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EAST END STAGES 3 & 4, NEWCASTLE

Acoustic Assessment for Development Application

21 February 2024

Iris Capital

TM970-03F01 DA Acoustic Report (r6)

35 1982-2017 ACOUSTIC ENGINEERING EXCELLENCE

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Contents

1 Introduction

Renzo Tonin & Associates has been engaged to undertake an acoustic assessment for Stages 3 and 4 of the Newcastle East End development.

This assessment addresses:

- The impacts of external noise (primarily road traffic noise and from retail activity on Hunter Steet) and determines building shell acoustic treatments to ensure suitable levels of amenity for future occupants of the site.
- Operational noise emissions from the proposed development and the potential impacts on nearby noise sensitive receivers.

This report is based on architectural drawing set prepared by SJB March 2023.

The work documented in this report was carried out in accordance with RTA's Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. A glossary of acoustic terms used in this report is detailed in 0.

2 Site Description and Surrounding Sensitive Land Uses

Stages 3 & 4 of the Newcastle East End Masterplan project is proposed to occupy 105 – 137 Hunter Street, 1 Morgan Street, or 66-74 King Street (Lot 1 DP 819134), 3 Morgan Street and 22 Newcomen Street in Newcastle. The subject sites are located within the City of Newcastle local government area (LGA) and are bounded by Hunter Street to the north, Newcomen Street to the east, Thorn Street to the west and King Street to the south. 92 King Street (demolished Mall carpark) at is not part of the subject site.

The proposed development consists of:

- Two basement car parks.
- Five new buildings, being predominantly residential (with associated communal facilities and ground level retail).

This DA seeks consent for the demolition of:

- Four buildings, as indicated in Figure 2-1 (below).
- Existing ground slabs, basements, excavation, and construction work.

Noise associated with demolition down to ground plane of reaming buildings on the site is the subject of a separate report (*Construction Noise and Vibration Management Plan – Early Works (Demolition)* by Renzo Tonin dated 20/4/2023).

Ground level retail development will be subject to their own DAs for use, at which time the capacity of outdoor dining areas and times of use will be determined.

Existing noise sources impacting the site are:

- King Street, to the south. King Street carries moderate levels of traffic noise.
- Newcomen Street, to the east. Newcomen Street carries low-moderate levels of traffic noise.
- Hunter Street to the north. Hunter Street carries low-moderate levels of traffic noise as well as noise from existing retail/food and beverage and commercial developments.

Figure 2-1 illustrates the subject development sites and surrounding development. Figure 2-1 also shows the location of long-term noise loggers that were installed on site in order to quantify the existing noise environment.

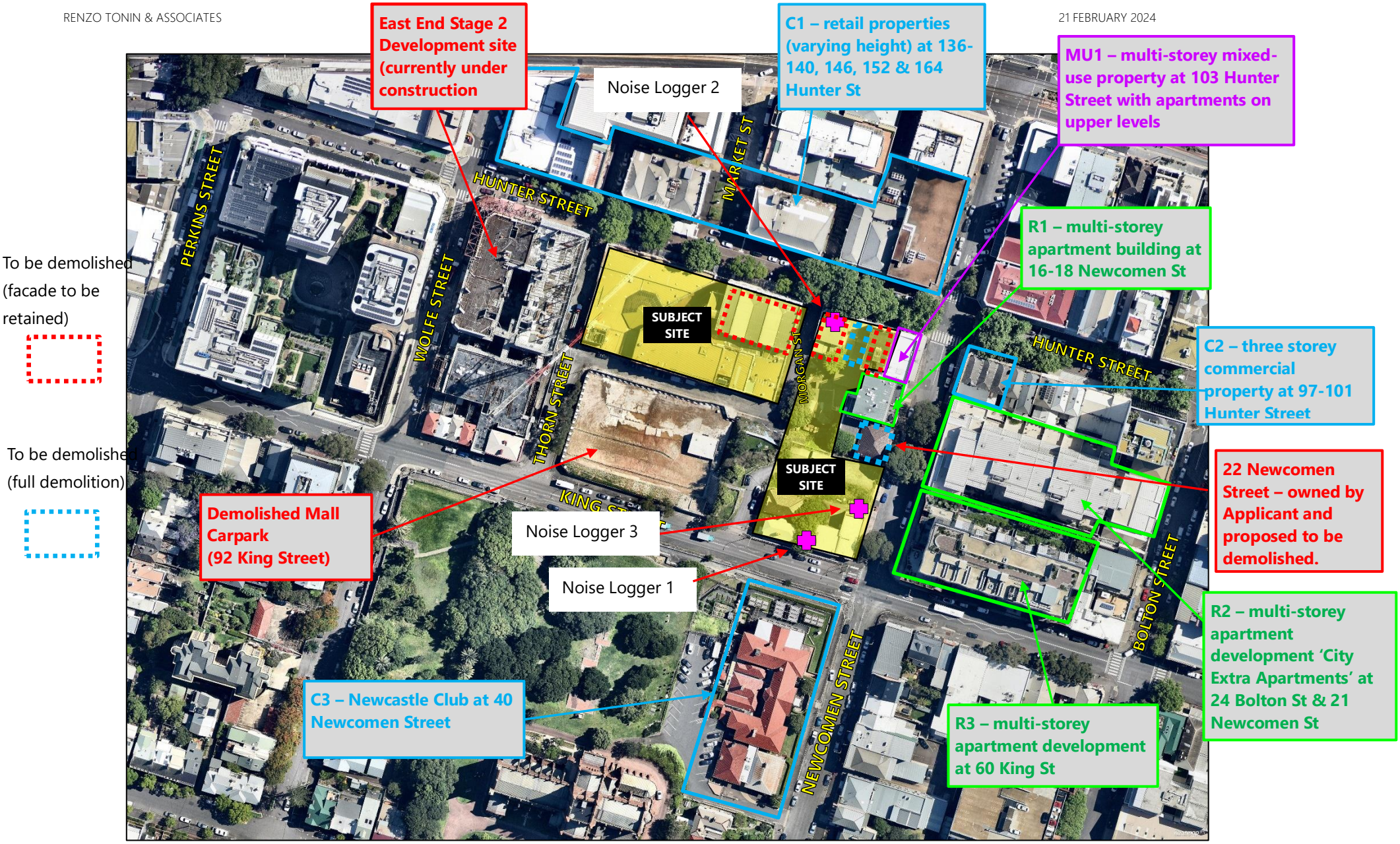
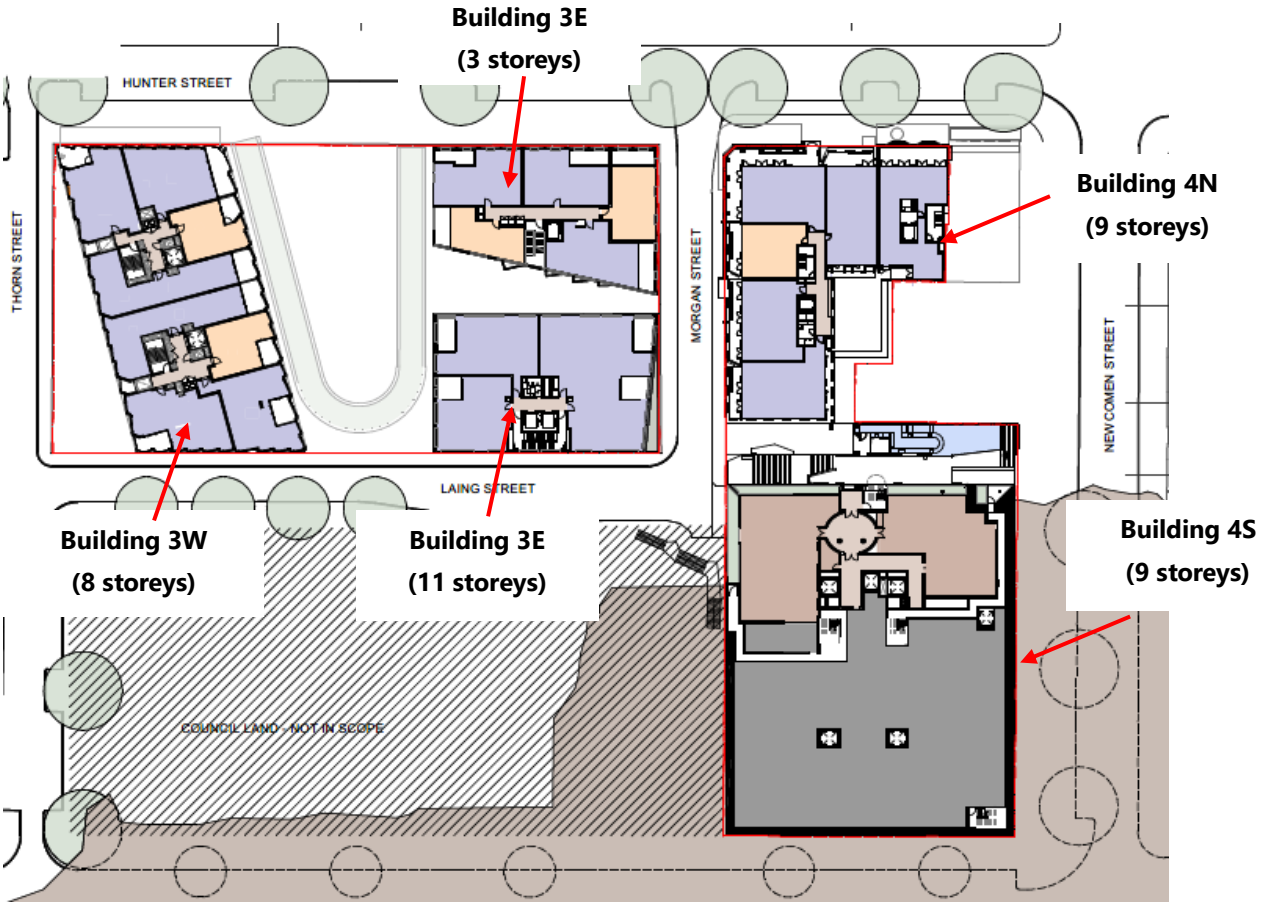


Figure 2-1: Locations of project site, surrounding noise sensitive properties and noise surveys (source: Nearmap Limited

The site slopes downwards heading south to north, with the ground level of Building 4S being approximately level to Level 4 of Buildings 3W, 3E, 3N and 4N at the northern end of the site.

Overall site plan showing building numbering is shown below.



Development in the vicinity of the site is consists of:

- MU1 – multi-storey mixed-use property at 103 Hunter Street, with retail tenancies across ground level and apartments on upper levels. This receiver adjoins the development site at the corner of Hunter and Newcomen Streets.
- R1 – multi-storey apartment building at 16-18 Newcomen Street, adjoining part of the development site (3 Morgan Street) to the east.
- R2 – multi-storey apartment development 'City Extra Apartments' at 24 Bolton Street & 21 Newcomen Street, directly opposite Newcomen Street.
- R3 – multi-storey apartment development at 60 King Street, directly opposite Newcomen Street.
- C1 – commercial properties (varying height) at 136-140, 146, 152 & 164 Hunter Street, directly opposite the site to the north.
- C2 – three storey commercial property at 97-101 Hunter Street, at the corner of Hunter and Newcomen Streets.

- C3 – Newcastle Club at 40 Newcomen Street, directly opposite part of the development site (1 Morgan Street or 66-74 King Street) to the south,

3 Existing Noise Environment

The noise environment of an area varies over time. The NSW Environmental Protection Authority's (EPA) Noise Policy for Industry (NPfI) outlines standard time periods over which the background and ambient noise levels are to be determined, which is as follows:

- Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
- Evening: 18:00-22:00 Monday to Sunday & Public Holidays
- Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

An unattended noise survey was carried out by Renzo Tonin & Associates from Monday, between 15 and 24 March 2023 to quantify the existing noise environment:

- Logger 1 was installed on the roof of the existing building on the corner of King and Newcomen Street (68 King Street). Logger was placed such that had a clear line of site to King Street traffic.
- Logger 2 was installed on the projecting from a Level 1 window at 107-109 Hunter Street. Logger was placed such that had a clear line of site to Hunter Street traffic and retail noise.
- Logger 3 was installed on the roof of the existing building on the corner of King and Newcomen Street (68 King Street). Logger was placed such that had a clear line of site to Newcomen Street traffic.

The noise monitor records noise levels on a continuous basis and stores data every fifteen minutes. The noise logger was calibrated before and after measurements and no significant deviation in calibration was noted. The noise monitoring equipment used here complies with Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and is designated as Type 2 instruments suitable for field use.

The graphical recorded output from the long-term noise monitoring is included in Appendices B, C and D..

3.1 Background/Ambient noise levels

The results from the noise survey were summarised and the representative background L_{A90} noise levels were determined in accordance with the EPA's NPfI and presented in Table 1 below.

Table 1: Measured background and ambient noise levels

Monitoring Duration	Noise Descriptor	Representative Noise Levels			
		Day (7am-6pm)	Evening (6pm-10pm)	Late Evening (10pm-12am)	Night (10pm-7am)
L1 – King Street					
15/3 to 24/3/2023	L_{90} Background Noise Levels	52	48	46	46
	L_{Aeq} Ambient Noise Levels	62	61	58	58
L2 – Hunter Street					
15/3 to 24/3/2023	L_{90} Background Noise Levels	50	47	44	44
	L_{Aeq} Ambient Noise Levels	61	60	58	57
L3 – Newcomen Street					
15/3 to 24/3/2023	L_{90} Background Noise Levels	50	49	48	48
	L_{Aeq} Ambient Noise Levels	57	56	54	54

Note: 1. Number in brackets represents the measured (actual) RBL value. When conducting noise emission assessments based on Noise Policy for Industry Acoustic criteria (e.g. – car park noise), the NPfI adopts minimum background noise levels of 30dB(A)L_{90} in the event that the actual background noise level is below 30dB(A) in the evening or night period.

The measured background noise spectra are presented below:

Table 2: Measured Background Noise Spectra dB(Z) $L_{90, 15min}$

Description	Time of Day	Overall dB(A)	Octave band centre frequency – Hz, dB(Z)								
			31.5	63	125	250	500	1k	2k	4k	8k
L01 – East End Stages 3 & 4, Newcastle (representative of receiver south of site)	7am-6pm	51	55	56	52	52	47	46	42	35	25
	6pm-10pm	48	54	55	51	52	45	42	39	34	28
	10pm-7am	46	50	53	49	51	42	38	36	34	23
	10pm-12am	46	51	53	50	50	42	38	35	31	24
L02 – East End Stages 3 & 4, Newcastle (representative of receiver north of site)	7am-6pm	50	58	57	54	49	47	45	42	37	28
	6pm-10pm	46	54	53	50	46	44	41	36	32	28
	10pm-7am	44	53	52	50	46	42	37	33	35	27
	10pm-12am	45	53	53	49	46	42	38	34	32	34
L03 – East End Stages 3 & 4, Newcastle (representative of receiver east of site)	7am-6pm	50	55	56	53	51	47	45	40	34	22
	6pm-10pm	49	52	54	52	50	45	43	42	35	24
	10pm-7am	48	51	54	52	50	45	42	41	36	22
	10pm-12am	48	52	55	53	51	44	42	41	35	26

3.2 Road traffic noise levels

Measured road traffic noise levels are presented below.

Table 3: Road traffic noise levels

Noise Monitoring	Representative Traffic Noise Levels	
Location	Day (7am-10pm)	Night (10pm-7am)
L1 – King Street (In line with future south facade)	62 $L_{Aeq,15hr}$	58 $L_{Aeq,9hr}$
L2 – Hunter Street (In line with future south facade)	61 $L_{Aeq,15hr}$	58 $L_{Aeq,9hr}$
L3 – Newcomen Street (In line with future south facade)	57 $L_{Aeq,15hr}$	54 $L_{Aeq,9hr}$

4 Noise Intrusion Assessment

4.1 Internal noise intrusion criteria

Relevant standards with respect to traffic noise impacts are as follows:

- Department of Planning (DoP) publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008 ('DoP Guideline')
- Australian Standard AS/NZS 2107:2016 "Acoustics – Recommended design sound pressure levels and reverberation times for building interior"

4.1.1 NSW Planning – Development Near Rail Corridors and Busy Roads

While not a classified road, building facades in the development will be designed to meet the internal noise level requirements of the NSW Planning document *Development Near Rail Corridors and Busy Roads*.

Table 4: Internal Noise Goals for Control of External Noise Impacts

Condition	Occupancy	Design Internal Noise Level
Windows closed	Bedroom (10pm – 7am)	35dB(A)$L_{ee(9hr)}$
	Living / Dining /Kitchen (24 hours)	40dB(A)$L_{ee(9hr)}$

4.1.2 AS 2107:2016

For occupancies that are not covered in the guidelines and standards presented above, the internal design sound levels from AS 2107 are adopted. The standard notes that where the traffic noise levels vary over a 24-hour period, an appropriate measurement period should be selected.

Table 5: Internal design sound levels

Building type and activity	Satisfactory design sound level ($L_{Aeq,t}$)
Shop Buildings	
Small retail stores (general)	45

4.2 Recommendations – External noise intrusion

Noise calculations were conducted which take into account external noise levels, facade transmission loss and room sound absorption characteristics. Noise levels were calculated for each building facade to account for any variation in the external noise levels affecting different parts of the building.

Glazing constructions required to comply with the nominated noise criteria are presented in the following section.

4.2.1 Glazing design requirements

The table below summarises the recommended glazing treatment for the building facades to achieve compliance with the internal noise criteria.

In the case of apartments fronting Hunter Street, glazing has been provided to also mitigate future noise increase from Hunter Street as a result of increased activation of ground plane retail tenancies (outdoor dining).

Table 6: Recommended glazing treatment

Occupancy Type		Level	Recommended Glazing System	Laboratory Test Reference
Building 3W, 3N, 4N				
North Façade (inclusive east/west face for corner rooms)	Bedrooms	Up to Level 4 Level 5 and above	10.38mm laminated (R_w 35) 6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	Up to Level 2 Level 3 and above	10.38mm laminated (R_w 35) 6.38mm laminated (R_w 31)	ESTIMATE
East and West Facade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6mm (R_w 29)	ESTIMATE
South Facade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6mm (R_w 29)	ESTIMATE
Building 3E				
North Façade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6mm (R_w 29)	ESTIMATE
East and West Facade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6mm (R_w 29)	ESTIMATE
South Facade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6mm (R_w 29)	ESTIMATE
Building 4S				
North Façade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6mm (R_w 29)	ESTIMATE
East and West Facade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6mm (R_w 29)	ESTIMATE
South Facade	Bedrooms	All	6.38mm laminated (R_w 31)	ESTIMATE
	Living/Kitchen /Dining	All	6.38mm laminated (R_w 31)	ESTIMATE

Occupancy Type		Level	Recommended Glazing System	Laboratory Test Reference
Retail				
All facades	All front of house spaces	All	10mm (Rw 33)	ESTIMATE

By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the partition, a higher rating implying a higher sound reduction performance.

Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.

LEGEND where no appropriate test certificate exists:

1. ESTIMATE: The client is advised not to commence detailing or otherwise commit to partition construction systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of partition construction systems is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested partition construction systems, estimates or opinions. The advice provided here is in respect of acoustics only.
2. ESTIMATE – APPROVED FOR CONSTRUCTION: Use of the form of construction is approved prior to laboratory certification. To complete the quality control of the design process and confirm the acoustical performance of the construction, we recommend testing in a laboratory to confirm the Rw rating as soon as practicable. In the case of impact rating for floor systems, no particular impact rating is guaranteed to comply with either the Building Code of Australia or Strata Scheme Management Act and hence carpet runners may still be required.
3. ESTIMATE – TEST NOT REQUIRED: Use of the form of construction is approved without laboratory certification. The STC/Rw of the form of construction exceeds the project requirements.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

NOTES FOR GLAZING CONSTRUCTIONS:

4. The information in this table is provided for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant.
5. The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.
6. Before committing to any form of construction or committing to any builder, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction where only an "estimate" is available for the sound insulation properties of recommended materials.
7. The glazing supplier shall ensure that installation techniques will not diminish the Rw performance of the glazing when installed on site.
8. All openable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the Rw rating performance of the glazing to not be reduced.
9. The above glazing thicknesses should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

GENERAL

10. The sealing of all gaps in partitions is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
11. Check design of all junction details with acoustic consultant prior to construction.
12. Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
13. The information provided in this table is subject to modification and review without notice.
14. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

4.2.2 External walls

External walls consisting of masonry or concrete elements will not require further upgrade for acoustic purposes.

4.2.3 Roof and ceiling

At present, all external roof elements are proposed to be concrete and no further upgrade is required for acoustic purposes. In the event that light weight roof systems are proposed, this will need to be reviewed

in detail at CC stage to determine if additional internal plasterboard lining to the ceiling system will be required.

4.2.4 Ventilation

In rooms where suitable internal noise are only met by closing windows/external doors, supplementary fresh air should be provided to the rooms to meet the requirements of AS1668. This applies to the following:

- Northern facades of 3W, 3E (north building), 4N northern façade.
- 4S south facade.

5 Noise Emission Assessment

This section examines noise emissions from the site and their potential impact on nearby development.

This section addresses:

- Plant and equipment noise from the site (residential and retail)
- Retail/café noise (outdoor dining).

We assume that a DA for use would be lodged for specific ground level retail tenancies. In the event they intend to provide outdoor dining, an acoustic review would be expected to be included in the DA for use.

For any retail premises that are proposed to be licenced, any acoustic report for use would need to address both the:

- Office of Liquor and Gaming standard noise emission guidelines and
- Newcastle Council *Internal Technical Guideline for the Assessment and Control of Low Frequency Noise from the Development of Musical Entertainment Venues*. if intended to be used as an entertainment venue.

5.1 Noise Emission Criteria

5.1.1 Licensed premises (Patron/Music)

Noise emissions from licensed premises in NSW, such as restaurants, bars, and clubs, should aim to comply with the standard noise criteria set by the L&GNSW. The L&GNSW, through the Liquor Act 2007, is the regulatory authority that deals with noise pollution issues pertaining to licensed premises. The L&GNSW criteria apply to noise emission associated with activities from the licensed area of the premises, including music and patron noise but excludes mechanical plant. Noise emissions are assessed in terms of the noise limits set out in the L&GNSW's 'Standard Noise Condition' which states as follows:

> *"The LA10* noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) by more than 5dB between 7:00am and 12:00 midnight at the boundary of any affected residence.*
>
> *The LA10* noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) between 12:00 midnight and 7:00am at the boundary of any affected residence.*
>
> *Notwithstanding compliance with the above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 7:00am.*

Interior noise levels which still exceed safe hearing levels are in no way supported or condoned by the Liquor Administration Board.

This is a minimum standard. In some instances, the Board may specify a time earlier than midnight in respect of the above condition.

**For the purposes of this condition, the LA10 can be taken as the average maximum deflection of the noise emission from the licensed premises."*

Based on the noise emissions criteria stated above and the background noise levels presented in Section 3.1, the noise emission goals for the licensed premises in this development are as follows:

Table 7: Licensed premises noise spectra criteria, dBL_{10} – Noise Target for Licenced Premises

Description	Time of Day	Overall dB(A)	Octave band centre frequency – Hz, dB(Z)								
			31.5	63	125	250	500	1k	2k	4k	8k
L01 – East End Stages 3 & 4, Newcastle (representative of receiver south of site)	7am-6pm (Background+5)	56	60	61	57	57	52	51	47	40	30
	6pm-10pm (Background+5)	53	59	60	56	57	50	47	44	39	33
	10pm-12am (Background+5)	51	55	58	54	56	47	43	41	39	28
L02 – East End Stages 3 & 4, Newcastle (representative of receiver north of site)	7am-6pm (Background+5)	55	56	58	55	55	47	43	40	36	29
	6pm-10pm (Background+5)	51	63	62	59	54	52	50	47	42	33
	10pm-12am (Background+5)	50	59	58	55	51	49	46	41	37	33
L03 – East End Stages 3 & 4, Newcastle (representative of receiver east of site)	7am-6pm (Background+5)	55	58	57	55	51	47	42	38	40	32
	6pm-10pm (Background+5)	54	58	58	54	51	47	43	39	37	39
	10pm-12am (Background+5)	53	60	61	58	56	52	50	45	39	27

5.1.2 NSW EPA Noise Policy for Industry (NPfI) 2017 (Plant and Equipment Noise, Café Noise)

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level. The project noise trigger level is the noise level which is the lower value of the project intrusiveness noise levels and project amenity noise levels, as detailed below.

5.1.2.1 Intrusiveness Noise Trigger Level

The intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does

not exceed the background noise level measured in the absence of the source by more than 5dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$L_{Aeq,15min}$ Intrusiveness noise level = Rating Background Level (RBL) plus 5 dB(A)

Based on the long-term background noise monitoring results obtained and presented in Table 1 above, the intrusiveness noise levels for residential receivers are determined and shown in the table below.

Table 8: Intrusiveness noise levels

Receivers	Representative Logger	Intrusiveness noise level, dB(A)Leq,15min		
		Day[1]	Evening[2]	Night[3]
Stage 2 Apartments, Future Stage 3 and 4 Apartments, Hunter Street Apartments	Logger 2	50 + 5 = 55	47 + 5 = 52	44 + 5 = 49
Newcomen Street Residences	Logger 3	50 + 5 = 55	49 + 5 = 54	48 + 5 = 53

Notes: 1. Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
2. Evening: 18:00-22:00 Monday to Sunday & Public Holidays
3. Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

5.1.2.2 Amenity Noise Trigger Level

The project amenity noise levels for different time periods of day are determined in accordance with Section 2.4 of the NPfI. The NPfI recommends amenity noise levels (LAeq, period) for various receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These "recommended amenity noise levels" represent the objective for total industrial noise experienced at receiver location. However, when assessing a single industrial development and its impact on an area, "project amenity noise levels" apply.

To ensure that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level that applies for each new industrial noise source is determined as follows:

$L_{Aeq,period}$ Project amenity noise level = $L_{Aeq,period}$ Recommended amenity noise level – 5dB(A)

However, in developments close to busy roads, the traffic noise levels may be high enough to effectively mask noise from industrial sources. When the existing traffic noise levels exceed the recommended amenity noise level by 10dB, the project amenity noise level may be derived from the traffic L_{Aeq} as follows:

$L_{Aeq,period}$ High traffic project amenity noise level = $L_{Aeq,period\ (traffic)}$ – 15dB(A)

Furthermore, given that the intrusiveness noise level is based on a 15-minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, the NPfI provides the

following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15minute}$ level in order to standardise the time periods.

$L_{Aeq,15minute} = L_{Aeq,period} + 3dB(A)$

The project amenity noise levels ($L_{Aeq, 15min}$) applied for this project are reproduced in Table 9 below.

Table 9: Project amenity noise levels for nearby receivers

Period	Recommended Amenity Noise Level[1]	Project Amenity Noise Level	Project Amenity Noise Level (15 minute criteria)
	dB(A)$L_{Aeq, Period}$	dB(A)$L_{Aeq, Period}$	dB(A)$L_{Aeq, 15min}$
Stage 2 Apartments, Future Stage 3 and 4 Apartment, Hunter Street Apartments (urban residential)			
Day (7am-6pm)	60	60 – 5 = 55	55 + 3 = **58**
Evening (6pm-10pm)	50	50 – 5 = 45	45 + 3 = **48**
Night (10pm-7am)	45	45 – 5 = 40	40 + 3 = **43**
Newcomen Street Residences (urban residential)			
Day (7am-6pm)	60	60 – 5 = 55	55 + 3 = **58**
Evening (6pm-10pm)	50	50 – 5 = 45	45 + 3 = **48**
Night (10pm-7am)	45	45 – 5 = 40	40 + 3 = **43**

Notes: Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
Evening: 18:00-22:00 Monday to Sunday & Public Holidays
Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays
1. Recommended amenity noise levels are based on the Urban amenity area.

5.1.2.3 NPfI Project noise trigger levels

In accordance with the NPfI, the project noise trigger levels, which are the lower (ie. more stringent) value of the project intrusiveness noise level and project amenity noise level, have been determined and shown in Table 10 below.

Table 10: Project noise trigger levels

Receiver type	Project noise trigger levels, dB(A)$L_{Aeq, 15min}$		
	Day	Evening	Night
Stage 2 Apartments, Future Stage 3 and 4 Apartment, Hunter Street Apartments (urban residential)	55	48	43
Newcomen Street Apartments	55	48	43

Notes: Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
Evening: 18:00-22:00 Monday to Sunday & Public Holidays
Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

5.1.3 Sleep disturbance noise levels (10pm-7am)

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. In accordance with NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development 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} 52dB(A) or the prevailing RBL plus 15dB, whichever is the greater.

Where there are noise events found to exceed the initial screening level, further analysis is undertaken to identify:

- The likely number of events that might occur during the night assessment period,
- The extent to which the maximum noise level exceeds the rating background noise level.

The sleep disturbance noise levels for the project are presented below.

Table 11: Sleep disturbance assessment levels

Receiver type	Assessment Level $L_{Aeq,15min}$	Assessment Level L_{AFmax}
Stage 2 Apartments, Future Stage 3 and 4 Apartment, Hunter Street Apartments (urban residential)	44 + 5 = 49	44 + 15 = 59
Newcomen Street Apartments	48 + 5 = 53	48 + 15 = 63

5.2 Assessment of Noise Emissions / Recommendations

5.2.1 Food and Beverage Tenancy Noise

5.2.1.1 Assumptions used in noise emission predictions.

While it is not known if the individual Food and Beverage Tenancies will be licenced, for the purpose of noise emission predictions, it will be assumed that they are licenced and the Office of Liquor and Gaming noise emission criteria will be adopted.

Assumptions relied on are as follows:

- Outdoor Dining is restricted to Food and Beverage Tenancies located on the Hunter Street frontages and the plaza between Stage 3 East and West. Outdoor dining on the Newcomen Street frontage is not proposed.
- Approx 20 patrons in the outdoor dining areas in front of any given food and beverage tenancy on the Hunter Street frontages (or Plaza between Stages 3 East/West).
- Outdoor dining areas are assumed to be used up to 10pm. Between 10pm and 12am, only internal spaces of Food and Beverage Tenancies are proposed to be used.
- Outdoor dining areas are assumed to have awnings over the seated area, as indicated on architectural plans (assisting in noise screening to apartments above).
- The average patron vocal sound power for a patron in an outdoor area is assumed to be 77dB(A)L_{10}, one in two speaking (raised voice). This is consistent with licensed premises outdoor dining spaces in our experience.

Table 12: Patron Sound Power in Outdoor Areas – dBL_{10}

Area	Applicable noise source Noise Source/Comment	Overall dB(A)	Octave band centre frequency - Hz (dBZ)								
			31.5	63	125	250	500	1k	2k	4k	8k
Outdoor Dining	Patron vocal noise (raised speech)	77	52	56	66	70	75	72	69	64	52

- Assumed sound pressure levels for patrons/music within the internal areas are as per the table below. These noise source levels as based on guidance in the AAAC document *Licenced Premises Noise Assessment Technical Guideline* V2, table 1, adopting similar patron density and moderate amount of noise absorption (a 1 second reverberation time). This noise level is also consistent with measurements by this office of lively internal bar areas with some noise absorption and limit in music noise level.

Table 13: Internal Space Sound Pressure Level – dBL_{10}

Area	Applicable noise source	Overall	Octave band centre frequency - Hz (dBZ)								
	Noise Source/Comment	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
Patron Noise – internal areas	Patron vocal noise (raised speech), background music	84	80	84	83	84	79	80	75	73	68

- It is assumed that the windows/doors to the licenced premises are closed.

5.2.1.2 Food and Beverage Noise Emission Prediction and Assessment

Noise emissions are predicted below.

Predictions are made of the following scenarios:

- 10pm assessment. Both outdoor and indoor areas in use. Assessment to future apartments above and to existing residences on Newcomen Street.
- 12am assessment. Indoor areas in use only (windows/doors closed). Assessment to future apartments above and to existing residences on Newcomen Street.

5.2.1.3 Food and Beverage - 10pm Assessment (Outdoor and Indoor Areas In Use)

Predicted noise levels as follows:

Table 14: 10pm Operation – Noise Emission to Future Apartments Overlooking Outdoor Dining Area

Noise Source	Noise Emission to Residence – dBL_{10}									
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**A-wt**
Contribution 1 - Patrons (Outside)	21	21	37	44	46	45	37	29	24	48
Contribution 2 - Patrons (Inside)	31	31	27	25	9	6	-2	-14	-22	18
Total Noise Level at Resident - dBL_{10}	**32**	**32**	**38**	**44**	**46**	**45**	**37**	**29**	**24**	***48***
Permissible Noise Level (46BG+5dB)	*59*	*58*	*55*	*51*	*49*	*46*	*41*	*37*	*33*	***51***
Complies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Table 15: 10pm Operation – Noise Emission to Newcomen Street Residences

Noise Source	Noise Emission to Residence – dBL_{10}									
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**A-wt**
Contribution 1 - Patrons (Outside)	7	7	24	32	36	37	29	23	20	40
Contribution 2 - Patrons (Inside)	28	28	25	24	13	12	6	-4	-9	19
Total Noise Level at Resident - dBL_{10}	**28**	**28**	**28**	**33**	**36**	**37**	**29**	**23**	**20**	***40***
Permissible Noise Level (49BG+5dB)	57	59	57	55	50	48	47	40	29	***54***
Complies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Noise emissions are compliant provided that the recommendations at the end of this section are adopted..

5.2.1.4 Food and Beverage - 12am Assessment (Indoor Areas In Use Only)

Predicted noise levels as follows:

Table 16: 12am Operation – Noise Emission to Future Apartments Overlooking F+B Tenancies

Noise Source	Noise Emission to Residence – dBL_{10}									
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**A-wt**
Contribution 1 - Patrons (Outside)	Not in Use									
Contribution 2 - Patrons (Inside)	31	31	27	25	9	6	-2	-14	-22	18
Total Noise Level at Resident - dBL_{10}	**31**	**31**	**27**	**25**	**9**	**6**	**-2**	**-14**	**-22**	**18**
Permissible Noise Level (45BG+5dB)	58	58	54	51	47	43	39	37	39	**50**
Complies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Table 17: 12am Operation – Noise Emission to Newcomen Street Residences

Noise Source	Noise Emission to Residence – dBL_{10}									
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**A-wt**
Contribution 1 - Patrons (Outside)	Not in Use									
Contribution 2 - Patrons (Inside)	28	28	25	24	13	12	6	-4	-9	19
Total Noise Level at Resident - dBL_{10}	**28**	**28**	**25**	**24**	**13**	**12**	**6**	**-4**	**-9**	**19**
Permissible Noise Level (48BG+5dB)	57	60	58	56	49	47	46	40	31	**53**
Complies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Noise emissions are compliant provided that the recommendations at the end of this section are adopted..

The above indicates that:

- The site should be capable of accommodating Food and Beverage uses for ground level retail tenancies on Hunter, Newcomen Street and the public domain corridor between Buildings 3E and 3W. This would involve:
    - Usage of outdoor areas until 10pm and
    - Usage of Indoor Areas until 12am

  provided that the management controls identified below are adopted. These management controls provide protection on existing residences (Newcomen Street) and future residences within the Stage 3 and 4 site itself.
- The assessment is made on the assumption that there is a moderate level of music provided to internal areas of the F+B tenancies (75dB(A)L_{10} sound pressure). It would be feasible that higher music noise levels/performance can be accommodated however this would potentially necessitate further acoustic treatment by the operator (and would be the subject of a separate Development Application for Use).

With respect to noise impacts on the future apartments in the Stage 3 and 4 site:

- Acoustic treatments have been determined for F+B tenancies on the assumption that satisfactory noise levels are achieved at the future apartment façade. This enables a suitable level of amenity for those apartments, regardless of whether their windows are open or closed.
- However we also note that the Hunter Street façade for buildings 3W, 3N, 4N are proposed to have upgraded glazing as an additional protection against Hunter Stret noise which will have a further benefit with respect to Food and Beverage tenancy noise emissions. With the glazing systems proposed, internal noise levels within apartments will be below 30dB(A) as a result of external noise from F+B tenancies.

<u>Recommendation</u>:

- Base building retail tenancies are to have minimum 10mm thick shop front glazing.
- Outdoor Dining:
    - To be limited to 20 patrons per retail tenancy.
    - To be permitted up to 10pm.
    - Not to be adopted on the Newcomen Street frontage unless a DA for use lodged by the operator.
    - After 6pm, outdoor dining areas to be limited to areas that have an awning over.

- If larger patron numbers, later trading or outdoor areas or use on an outdoor area on Newcomen Street is proposed, a Development Application for use should be lodged by potential operator detailing proposed trading times, times of use and patron numbers for outdoor areas, (and assessment of noise impact).

- Internal areas:
  - Cease trading at 12am unless DA for use is lodged to permit later trading.
  - Windows and doors to be kept closed after 10pm generally, (6pm on Newcomen Street).
  - Music in internal areas is to be limited to 75dB(A)L_{10} within the space (moderate background music). If louder music/performances are proposed, a Development Application for use should be lodged detailing any additional noise mitigation measured, including any ceiling construction necessary within the tenancy to ensure that noise through slab into an apartment above will less than 25dB(A)L_{10} if operating up to 12am and inaudible if trading after 12am.

5.2.2 Plant Noise Emissions

Noise from plant and equipment is assessed with reference to the EPA Noise Policy for Industry (criteria as outlined in Section 5.1.1.3).

The details of the mechanical plant and equipment servicing this development are yet to be finalised at this stage of the development. Therefore, the noise impacts from mechanical plant and equipment should be undertaken during the Detailed Design stage of the project.

However, we note:

- Major fans located in the basement (car park ventilation, typically 75dB(A) at 3m), and utilities fans (typically 65dB(A) at 3m distance) are likely to require induct acoustic treatment between fan and external intake/discharge. This will consist of lined ducting or acoustic attenuators. The extent of treatment will depend on fan selection and position relative to the nearest apartment.
- Roof top plant and equipment.
    - The new buildings will typically be taller than existing residential development in the vicinity. It is unlikely that significant acoustic treatment will be required to address roof top plant and equipment noise to existing residences. Acoustic treatment, if needed, is likely to consist of:
        - Internally lined acoustic ducting or acoustic attenuators on commercial kitchen exhaust fans.
        - Fans and condensers serving commercial spaces would typically require 25mm static deflection springs.
        - Condensers typically to have noise level not to exceed 52dB(A) at 1m distance (see also comments with respect to Building 3E Level 3 roof, below).
        - All equipment to be vibration isolated. Indicatively, the following vibration isolated:
            - Embelton NRD mounts for condensers.
            - Spring isolation mounts (10-25mm static deflection) for fans.
            - For any refrigeration equipment, pump, pool plant or air-cooled chiller – install on concrete plinth. Plinth isolated form building structure using 20mm rubber matting (Embelton Impactamat). 25mm static deflection spring isolator between equipment items and plinth.
    - Solid fence/screen should be used around plant areas when separating plant areas from occupiable roof space.
    - Apartments located below roof top plant:

- Minimum 180mm thick concrete slab thickness required.
- Apartments to have suspended ceiling with minimum 75mm thick insulation to ceiling cavity.

5.2.3 Loading Docks

There are loading docks located on the Loading Level in Building 3E and Basement 1 of Building 4S.

- The dock in Building 4S sits adjacent to Back of House areas and below a commercial use.
- The dock in Building 3E lies adjacent to and below residential apartments.

Typically, the primary noise associated with loading docks occurs if the dock serves supermarkets or similar, which:

- Are typically used late at night (10pm-7am) and
- Have high levels of pallet jack use (which create structure bone noise issues when pushing the pallet jack into/out of the pallet as the jack wheels run across the bottom slats of the pallet).

With respect to the docks at the subject site:

- Neither dock serves a supermarket or similar.
- They will be used for waste removal (typical in any residential development) and for deliveries to the retail tenancies (which would occur between 7am and 10pm) and would not typically require use of pallet jacks.

Given the above, vibration isolation of the loading dock is not warranted.

<u>Recommendations:</u>

- Dock usage to be limited to 7am to 10pm, unless for Council residential rubbish removal.
- Loading dock doors to be vibration isolated (Embelton NRD mount to lift motor). Dock door to have a soft stop/start mechanism.
- Wall separating the dock from residential apartments to consist of minimum 140mm concrete block with stud lining on the apartment side (stud spaced 20mm from blockwork, 13mm plasterboard lining and 75mm thick 14kg/m^3 insulation to cavity.

6 Construction Noise and Vibration Assessment

6.1 Construction noise objectives

6.1.1 Noise management levels (NMLs)

The NSW Interim Construction Noise Guideline (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.
- Application of reasonable and feasible noise mitigation measures.
- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice and is practical to build given the project constraints.
- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic, and environmental effects.

The ICNG provides two methods described for the assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration and involves the measurement and prediction of noise levels and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification. Given the scale and duration of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

The table below, reproduced from the ICNG, sets out the airborne noise management levels and how they are to be applied for residential receivers.

Table 18: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(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, considering: - times identified by the community when they are less sensitive to noise (such as before/ after school for works near schools, or mid-morning or mid-afternoon for works near residences - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• 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 5dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see ICNG section 7.2.2.

* 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.

The table below sets out the ICNG noise management levels for other noise sensitive receiver locations.

Table 19: Noise management levels at other noise sensitive land uses

Land use	Time of day	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Industrial premises	When in use	Outdoor noise level	75

6.1.2 Project construction noise goals

The table below presents the construction NMLs established for the identified nearest affected noise sensitive receivers (see Section 2). In the event these NMLs are exceeded, reasonable and feasible construction noise mitigation is required.

Table 20: Project construction noise management levels

Receiver	Receiver Type & Location	Noise Management Level, dB(A) $L_{eq(15\ min)}$
		Monday to Friday (7:00am to 6:00pm) **Saturdays (8:00am to 1:00pm)**
R1	Apartment building @ 16-18 Newcomen Street	62 [1]
R2	'City Extra Apartments' @ 24 Bolton Street & 21 Newcomen Street	62 [1]
R3	Apartment building @ 60 King Street	62 [1]
MU1	Apartment levels of 103 Hunter Street	62 [1]
	Ground level retail areas of 103 Hunter Street	70 [2]
C1	3-storey building @ 97-101 Hunter Street (commercial)	70 [2]
C2	Buildings (varying heights) @136-140, 146, 152 & 164 Hunter Street (commercial)	70 [2]
C3	Outdoor areas (adjacent to King St & Newcomen St) of Newcastle Club – Active recreational space	65 [2]

Notes:

1. Noise levels apply at the property 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 noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.
2. Noise levels apply at the most affected point within 50m of the area boundary.

6.1.3 Construction vibration objectives

Construction vibration is associated with three main types of impact:

- disturbance to building occupants
- potential damage to buildings, and
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to buildings.

Vibration amplitude may be measured as displacement, velocity, or acceleration.

- Displacement (x) measurement is the distance or amplitude displaced from a resting position. The International System of Units (SI unit) for distance is the metre (m), although common industrial standards include mm.
- Velocity ($v=\Delta x/\Delta t$) is the rate of change of displacement with respect to change in time. The SI unit for velocity is metres per second (m/s), although common industrial standards include mm/s. The

Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis (x, y, and z) then the resultant PPV is the vector sum (i.e., the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.

- Acceleration ($a=\Delta v/\Delta t$) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is metres per second squared (m/s2). Construction vibration goals are summarised below.

Construction vibration goals are summarised below.

6.1.3.1 Disturbance to buildings occupants

The acceptable vibration values to assess the potential for human annoyance from vibration are set out in the NSW 'Environmental Noise Management Assessing Vibration: A Technical Guideline' (AVTG).

To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The screening test is based on the continuous vibration velocity (i.e., vibration that continues uninterrupted for a defined period). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e., eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

The initial screening test values and VDVs recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected, are presented in Table 5 4. The 'Low probability of adverse comment eVDV' represent the preferred and maximum value presented in the AVTG.

Table 21: Vibration management levels for disturbance to building occupants

Place and Time	Initial screening test Velocity, PEAK, mm/s (>8Hz)	Low probability of adverse comment eVDV $m/s^{1.75}$	Adverse comment possible eVDV $m/s^{1.75}$	Adverse comment probable eVDV $m/s^{1.75}$
Critical areas (day or night)1	0.28	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day2	0.56	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night2	0.40	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions, and places of worship (day or night)	1.10	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	2.20	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

Notes:
1. 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 specify above
2. Daytime is 7am to 10pm and night-time is 10pm to 7am

6.1.3.2 Building damage

Potential structural damage of buildings because of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385

Part 2 and German Standard DIN4150-3. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 times higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

Within British Standard 7385 Part 1, different levels of structural damage are defined:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

The vibration limits in Table 1 of British Standard 7385 Part 2 are for the protection against cosmetic damage, however guidance on limits for minor and major damage is provided in Section 7.4.2 of the Standard:

7.4.2 Guide values for transient vibration relating to cosmetic damage

Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.

Within DIN4150-3, damage is defined as "any permanent consequence of an action that reduces the serviceability of a structure or one of its components" (p.4). The Standard also outlines:

"For buildings as in lines 2 and 3 of Tables 1, 4 or B.1, the serviceability is considered to have been reduced if, for example

- *cracks form in plastered or rendered surfaces of walls;*
- *existing cracks in a structure are enlarged;*
- *partitions become detached from load-bearing walls or floor slabs.*

These effects are deemed 'minor damage. " (DIN4150.3:2016, p.6)

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

6.1.3.3 German Standard

German Standard DIN 4150 - Part 3 (2016) 'Vibration in buildings - Effects on Structures' (DIN 4150-3:2016), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3:2016 presents the recommended maximum limits over a range of frequencies (Hz), measured at the foundations, in the plane of the uppermost floor of a building or structure or vertically on floor slabs. The vibration limits at the foundations increase as the frequency content of the vibration increases. The criteria are presented in Table.

Table 22: DIN 4150-3:2016 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s				
		At foundation in all directions at frequency of			Plane of floor uppermost storey in horizontal direction	Floor slabs, vertical direction
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that because of their particular sensitivity to vibration, cannot be classified under Groups 1 and 2 and are of great intrinsic value (eg listed buildings)	3	3 to 8	8 to 10	8	20

6.1.3.4 Damage to buried services

Section 5.3 of DIN 4150-3:2016 also sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values, which apply at the wall of the pipe, are reproduced, and presented in Table 5 7 below.

Table 23: DIN 4150-3:1999 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50

For long-term vibration the guideline levels presented in Table should be halved.

Recommended vibration goals for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s. It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment should be carried out. This may include a specific vibration impact statement addressing impact on the utility and consultation with the utility provider to confirm specific vibration requirements.

6.2 Construction Assessment

6.2.1 Construction noise sources

A list of the loudest typical construction items is presented in the table below.

Table 24: Typical construction equipment & sound power levels, dB(A) re 1pW

Equipment/Activity	Sound power levels, dB(A) re 1pW
Demolition Works	
Excavator (with hydraulic hammer, stop/start use)	120 (inclusive of 5dB(A) penalty for irritating characteristics)
Concrete/rock saws	120 (inclusive of 5dB(A) penalty for irritating characteristics)
Excavator with bucket or ripper attachment	108
Truck and dog/tipper	105
Loader (front end) / bobcat	103

The sound power levels for most of the construction plant and equipment presented in the above table are based on maximum noise levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', the Interim Construction Noise Guideline (ICNG), information from past projects and/or information held in our library files.

6.2.2 Predicted Construction Levels

The table below presents noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant and equipment associated with the proposed site. The noise level range presented represents the plant item operating at a location furthest from the receiver and a location closest to the receiver.

Table 25: Predicted noise levels for typical construction works

Noise Criteria	*Time*	*Construction Noise Management Levels, dB(A)$L_{eq(15min)}$*						
		Residential Receivers				*Non-Residential Receivers*		
		MU1 (residential levels)	*R1*	*R2*	*R3*	*C1*	*C2*	*C3*
ICNG NMLs	*Monday to Friday (7:00am to 6:00pm)* *Saturdays (8:00am to 1:00pm)*	*62*	*62*	*62*	*62*	*70*	*70*	*70*
Phase of Works	**Location / Plant Description**	**Predicted Construction Noise Levels – External, dB(A)$L_{eq(15min)}$**						
		Residential Receivers				**Non-Residential Receivers**		
		MU1 (residential levels)	**R1**	**R2**	**R3**	**C1**	**C2**	**C3**
Demolition	Excavator (with hydraulic hammer, stop/start use)*	60-95	70-100	68-86	68-86	70-86	58-82	68-82
	Concrete/rock saws*	58-93	69-100	67-84	66-84	69-84	57-81	66-80
	Excavator with bucket	48-77	58-86	56-72	56-72	58-72	46-69	56-70
	Truck and dog/tipper	42-71	52-74	50-66	50-66	52-66	40-62	50-62
	Loader (front end) / bobcat	43-78	53-81	51-67	51-67	53-67	41-64	51-65

The predicted noise levels presented above indicate that:

- Hammering and sawing operations associated with the demolition works are likely to results in the highest levels of noise impacts to the identified surrounding nearest affected receivers.
- The residential property at 16-18 Newcomen Street (R1) is located immediately adjacent to the eastern section of the development sites, has windows along the western façade of the building (overlooking the development sites) and hence are predicted to be the worst affected residential receiver.
- The mixed-use property at 103 Hunter Street (MU1) is located immediately adjacent to the development site, however, no windows are located along the western façade of the upper residential levels. It is proposed to retain the heritage northern façade of the properties at 105, 109 & 111 Hunter Street (part of the development sites) and this structure and the building structure of MU1 are likely to provide some screening from the proposed demolition activities to the windows of MU1 along the northern façade, hence lower noise impacts are predicted for this receiver when compared to R1.

Considering the predicted noise levels above, it is recommended that a feasible and reasonable approach towards noise mitigation measures be applied to reduce noise levels as much as possible to mitigate the impact from construction noise.

Further details on construction noise mitigation and management measures are provided below.

6.2.3 Recommendations

Other potential management/mitigation measures include:

- Neighbour notification and consultation
  - Community consultation procedures and site point of contact must be established.
  - Demolition contractor should notify surrounding properties (MU1, R1, R2, R3, C1 & C2) by letter box drops and/or notification to the building management, of estimated duration of demolition noise intensive activities (breaking, ripping, sawing etc.).
  - Given the proximity of MU1 and R1 to a section of the development sites (east of Morgan Street), these receivers should be notified of the days of breaking, ripping and sawing operations.
- Equipment selection:
  - Where feasible, use of excavator with bucket, bobcat/loaders and/or concrete pulveriser as opposed to hydraulic hammer and concrete saw is recommended to reduce both airborne noise and vibration generation. Note – this is not always feasible, depending on the size of the concrete slab element being demolished.
  - To minimise structure borne noise and vibration impacts to MU1 (103 Hunter Street) and R1 (16-18 Newcomen Street) and heritage building elements to be retained (103-119 Hunter Street) ensure any physical connection to these properties is removed prior to commencement of demolition works. If feasible, this should be done using rotary equipment (concrete saw) as opposed to percussive equipment (hydraulic hammers).
  - A similar process should be used to isolate the heritage façade elements on the development sites. to protect them from vibration damage.
- Vehicle management
  - Trucks should not queue on Newcomen Street or along Hunter Street near the intersection of Newcomen & Hunter Streets, if waiting to get access to the site.
  - Truck engines should be turned off, as opposed to idling, where engine ignition is not required for their operations. Where feasible (for safety reasons) non-tonal reversing beacons should be considered for all demolition vehicles.
- Respite periods
  - Appropriate respite periods shall be determined based on confirmation of the proposed methodology and equipment/machinery by demolition contractor.
  - These respite periods must be discussed with receivers MU1 and R1 for any pneumatic hammering operations proposed on the development sites east of Morgan Street.
  - Given the mix of both residential and commercial type receivers around the development sites, respite periods should be scheduled to provide benefit to both groups. This would typically include:

- No pneumatic hammering prior to 8am on the development sites east of Morgan Street.
- Inter-day respite period (e.g. lunch period 12.30pm to 1.30pm), to benefit both residential and commercial noise receivers.

- Noise shielding
  - Plywood or similar hoarding is unlikely to provide any acoustic benefit, given the multi-storey nature of surrounding receivers (they will overlook any practical hoarding).

6.2.4 Construction Vibration assessment

6.2.4.1 Minimum working distances

The recommended minimum working distances for vibration intensive plant are presented below

Table 26: Recommended minimum working distances for vibration intensive equipment

Plant item	Minimum working distance, m					
	Cosmetic damage			Human disturbance		
	Commercial and industrial buildings1	Dwellings and similar structures1	Sensitive structures (e.g., heritage)1	Residences Day	Offices	Workshops
5 Tonne Excavator w/Hydraulic Breaker, Vibratory Compactor	5	5	10	20	15	10

Notes: 1. Vibration limits referenced from DIN 4150 Structural Damage - Safe Limits for Short-term Building Vibration.
2. Daytime is 7 am to 10 pm;

Site specific buffer distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the minimum working distances for cosmetic damage.

With respect to vibration impact on the rail corridor - acceptable vibration impact on rail infrastructure would typically be indicated by Sydney Trains as approval stage. This is commonly approximately 15mm/s PPV, however must be confirmed. This is necessary to determine whether safe working distances or vibration monitoring would be required.

6.2.5 Potential vibration impacts to residential and commercial uses

Based on the proposed plant items presented, vibration generated by demolition plant was estimated and potential vibration impacts are summarised in the table below.

Table 27: Potential vibration for nearest sensitive receivers – machine mounted pneumatic breaker

Receiver Location	Approx. Distance to Nearest Buildings from Works	Type of Nearest Sensitive Buildings	Assessment on Potential Vibration Impacts		
			Structural Damage Risk	Human Disturbance	Vibration Monitoring
R1 and MU1	<5m	Retail Mixed-use with residential uses and Residential	Medium risk of cosmetic/structural damage from percussive demolition works	Moderate to high risk of adverse comment from demolition activities	Vibration monitoring should be conducted at the commencement of demolition/ excavation works
R2 & R3	20m	Residential	Low risk of cosmetic/structural damage from demolition works	Low risk of adverse comment from demolition activities	Vibration monitoring not required
C1, C2 & C3	>20m	Commercial	Low risk of cosmetic/structural damage from demolition works	Low risk of adverse comment from demolition activities	Vibration monitoring not required
Existing Heritage Elements to be retained on Development Sites	<5m	Heritage elements to be retained	Medium to high risk of structural damage from demolition works	Low risk – buildings not occupied	Vibration monitoring should be conducted at the commencement of demolition/ excavation works

Notes:

1. The potential vibration impacts are based on the equipment/machinery operating near the property boundaries (i.e. within 5-10m)

Based on the above assessment for the receivers surrounding the site, adjoining properties MU1 and R1 would be most at risk from vibration impacts associated with the proposed demolition works. The main risks are from machine mounted pneumatic hammering operations (excavator mounted hydraulic hammers).

Recommendations for reducing potential vibration impacts are provided in the sections below.

6.2.6 Vibration Mitigation Measures and Management Strategies

The following vibration mitigation measures and management strategies are recommended to minimise vibration impact from demolition activities to the nearest affected receivers:

- A management procedure must be implemented to deal with vibration complaints. Each complaint must be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures must be put in place to mitigate future occurrences.
- Where vibration is found to be excessive, management measures must be implemented to ensure vibration compliance is achieved. Management measures may include modification of demolition methods such as using rotary and pulverising operations (saws and rippers/pulveriser attachments) in place of percussive methods (hydraulic hammer), employing smaller equipment when working near property boundaries and time restrictions for the most excessive vibration activities. Time restrictions shall be negotiated following consultation with affected receivers.
- Notification by letterbox drops and/or communication with building management should be carried out for receivers MU1 and R1. These measures are to address potential community concerns that

perceived vibration may cause damage to property. Notification is to be provided prior to the commencement of demolition activities near these receivers (works east of Morgan Street).

- Dilapidation surveys must be conducted for the existing heritage structures on the development sites, to determine whether these elements are structurally unsound. The results of the survey will determine the adoption of the criteria for major or minor damage, rather than cosmetic damage.

6.2.7 Vibration monitoring and monitoring triggers

- With respect to receivers MU1 & R1 and site heritage structures to be retained (façade and internal walls):
  - On site testing is recommended at the commencement of demolition activities, in order to determine safe working distances for excavators, hydraulic hammers and rippers.
  - In the event that exceedance of building damage acoustic criteria are expected at the assessment locations, changes in work method must be considered. This will typically include:
    - Use of concrete/rock saw to create a saw cut around the perimeter of the heritage elements prior to use of the hydraulic hammers or rippers.
    - In the event that this does not produce the required vibration reduction, a series of additional saw cuts would typically be made (90 degrees to the cut around the perimeter). This will effectively divide the rock into blocks which can then typically be removed using the hydraulic hammer but with less vibration generated.
- Installation of vibration monitors is recommended at the locations below. . This is to be commenced prior to the commencement of demolition works. Monitoring locations to include as a minimum:
  - MU1 - 103 Hunter Street
  - R1 – 16-18 Newcomen Street
  - Heritage building elements to be retained
- The vibration monitors shall be equipped with SMS warning triggers, to enable demolition contractor to be notified immediately in the event vibration limits are reached.
- Triggers are to be determined based on DIN 4150, as detailed below (unless structural/geotechnical engineer advise of different triggers as a result of dilapidation surveys):
  - Heritage elements – DIN 4150 Curve 3.
  - Other Elements – DIN 4150 Curve 2.

6.2.8 Complaints management

Noise and vibration levels generated by construction activities associated with the construction of the development must aim to comply with the noise and vibration goals set by the relevant regulations and guidelines.

The contractor is responsible for implementing this Construction Noise and Vibration Management Plan and ensuring that all reasonable measures are implemented such as the provision of a Noise and Vibration Complaints Program, to minimise the generation of excessive noise and/or vibration levels from the site to nearby sensitive areas.

Owners and occupants of nearby affected properties are to be informed by direct mail of a direct telephone line and contact person where any noise and/or vibration complaints related to the operation of the construction activities are to be reported.

7 Conclusion

This assessment has been prepared by Renzo Tonin & Associates for the proposed Newcastle East End Stages 3 & 4 project.

We note:

- Recommendations to building shell constructions to address external (road traffic) noise is presented in Section 4.2.
- Recommendations for the control of operational noise is detailed in Section 5.2.
- Consideration of construction noise is presented in Section 6.

Provided the recommendations in this report are adopted, noise impacts on the development, and from the development onto other sites, will be satisfactorily addressed.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

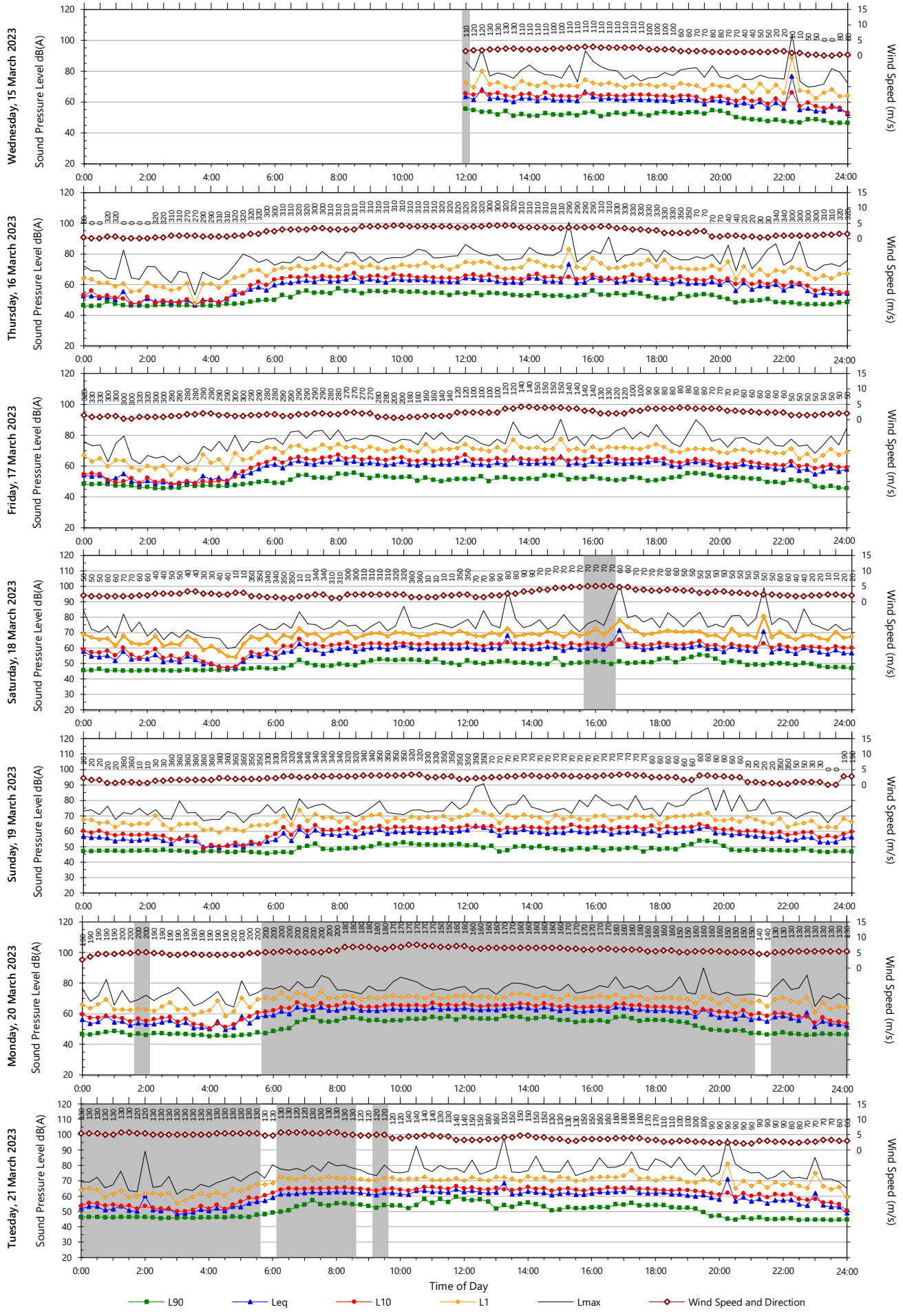
Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Noise Logger Results – Location 1 (King Street)

Unattended Monitoring Results

Location: L01 - RTA07-043 - East End Stages 3 & 4, Newcastle

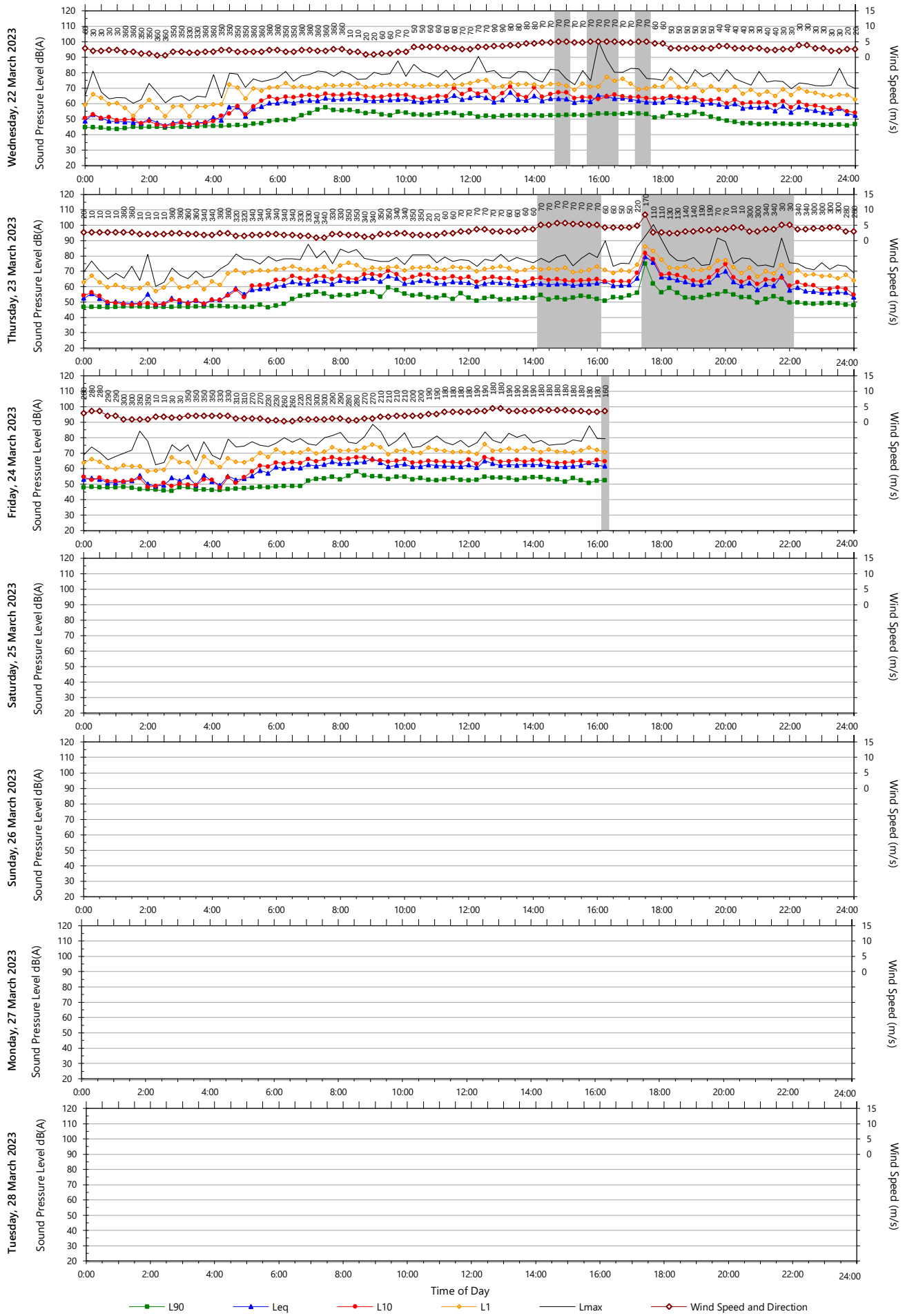


Data File: 2023-03-15_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r42)

Unattended Monitoring Results

Location: L01 - RTA07-043 - East End Stages 3 & 4, Newcastle



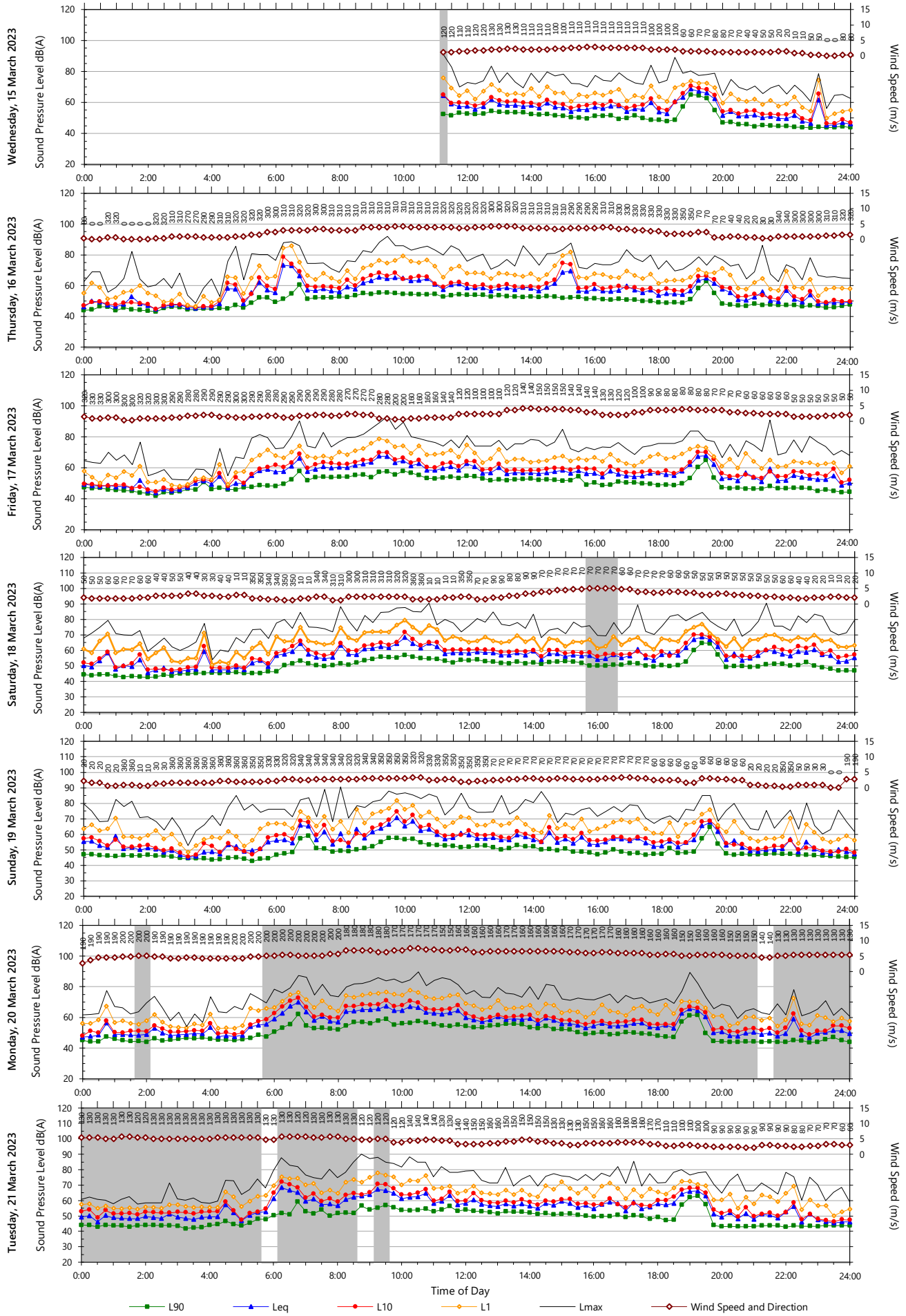
Data File: 2023-03-15_SLM_001_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r42)

APPENDIX C Noise Logger Results – Location 2 (Hunter Street)

Unattended Monitoring Results

Location: L02 - RTA07-050 - East End Stages 3 & 4, Newcastle

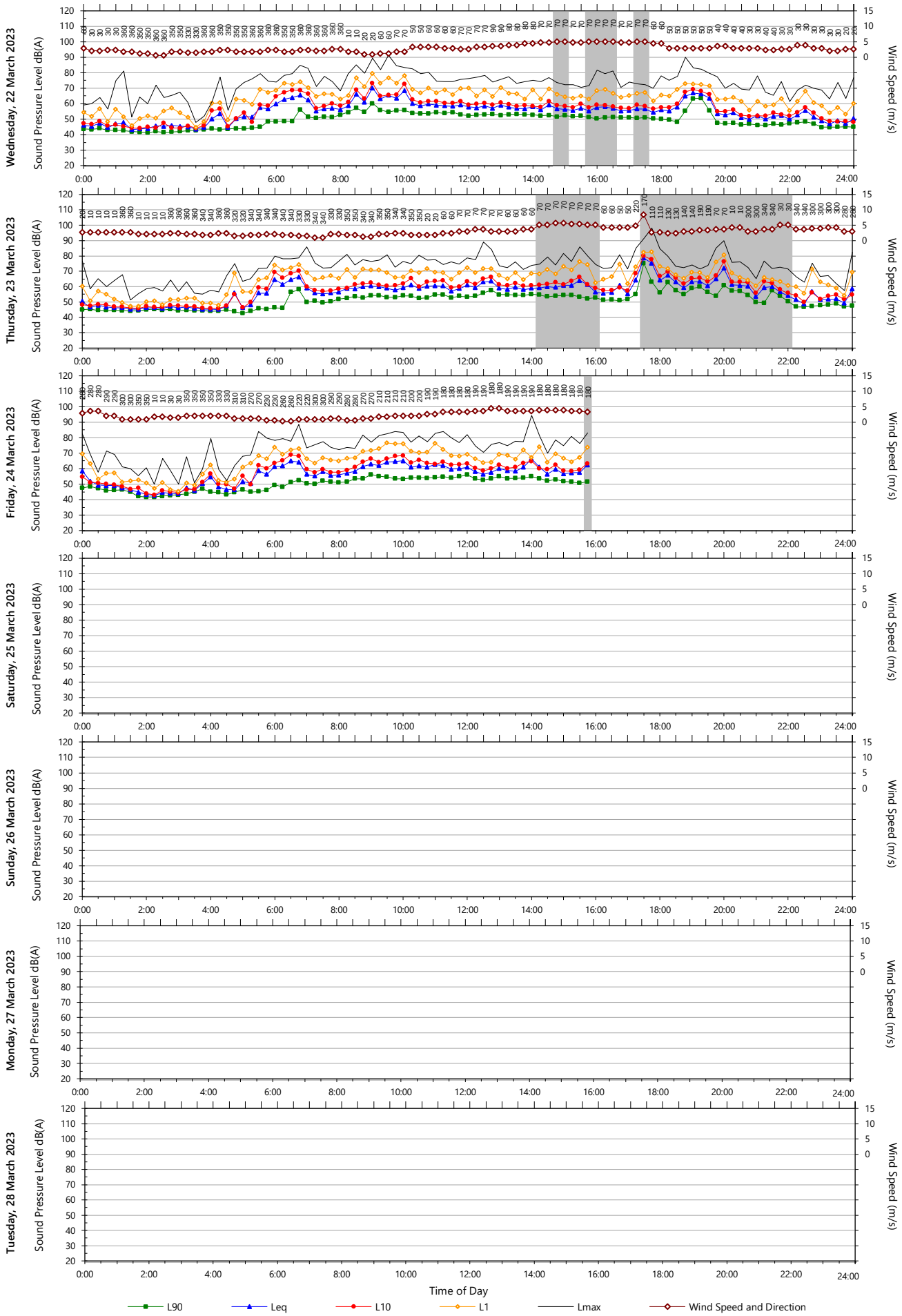


Data File: 2023-03-15_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r42)

Unattended Monitoring Results

Location: L02 - RTA07-050 - East End Stages 3 & 4, Newcastle



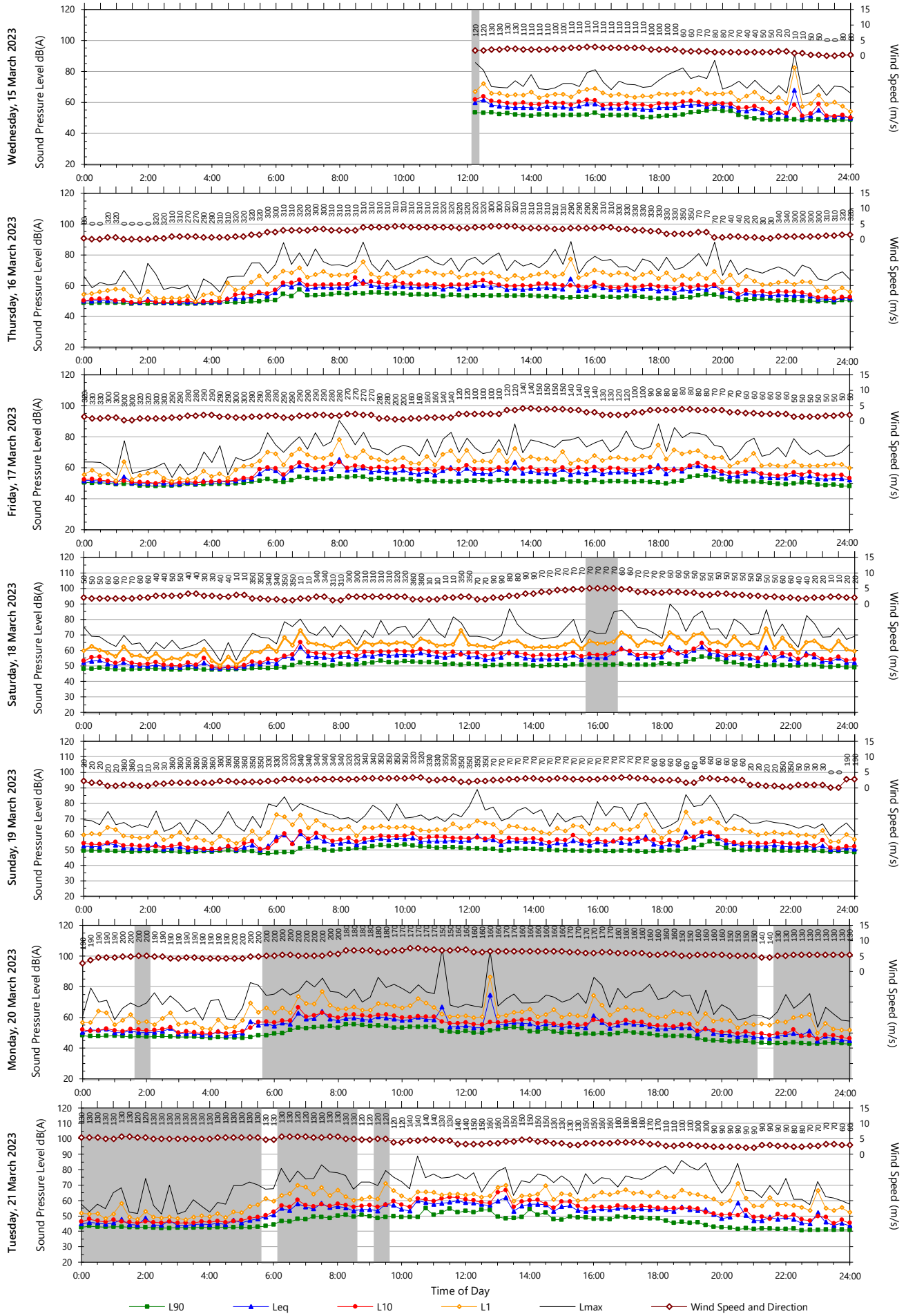
Data File: 2023-03-15_SLM_000_123_Rpt_Report.txt

Template: QTE-26 Logger Graphs Program (r42)

APPENDIX D Noise Logger Results – Location 3 (Newcomen Street)

Unattended Monitoring Results

Location: L03 - RTA07-051 - East End Stages 3 & 4, Newcastle



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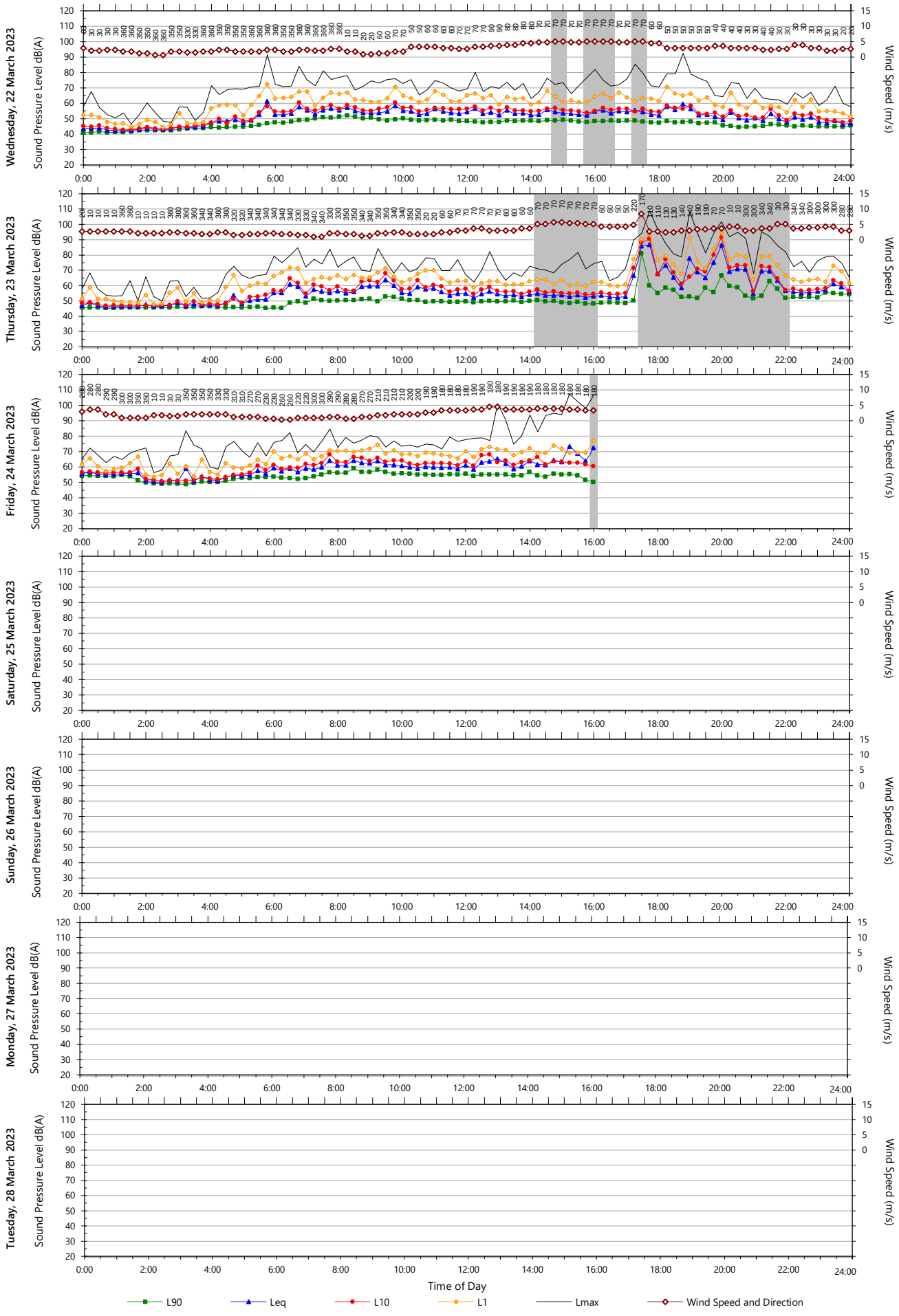

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Template: QTE-26 Logger Graphs Program (r42)