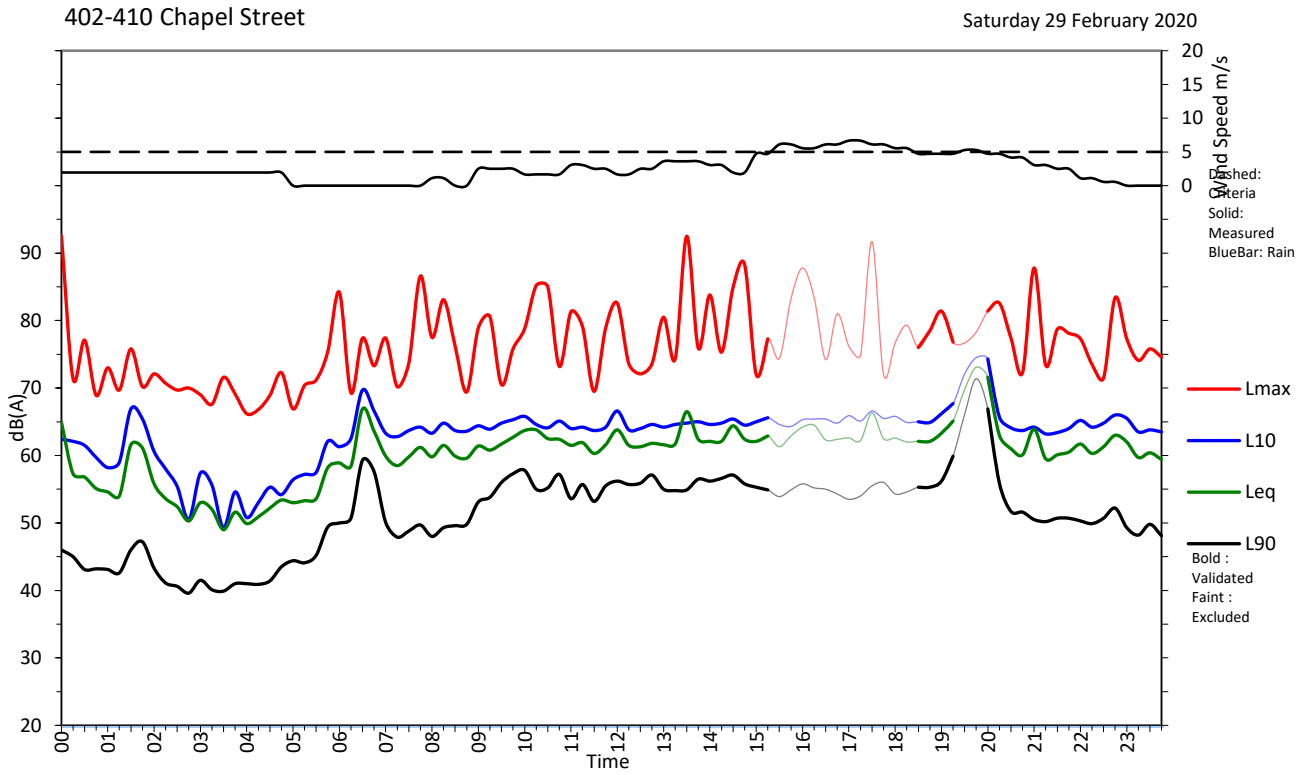
Lp - dB(A)
Wind Speed (m/s)
Friday 24 May 2019
Leq
Lmax
LA90
LA10
Wind Speed


402-410 Chapel Street
Friday 28 February 2020
dB(A)
Wind Speed m/s
Time
Dashed: Criteria
Solid: Measured
BlueBar: Rain
Bold : Validated
Faint : Excluded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Saturday 29 February 2020
dB(A)
Wind Speed m/s
Time
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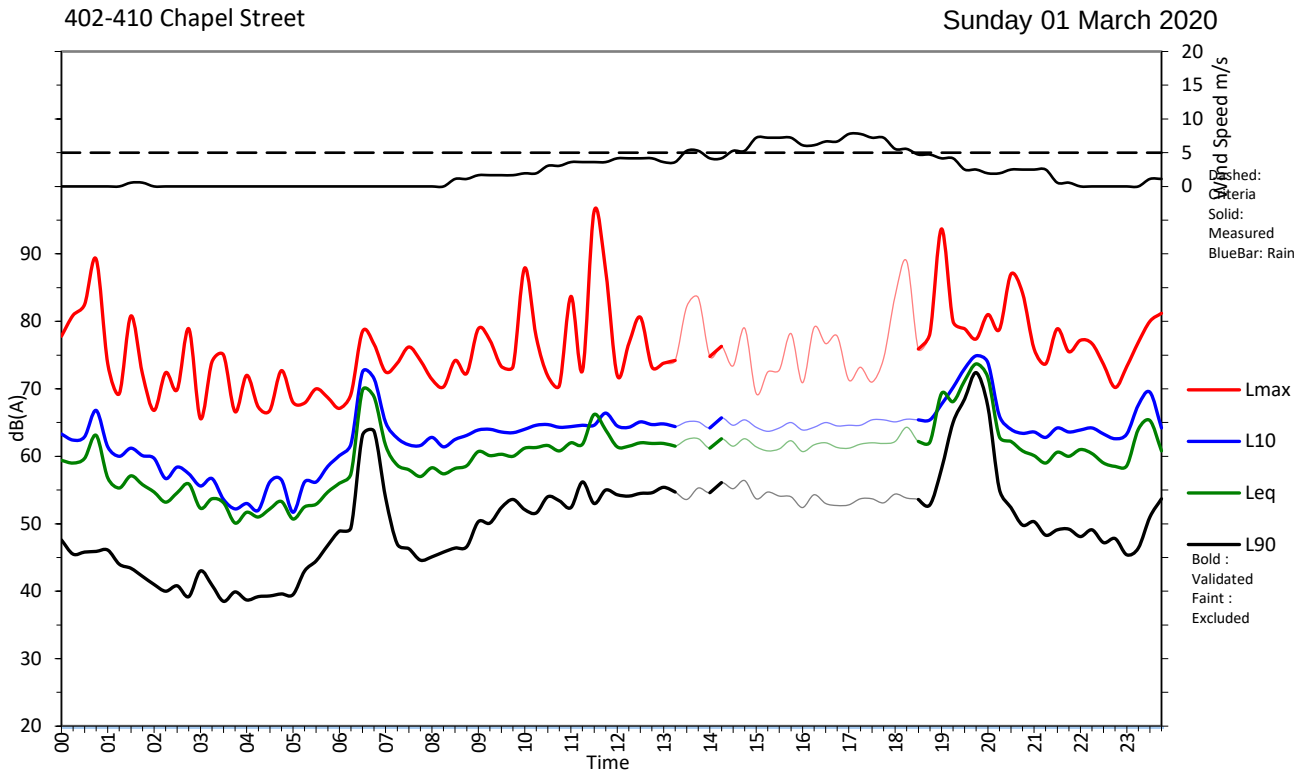
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Sunday 01 March 2020
dB(A)
Wind Speed m/s
Time
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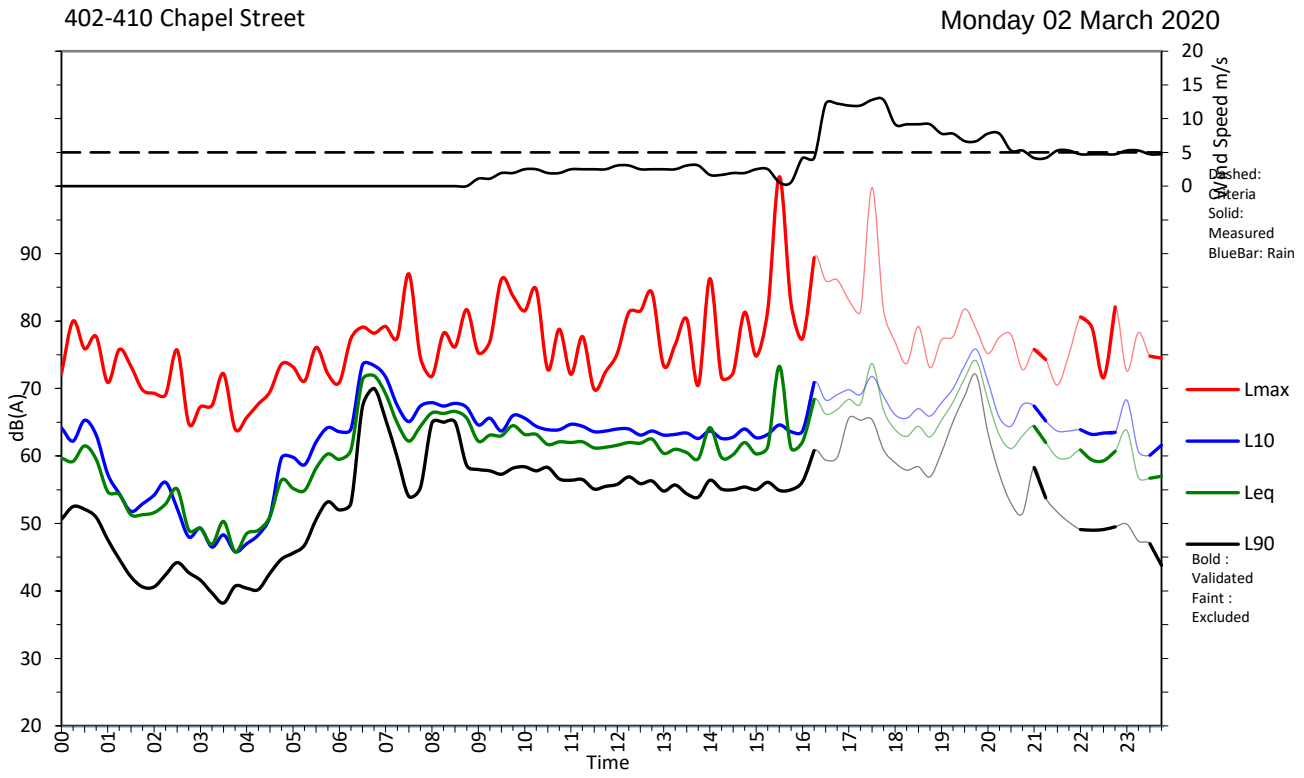
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Monday 02 March 2020
dB(A)
Wind Speed m/s
Time
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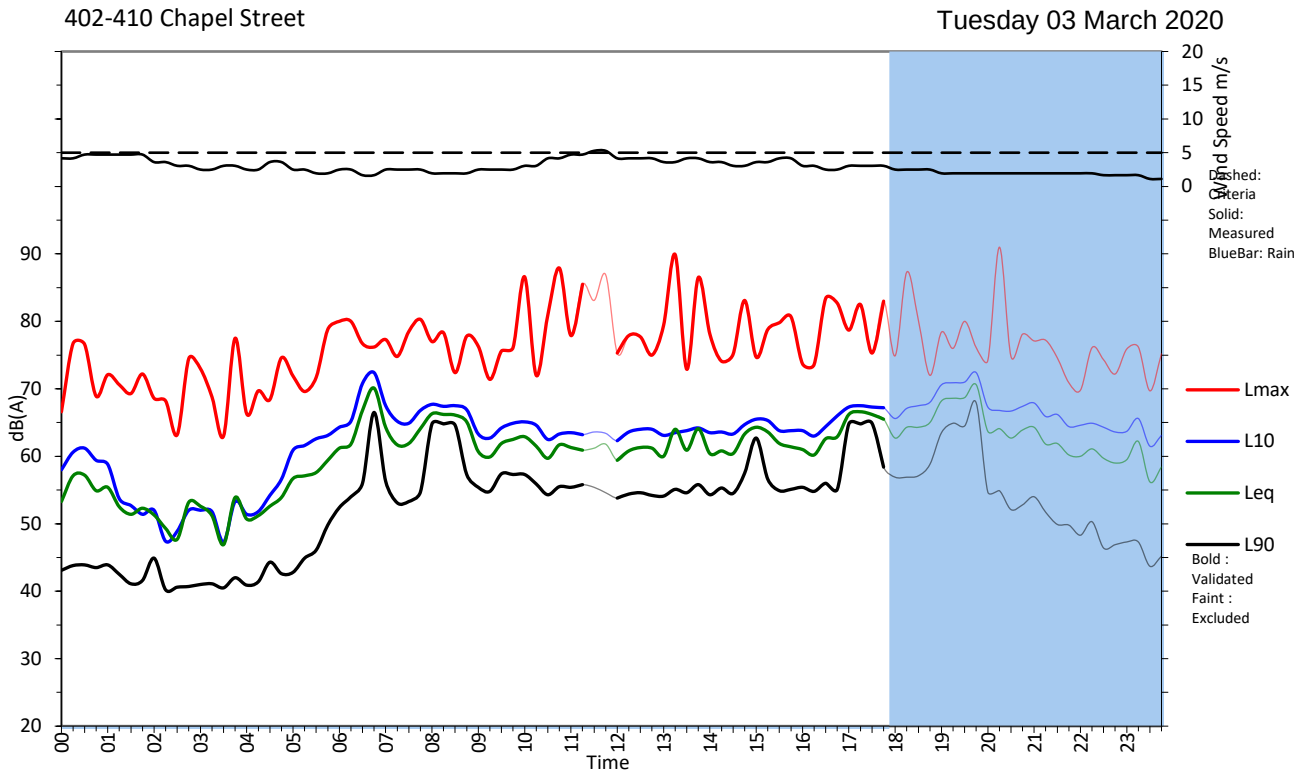
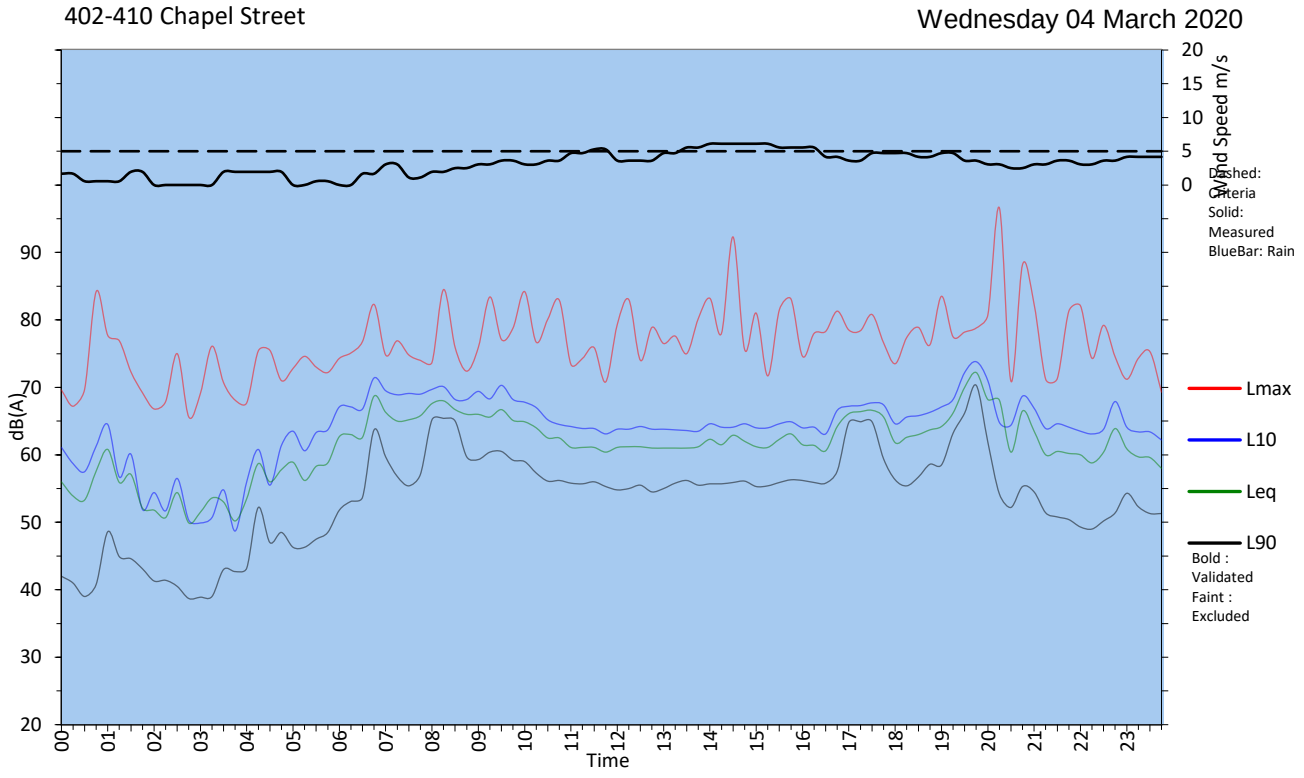
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Tuesday 03 March 2020
dB(A)
Wind Speed m/s
Time
Dashed: Criteria
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Wednesday 04 March 2020
dB(A)
Wind Speed m/s
Time
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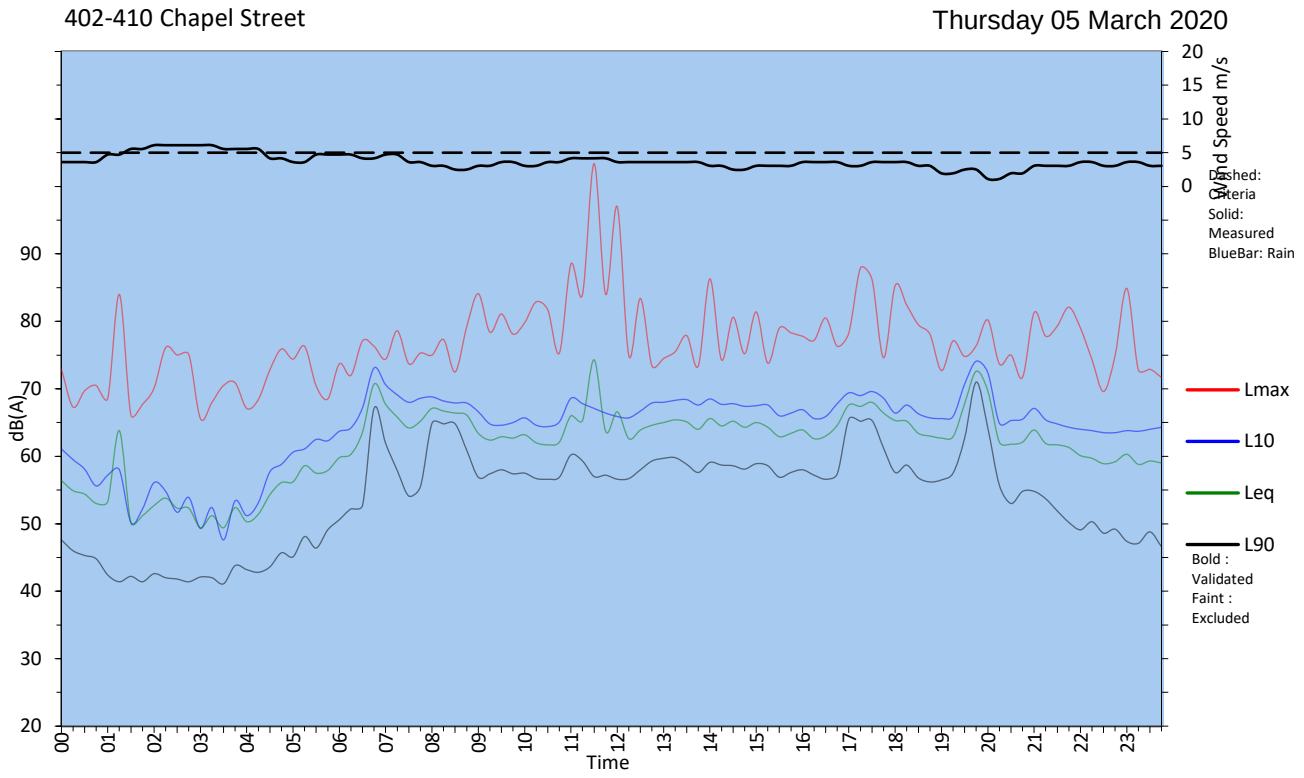
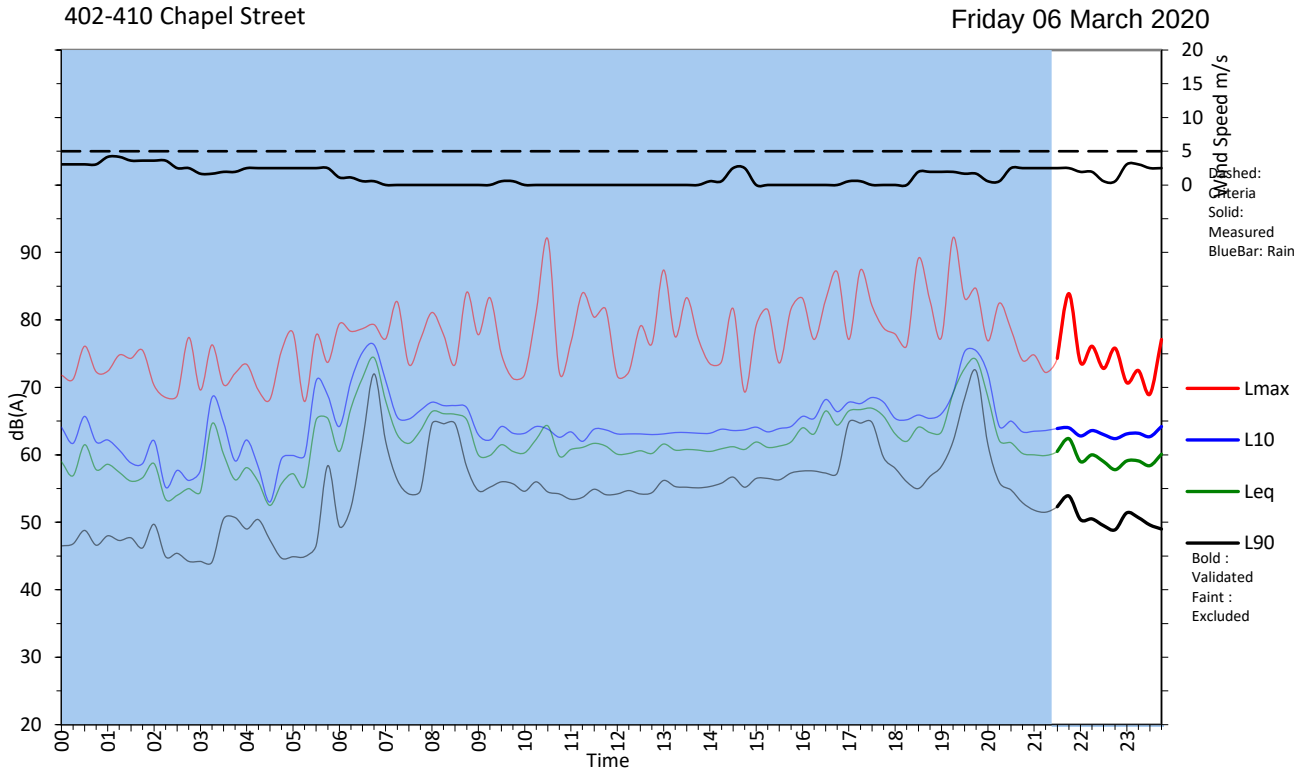
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Thursday 05 March 2020
dB(A)
Wind Speed m/s
Time
Dashed: Criteria
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Friday 06 March 2020
dB(A)
Wind Speed m/s
Time
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Leq
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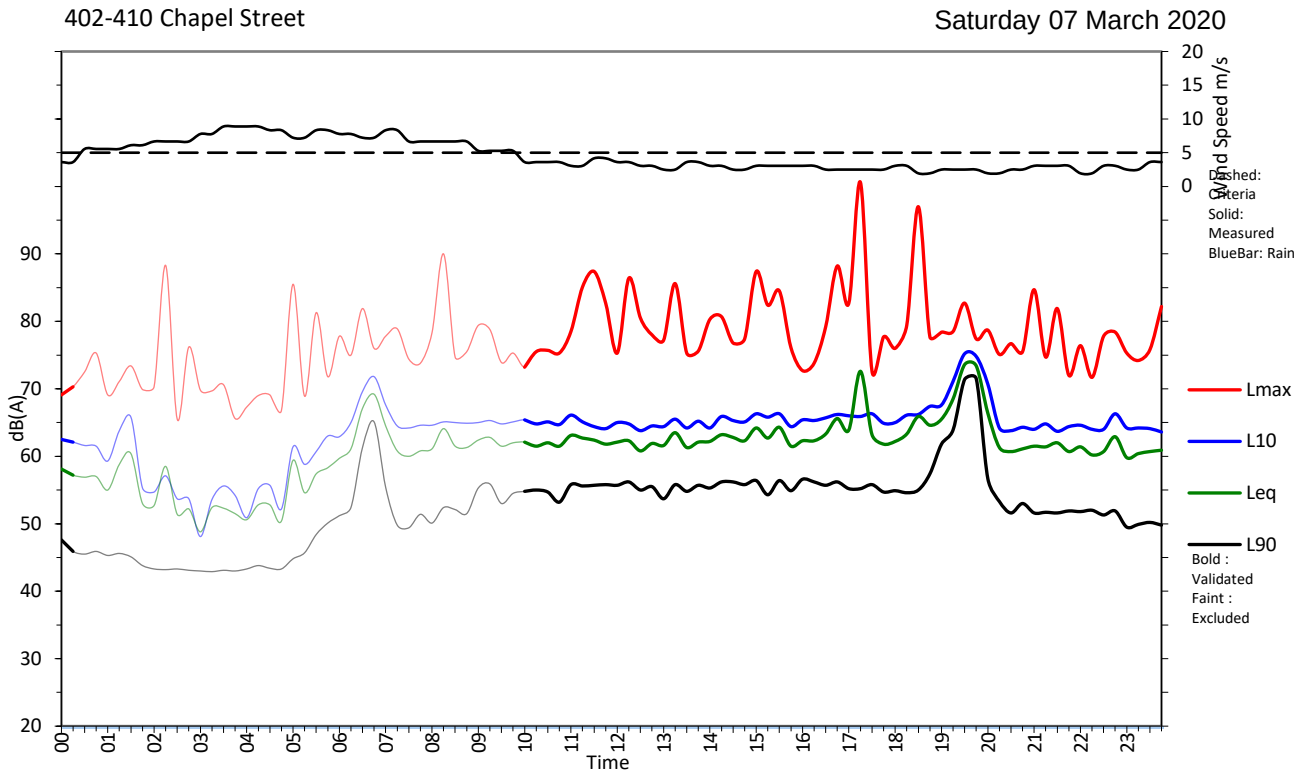
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Saturday 07 March 2020
dB(A)
Wind Speed m/s
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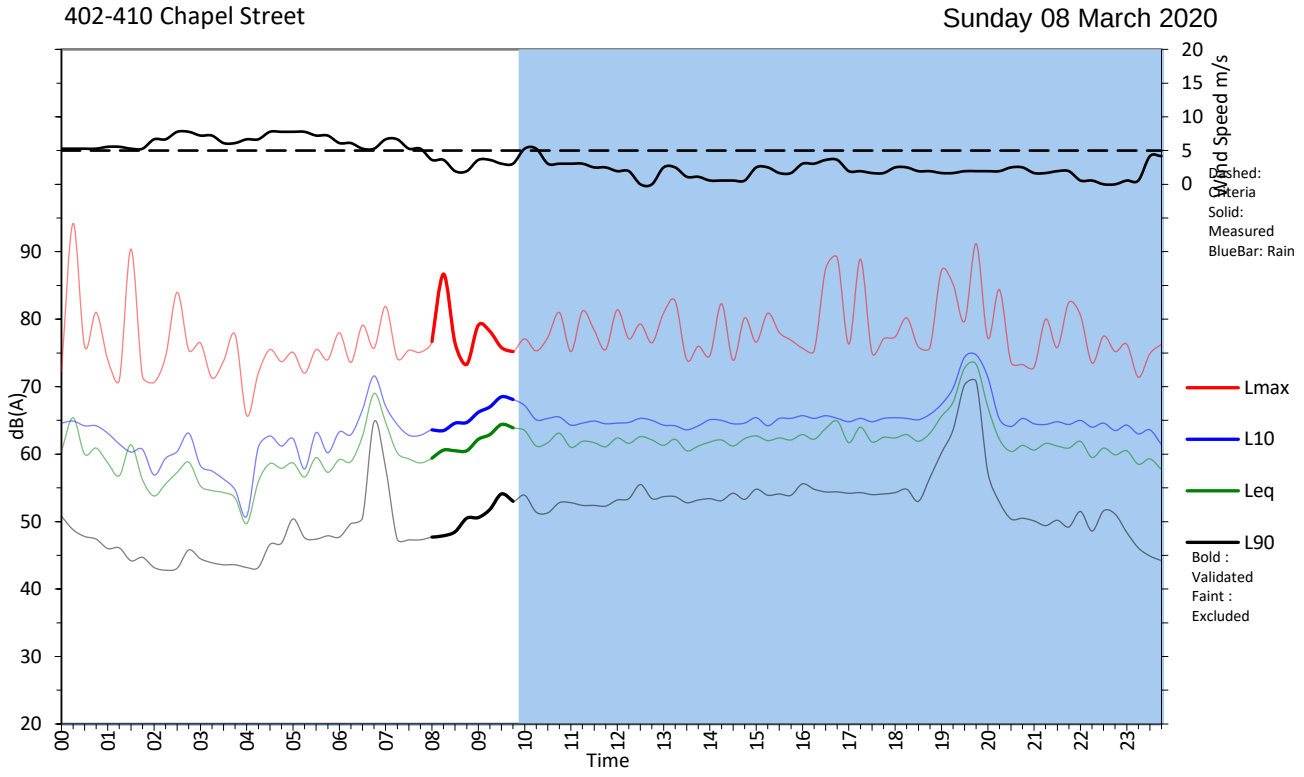
402-410 Chapel Street
Sunday 08 March 2020
dB(A)
Wind Speed m/s
Time
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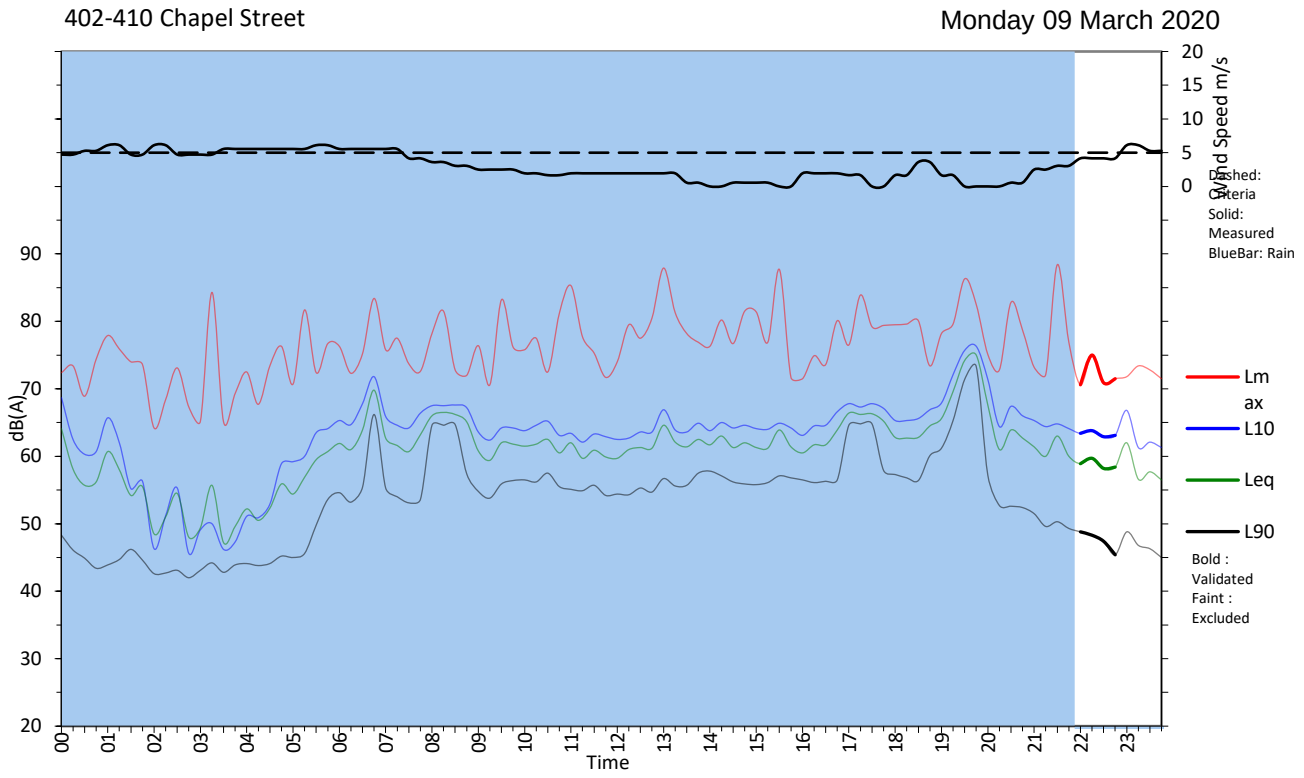
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Monday 09 March 2020
dB(A)
Wind Speed m/s
Time
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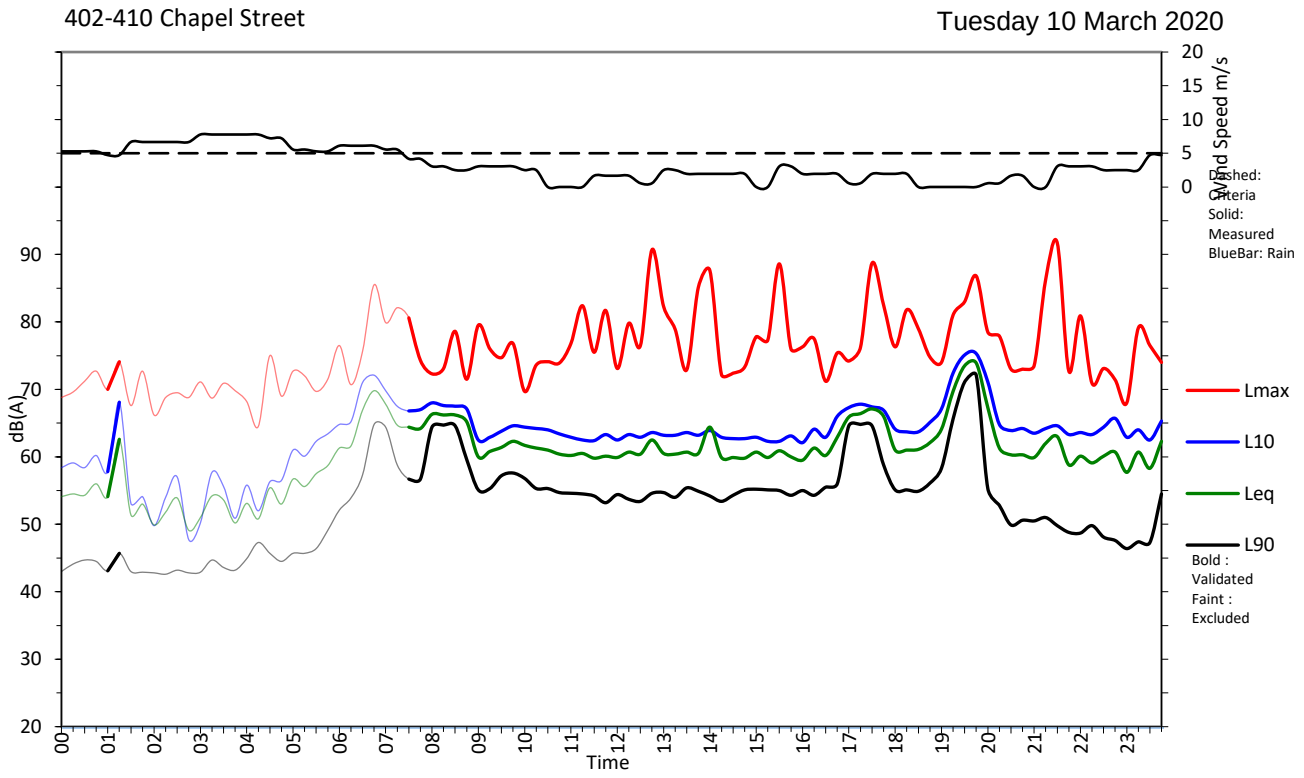
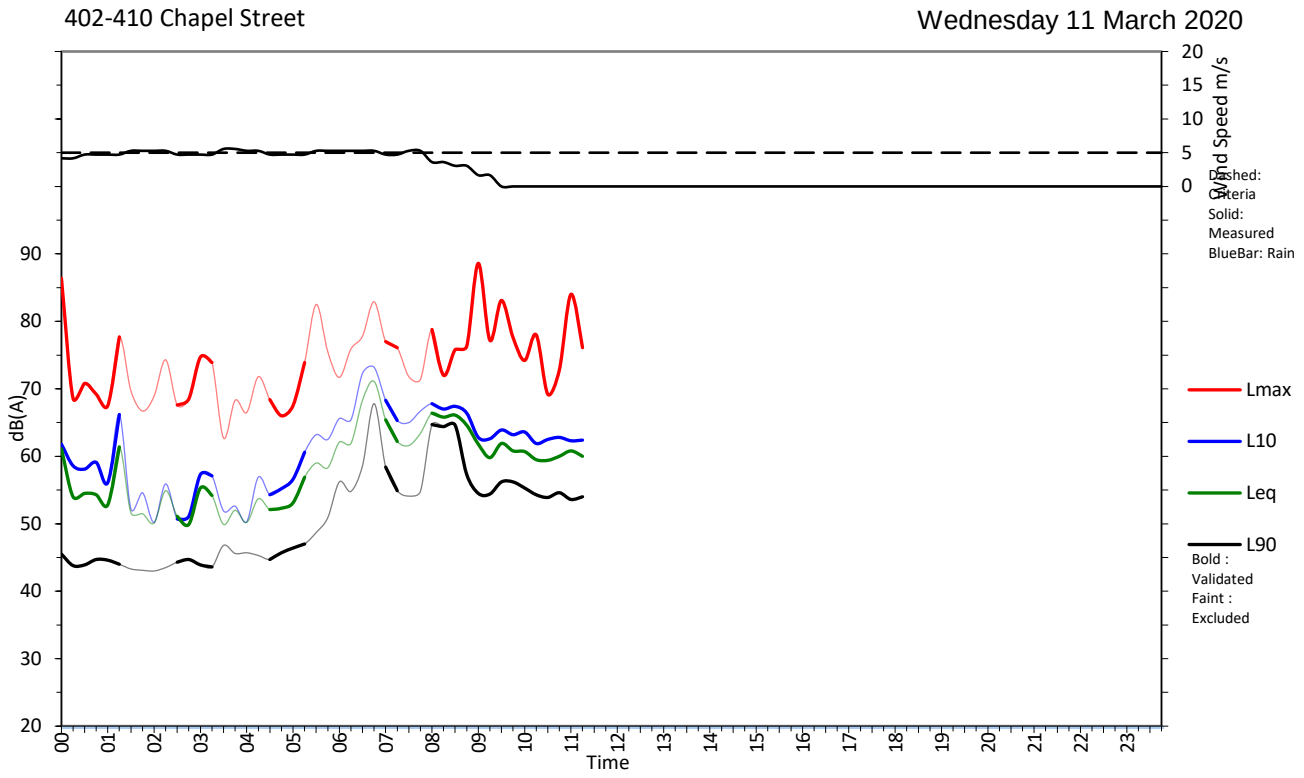
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Tuesday 10 March 2020
dB(A)
Wind Speed m/s
Time
Dashed: Criteria
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded


402-410 Chapel Street
Wednesday 11 March 2020
dB(A)
Wind Speed m/s
Time
Dashed: Criteria
Solid: Measured
BlueBar: Rain
Lmax
L10
Leq
L90
Bold : Validated
Faint : Excluded

APPENDIX B: BEST PRACTICE CONSTRUCTION NOISE AND VIBRATION MEASURES

General/Site Management Issues

- All employees, contractors and subcontractors are to receive an environmental induction and should instruct all persons at the site with regard to all relevant project specific and standard noise mitigation measures, including but not limited to permissible hours or work, limitation of high noise generating activities, location of nearest affected noise receivers, construction employee parking areas, designated loading/unloading areas and procedures, site opening/closing times (including deliveries) and environmental incident procedures.
- A dedicated person will form a point of contact for dissemination of general information regarding site operations. Contact persons will also be defined to receive comment or complaints from the community.

Noise Source Controls

General/ Work Practices:

- Avoid unnecessary revving of engines and turn off plant that is not being used/required.
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms.
- Where possible, avoid using tonal reverse alarm outside standard construction hours.
- Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously.
- Site set up/ movement of plant / delivery of material/ waste removal to site should generally be restricted to daytime period.
- Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling.
- Ensure there is no unnecessary shouting or loud stereo/radios on site. There must be no dropping of metal from heights, throwing of metal items or slamming of doors.
- Use less noise intensive equipment where reasonable and feasible.

Use and sitting of equipment/activities:

- Where practical fixed plant should be positioned as far as possible from the sensitive receivers.

Enclosures:

- Use temporary site buildings and material stockpile as noise barrier.
- Employ the use of solid barrier plywood hoardings if required.
- Where practical, a partial enclosure shall be used to minimise noise levels.

Vibration

Structural Damage:

- Use lower impact or low tonnage equipment.
- Maintain safety distance between construction plant and building, to be determined during detailed design stage.

Human Annoyance:

- Scheduling the use of vibration causing equipment at the least sensitive time of the day.

- Sequencing operations so that high vibration causing activities to do not occur simultaneously.

The contents of the log sheet will be regularly maintained and updated, as soon as a complaint is made.

Construction Activities and Mitigation

The following general construction noise source control measures may be required:

- Site access for construction vehicles to be set up away from the sensitive boundaries.
- During extended construction hours, less intrusive works will be scheduled to be carried out and/or works will be carried out away from sensitive receivers.
- Activities that approach the highly noise affected criteria for the residential receivers to be carried out during times where receivers are less sensitive to noise.
- Avoid unnecessary revving of engines and turn off plant that is not being used/required.
- Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms.
- Where possible, avoid using tonal reverse alarm outside standard construction hours.
- Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously.
- Site set up/ movement of plant / delivery of material/ waste removal to site should generally be restricted to day period.
- Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling.
- Ensure there is no unnecessary shouting or loud stereo/radios on site. There must be no dropping of metal from heights, throwing of metal items or slamming of doors.
- Use less noise intensive equipment where reasonable and feasible.
- Where practical fixed plant should be positioned as far as possible from the sensitive receivers.
- Use temporary site buildings and material stockpile as noise barrier.
- Employ the use of solid barrier plywood hoardings if required.
- Where practical, a partial enclosure shall be used to minimise noise levels.

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NDY QA SYSTEM

Revision No:	7.0
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Client Contact:	Stuart Nisbett
Project Leader:	Ryan Hahn
Editor:	Victoria Rastelli

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