Appendix 21

Acoustic Assessment prepared by Renzo Tonin & Associates

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Acoustics
Vibration
Structural Dynamics

LOT 3990 JORDAN SPRINGS BOULEVARD, JORDAN SPRINGS

Acoustic Assessment for Development Application

27 April 2018

Lend Lease Retirement Living

TK212-01F03 Acoustic Report for DA - Lot 3990 (r1)

30 1982 2012 ACOUSTIC EXCELLENCE
Sydney Melbourne Brisbane Gold Coast Kuwait
Renzo Tonin & Associates (NSW) Pty Ltd ABN 29 117 462 861
Level 1/418A Elizabeth St SURRY HILLS NSW 2010 | PO Box 877 STRAWBERRY HILLS NSW 2012
P (02) 8218 0500 F (02) 8218 0501 sydney@renzotonin.com.au www.renzotonin.com.au

aaac Association of Australian Acoustical Consultants

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Address:	Level 14, Tower Three, International Towers Sydney Exchange Place, 300 Barangaroo Avenue, Barangaroo NSW 2000
Attention:	Murray Robertson

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Contents

List of tables

List of figures

1 Introduction

Renzo Tonin & Associates was engaged to conduct a noise assessment of the proposed residential subdivision development at Lot 3990 Jordan Springs Boulevard, Jordan Springs. The proposed development consists of 31 residential lots.

The study examines the effects of external noise intrusion on the proposed development from nearby noise sources and noise emissions from the operation of the development impacting on surrounding residential receivers. Long-term noise surveys were conducted by Renzo Tonin & Associates from Tuesday 20th March 2018 to Thursday 29th March 2018 at the development site to determine the existing levels of ambient noise at the site. These levels were used to predict noise levels within the proposed residential spaces and assessed against the recommended internal noise criteria for the project.

As a result of our assessment, the following potential acoustic items have been identified;

- Noise intrusion into the development from existing traffic noise on The Northern Road and Jordan Springs Boulevard; and
- In principle noise emissions from proposed mechanical plant impacting onto neighbouring properties.

This report presents an assessment of the above acoustic components in accordance with Penrith City Council's Development Control Plans, State Environmental Planning Policy (Infrastructure) 2007, NSW Environment Protection Authority (EPA) Noise Policy for Industry (NPfI) and Australian Standards.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Site description

The proposed residential development at Lot 3990 Jordan Springs Boulevard, Jordan Springs comprises of 31 future detached residential lots.

The site is bound by Jordan Springs Boulevard to the north and The Northern Road is situated 150m west of site.

Long-term noise monitoring has been undertaken at the site to determine the existing acoustic environment. Refer to Figure 1 below for an aerial photograph showing the site, the surrounds and the locations of noise monitoring.

Figure 1: Aerial photograph (dated 20 January 2018) showing site and surrounds

3 Ambient and background noise survey

Two unattended long-term noise surveys were undertaken on site using NTi XL2 from Tuesday 20th March to Thursday 29th March 2018 to determine the existing level of ambient and background noise surrounding the site. One noise monitor, at Location L1, was installed approximately 26m south of Jordan Springs Boulevard and another, at Location L2, approximately 150m east of The Northern Road and at the south-west boundary of the site. Figure 1 above shows the location of the noise monitors.

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

The results of the background and ambient noise monitoring undertaken on site are presented in APPENDIX C.

3.1 Results of unattended noise monitoring

3.1.1 Road traffic noise

The design traffic noise levels are taken from the representative $L_{Aeq,\,T}$ for the week for both the day time (7am to 10pm) and night time (10pm to 7am) periods. The design external traffic noise levels are presented in Table 1 below.

Table 1: Representative Day and Night Road Traffic Noise Levels

Monitoring Location	Survey Period	Measured Traffic Noise Levels $L_{eq,\,T}$ [1,2], dB(A)
Location L1 – Long-term noise monitor installed approximately 26m south of Jordan Springs Boulevard.	Day time (7am to 10pm) 20/03/2018 to 29/03/2018	57
	Night time (10pm to 7am) 20/03/2018 to 29/03/2018	52
Location L2 – Long-term noise monitor installed approximately 150m east of The Northern Road.	Day time (7am to 10pm) 20/03/2018 to 29/03/2018	55
	Night time (10pm to 7am) 20/03/2018 to 29/03/2018	53

Notes:

1. Noise levels presented are facade corrected values.
2. Representative external noise levels in measured L_{Aeq} over 15 hour and 9 hour day and night period respectively.

3.1.2 Background noise

The following table presents the results of the long term unattended noise monitoring for background noise.

Table 2: Background Noise Levels

Noise Monitoring		Representative Background Noise Levels in dB(A)	Day[1]	Evening[2]	Night[3]
Location	Duration				
Location L1 – Long-term noise monitor installed approximately 26m south of Jordan Springs Boulevard.	20/03/2018 to 29/03/2018	L_{A90}	44	44	39
		L_{Aeq}	55	53	49
Location L2 – Long-term noise monitor installed approximately 150m east of The Northern Road.	20/03/2018 to 29/03/2018	L_{A90}	44	45	39
		L_{Aeq}	52	51	49

Notes:

Day, Evening & Night assessment periods are defined in accordance NSW EPA's Noise Policy for Industry as follows.

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period
2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays

4 Noise intrusion assessment

4.1 Criteria

The airborne noise criteria for this development are based on the following documents:

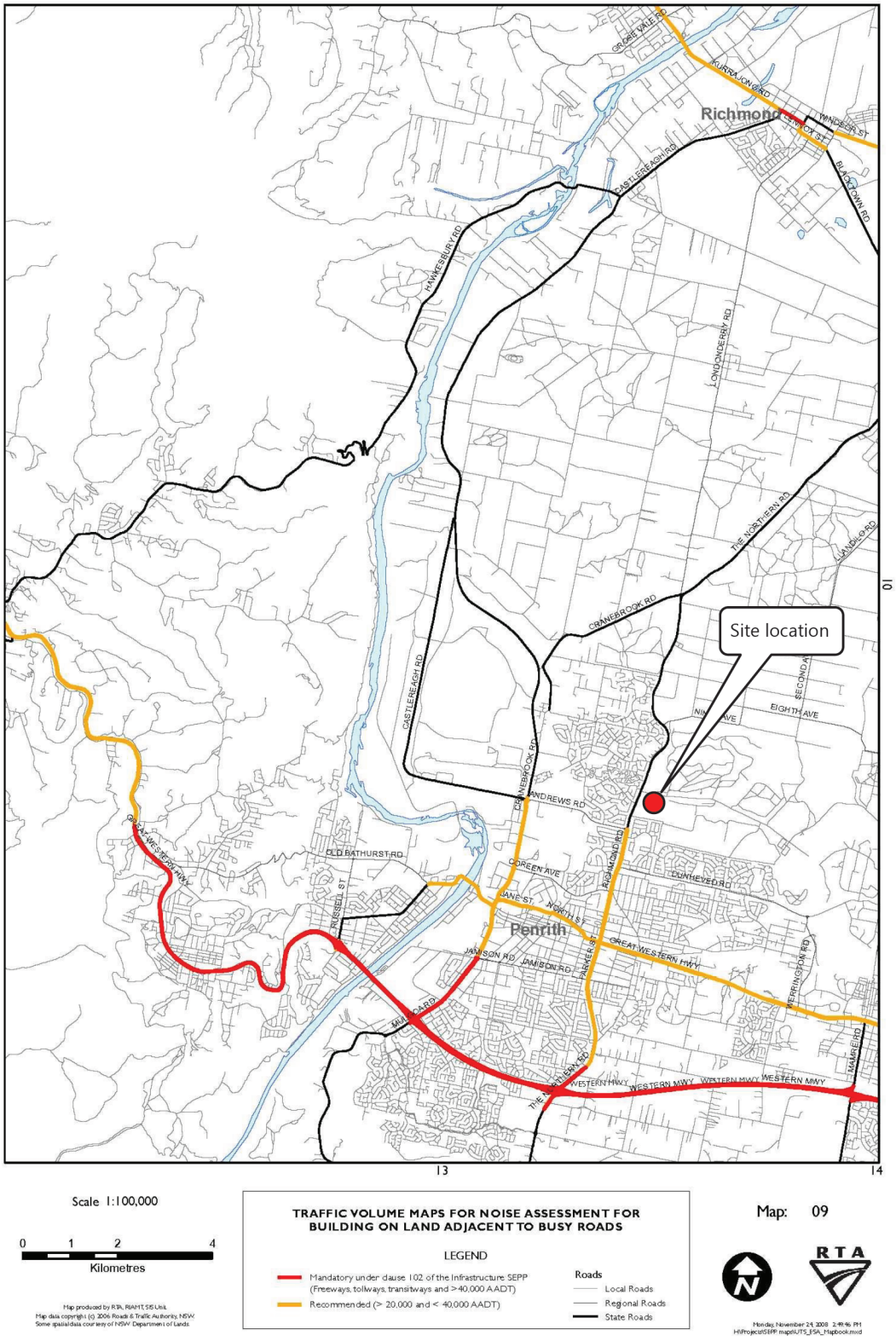
1. Penrith City Council Development Control Plan 2014 (DCP)
2. State Environment Planning Policy (Infrastructure) 2007 (ISEPP)
3. Department of Planning (DoP) publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008 (DoP Guideline 2008)
4. Australian Standard AS/NZS 2107:2016 "Acoustics – Recommended design sound pressure levels and reverberation times for building interiors"

In addition to the above documents, Council has stipulated the following requirements as part of the pre-lodgement advice:

> *Acoustics*
>
> *The proximity of the proposed development to The Northern Road and Jordan Springs Drive is likely to result in some parts of the proposed development being exposed to high levels of road traffic noise. An acoustic assessment of the impact of this needs to be submitted with the application. In addition, the acoustic assessment needs to include other noise sources such as mechanical plant and equipment from the RFBs (eg. Mechanical ventilation and lifts, and activities such as waste collection and deliveries. The acoustic assessment needs to be prepared in accordance with the NSW EPA's Noise Policy for Industry and the Road Noise Policy.*

The ISEPP applies to development impacted by roads with over 40,000 AADT, however, in the absence of specific noise goals presented by Penrith City Council, noise goals presented in the ISEPP are considered to be the most appropriate for this development. As shown in Figure 2 below, The Northern Road or Jordan Springs Boulevard are not considered as roads with over 40,000 AADT.

Figure 2: Traffic volume map for ISEPP 2007



A summary of the project noise intrusion goals is outlined in Table 3 below.

Table 3: Recommended Internal Noise Criteria for Road Traffic Noise

Type of Occupancy	Windows Condition	Design Noise Level	
		Day, $L_{Aeq\ (15hour)}$	Night, $L_{Aeq\ (9hour)}$
Bedrooms	Closed	-	35dB(A)
	Open	-	45dB(A)
Living/Dining/Kitchen	Closed	40dB(A)	40dB(A)
	Open	50dB(A)	50dB(A)

Relevant sections of the ISEPP, Department of Planning Documentation and Council DCP are presents in APPENDIX B of this report. Results of the background and ambient noise monitoring conducted on site are presented in APPENDIX C.

4.2 Calculated internal traffic noise levels

Results from the long-term noise survey were used to calculate internal road traffic noise levels within the proposed development. Noise calculations and predictions were conducted using the *Outside-In Glazing Spreadsheet* developed in this office which takes into account external ambient 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.

External facade & glazing constructions required to comply with the project noise criteria outlined in Table 3 above are presented in Section 4.3 below.

4.3 Glazing design requirements

Table 4 below presents recommended glazing treatment for the building facades to achieve compliance with the maximum noise levels nominated in Table 3 above.

Table 4: Recommended Glazing Treatment

Level	Facade	Occupancy Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly	Typical Compliance Glazing Configuration	Laboratory Test Reference
Proposed Lots 17, 18, 19, 20, 21, 22 & 23					
All Levels	West	Bedroom	For glazing area less than $6m^2$ = R_w 25	Minimum 4mm standard float or toughened glass	ESTIMATE
			For glazing area greater than $6m^2$ = R_w 28	Minimum 6mm standard float or toughened glass	ESTIMATE
		Living/Dining/Kitchen	R_w 25	Minimum 4mm standard float or toughened glass	ESTIMATE

Level	Facade	Occupancy Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly	Typical Compliance Glazing Configuration	Laboratory Test Reference
	North, East & South	Bedroom	R_w 25	Minimum 4mm standard float or toughened glass	ESTIMATE
		Living/Dining/Kitchen	R_w 25	Minimum 4mm standard float or toughened glass	ESTIMATE
All other proposed Lots					
All Levels	All Facades	Bedroom	R_w 25	Minimum 4mm standard float or toughened glass	ESTIMATE
		Living/Dining/Kitchen	R_w 25	Minimum 4mm standard float or toughened glass	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.
4. 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:

5. 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.
6. The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.
7. 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.
8. The glazing supplier shall ensure that installation techniques will not diminish the Rw performance of the glazing when installed on site.
9. 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.
10. 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

11. The sealing of all gaps in partitions is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
12. Check design of all junction details with acoustic consultant prior to construction.
13. Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
14. The information provided in this table is subject to modification and review without notice.
15. 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.

4.3.1 Glazing assembly requirements

The following acoustic measures should also be incorporated into the building design:

- All operable 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.

- The glazing thicknesses outlined in Table 4 should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

- The glazing supplier shall ensure that installation techniques will not diminish the Rw performance of the glazing when installed on site. Sliding door meeting stiles should form an airtight seal when closed and locked.

- The perimeter of all window and door frames are to be sealed airtight in the external facade using the following methods:

    - For gaps less than 10mm - Fill all gaps around the window perimeter with an acoustic mastic sealer (minimum specific gravity 1.6sg) equivalent to Promat Promaseal. The depth of sealer shall be at least equal to the width of the gap.

    - If the gap is greater than 10mm, fill the cavity with polyester insulation and a backing rod. Seal the gap airtight an acoustic mastic sealer (min specific gravity 1.6sg) equivalent to Promat Promaseal. The depth of sealer shall be at least equal to the width of the gap. The gaps between frames shall also be sealed using aluminium angle brackets (approximately 25 x 25 x 3mm).

4.4 Facade and roof sound insulation

In principle advice is provided below for the acoustic requirements of the roof and external walls for this proposed development.

4.4.1 External walls

The dominant path of external noise ingress into building interior is via window and doors. Assessment and recommendations regarding external noise intrusion has accordingly been made with respect to the windows and doors. It is therefore recommended that the external walls have a sound isolation rating (R_w) at least 15dB higher than that of the glazing specified in Table 4 above, to maintain the acoustic integrity of the overall facade system.

4.4.2 Roof and ceiling

Similar to the external wall design, the roof/ceiling construction can generally provide acoustic performances well in excess of glazing or doors. The roof construction should have a sound isolation rating (R_w) at least 10dB higher than that of the glazing on its facade.

5 Operational noise emission from development

5.1 EPA requirements

The NSW Environment Protection Authority (EPA) sets out noise criteria in its Noise Policy for Industry (NPfI) to control the noise emission from industrial sources.

The NPfI sets project noise trigger level to protect noise amenity for residential receivers. The project noise trigger level is set as the lower value of the following two assessment components:

- Controlling intrusive noise impacts in the short term for residences; and
- Maintaining noise level amenity for particular land uses for residences and other land uses.

Noise intrusiveness ensures that industrial noise does not exceed the background noise level by an excessive margin, preventing significant changes in the noise characteristic pertinent to the development site and surrounds. This is commonly referred to as the 'background plus 5' criterion. That is, the noise level from new industrial development, assessed in periods of 15 minutes, should not exceed the existing background noise level (measured in the absence of that development) by more than 5dB(A).

Noise amenity ensures that industrial noise levels do not increase without limit, for if a number of industrial noise sources are permitted to increase the background noise level by 5dB(A), in turn there would be a point where the ultimate noise level is unacceptable. A limit on the ultimate acceptable noise level is therefore included in the NPfI as a way of ensuring that cumulative noise impact from industrial growth is curtailed. This limit is referred to as the project amenity noise level. Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options, and subsequently determine achievable noise requirements.

The table below presents the recommended amenity noise level relevant to the receivers surrounding the proposed development site. The project amenity noise level is defined as the recommended amenity noise level minus 5dB(A).

Table 5: NPfI Amenity Noise Levels - Recommended L_{Aeq} Amenity Noise Levels from Industrial Noise Sources [EPA NPfI Table 2.1]

Receiver	Noise amenity area	Time of day	L_{Aeq}, dB(A)
			Recommended Amenity noise level
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40

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

Notes:

- Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
- On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
- The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

In accordance with Section 2.4 of the NPfI, the following **exceptions** to the above method to derive the project amenity noise level apply:

1. In areas with high traffic noise levels (see Section 2.4.1 of the NPfI).
2. In proposed developments in major industrial clusters (see Section 2.4.2 of the NPfI).
3. Where the resultant project amenity noise level is 10dB, or more, lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
4. Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.

Table 6 present the site-specific noise production criteria from industrial noise sources, namely mechanical plant.

Table 6: Project noise trigger level for noise emission from mechanical plant (EPA NPfI)

Time of Day	Column 1	Column 2	Column 3	Column 4
	Rating Background Level (RBL) L_{A90}	Project Intrusiveness Trigger Level (RBL+5)	Recommended Amenity Noise Level (RANL)	Project Amenity Noise Level (PANL)
Day (7am to 6pm)	44	49	55	50
Evening (6pm to 10pm)	44	49	45	40
Night (10pm to 7am)	39	44	40	35

Explanatory notes:

Column 1 – RBL measured in accordance with the NPfI and outlined in the results of the long-term noise monitoring has been summarised in accordance with NPfI requirements and are presented in Table 2 above.

Column 4 – Project Amenity Noise Level determined based on 'Residential - suburban' area in Table 2.2 (Amenity noise levels) of the EPA's NPfI minus 5dB

5.2 Maximum noise level event assessment

The potential for sleep disturbance from maximum noise level events, from the proposed development, needs to be considered. Section 2.5 of the NPfI provides sleep disturbance trigger levels, summarised as follows:

Table 7: Sleep disturbance noise trigger levels

Receiver	Sleep Disturbance Trigger Levels, 10:00pm to 7:00am	
	$L_{Aeq,\ 15\ minute}$	L_{AFmax}
All residential	Greater than 40dB(A) or RBL plus 5dB, whichever is the greater	52dB(A) or RBL plus 15dB, whichever is the greater

Where noise from the proposed development is predicted to exceed the sleep disturbance trigger levels above in Table 7, during the night time, a detailed noise level assessment is required. The detailed assessment is required to cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the frequency of events occurring during the night time.

5.3 Recommended noise control measures for mechanical plant

Where necessary, noise amelioration treatment will be incorporated in the design to ensure that noise levels comply with the recommended EPA's NPfI noise emission criteria noted above.

At this stage details of mechanical plant have not been finalised, the following in-principal recommendations are provided:

- Acoustic assessment of mechanical services equipment will need to be undertaken during the detail design phase of the development to ensure that they shall not either singularly or in total emit noise levels which exceed the noise limits in EPA's NPfI or Council's requirements;
- As noise control treatment can affect the performance of the mechanical services system, it is recommended that consultation with an acoustic consultant be made during the initial phase of mechanical services system design in order to reduce the need for revision of mechanical plant and noise control treatment;
- Mechanical plant noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following:
    - procurement of 'quiet' plant,
    - strategic positioning of plant away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises,
    - commercially available silencers or acoustic attenuators for air discharge and air intakes of plant;
    - acoustically lined and lagged ductwork;
    - acoustic screens and barriers between plant and sensitive neighbouring premises; and/or
    - Partially-enclosed or fully-enclosed acoustic enclosures over plant.
- Mechanical plant shall have their noise specifications and their proposed locations checked prior to their installation on site; and
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 "Rotating and Reciprocating Machinery – Mechanical Vibration".

We recommend a full and detailed assessment with fully documented acoustic treatments be undertaken at the detailed design phase of the development, followed by construction/installation supervision of mechanical plant and equipment acoustic treatment. Compliance testing following the installation of the plant should also be undertaken.

6 Conclusion

Renzo Tonin & Associates has completed an acoustic assessment of the proposed residential subdivision lots at Lot 3990 Jordan Springs Boulevard, Jordan Springs.

Noise impacts from road traffic (particularly on Jordan Springs Boulevard and The Northern Road) have been considered and in-principle treatments for the control of traffic noise intrusion have been presented for compliance with AS/NZS 2107:2016, the SEPP (Infrastructure) 2007 and DoP Guideline 2008.

Noise emission goals for the operation of mechanical plant and equipment have been set in accordance with the Noise Policy for Industry. It is feasible that noise emissions from the subject site can comply with these criteria, subject to detailed design for Construction Certificate.

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 Criteria and design

B.1 Penrith City Council Development Control Plan 2014

Penrith City Council's DCP 2014 contains guidelines in objectives and controls for assessing impacts from road traffic noise. Relevant sections of the DCP are reproduced below.

C12 Noise and Vibration

12.1. Road Traffic Noise

A. Background

Currently, road traffic is the most widespread source of environmental noise. The controls below seek to minimise the impact of road traffic noise.

This Section of the DCP applies to all development that generates a significant level of traffic noise (as determined by Council) that has potential to impact upon residential and other sensitive land uses.

This Section is also applicable to any residential development, subdivision or other sensitive land uses, which propose to locate near existing areas of significant road traffic noise.

B. Objectives

a) To ensure that the amenity of all residential development and other sensitive land uses is not significantly affected by road traffic noise;

b) To ensure that the traffic associated with development does not significantly impact upon the amenity of surrounding land uses;

c) To ensure that the traffic associated with development does not have a significant noise impact on the existing road network; and

d) To ensure that any subdivisions are designed to minimise the impact of road traffic noise on any residential development or other sensitive land uses.

C. Controls

1) Road traffic noise criteria including sensitive land uses

a) Council will not grant consent to development, particularly residential development, including subdivisions, unless the impact of traffic noise from freeway, arterial, designated or collector roads complies with the standards and guidelines for road traffic noise prepared by the relevant State Government authorities or agencies, as well as relevant Australian Standards.

b) Council will not grant consent to development for sensitive land uses unless it complies with the provisions and standards for road traffic noise prepared by the relevant State Government authorities or agencies, as well as relevant Australian Standards.

c) Sensitive land uses subject to road traffic noise criteria referred to in b) above include educational establishments (including schools), places of public worship, hospitals, and passive and active recreation areas.

Noise Impact Statements - Specific Requirements

a) Where a site is likely to be affected by unacceptable levels of road traffic noise, the applicant is required to provide a Noise Impact Statement prepared by a qualified acoustic consultant in accordance with the requirements set out in the DA Submission Requirements Appendix of this DCP.

b) The Noise Impact Statement should demonstrate acoustic protection measures necessary to achieve an indoor environment meeting residential standards, in accordance with EPA and Department of Planning Criteria, as well as relevant Australian Standards.

NOTE: To determine whether your site is likely to be exposed to levels of road traffic noise that exceed residential standards:

a) Contact Council regarding main road frontages known to exceed residential noise standards; and

b) Obtain detailed advice from a qualified acoustic consultant regarding appropriate planning and design measures.

B.2 State Environmental Planning Policy (Infrastructure) 2007

The NSW State Environmental Planning Policy (Infrastructure) 2007 (known as 'ISEPP') came into force in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. The aim of the policy includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure.

Pertinent to noise assessment, the ISEPP includes the following clauses:

87 Impact of rail noise or vibration on non-rail development

1. This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:

a. a building for residential use,

b. a place of public worship,

c. a hospital,

d. an educational establishment or child care centre.

2. Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.

3. If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

a. in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,

b. anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.

102 Impact of road noise or vibration on non-road development

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

a. a building for residential use,

b. a place of public worship,

c. a hospital,

d. an educational establishment or child care centre.

2. Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.

3. If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

a. in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,

b. anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.

2. In this clause, "freeway", "tollway" and "transitway" have the same meanings as they have in the Roads Act 1993

B.2.1 Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline'

To support the Infrastructure SEPP, the NSW Department of Planning released the *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008). The Guideline assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality. While the ISEPP applies only to roads with an AADT greater than 40,000 vehicles, the guideline is also recommended for other road traffic noise affected sites.

B.3 Australian/New Zealand Standard AS/NZS 2107:2016

As traffic noise levels are not constant, an L_{eq} noise level descriptor is used when assessing this type of noise source. The L_{eq} is the mean energy level of the noise being measured.

This standard provides recommended noise levels for steady state such as noise from building services and quasi-steady state sounds, such as traffic and industrial noise. The noise levels recommended in AS/NZS 2107:2016 take into account the function of the area and apply to the sound level measured within the space unoccupied although ready for occupancy.

This standard recommends the following noise levels for residential buildings.

Table 8: Recommended design sound levels for different areas of occupancy in buildings

Type of occupancy/ activity	Recommended design sound level, L_{Aeq}, dB(A)	Recommended reverberation time (T),s
5 OFFICE BUILDINGS		
General office areas	40 to 45	0.4 to 0.6
Private offices	35 to 40	0.6 to 0.8
Public spaces	40 to 50	0.5 to 1.0
Reception areas	40 to 45	0.6 to 0.8
Rest rooms and break-out spaces	40 to 45	0.4 to 0.6
Toilets	45 to 55	-
Undercover carparks	<65	-
7 RESIDENTIAL BUILDINGS (see Note 7 and Clause 5.2)		
Houses in areas with negligible transportation -		
Sleeping areas	25 to 30	-
Houses and apartments near minor roads -		
Living areas	30 to 40	-
Sleeping areas	30 to 35	-
Work areas	35 to 40	-

Type of occupancy/ activity	Recommended design sound level, L_{Aeq}, dB(A)	Recommended reverberation time (T),s
Apartment common areas (e.g. foyer, lift lobby)	45 to 50	-
Houses and apartments near major roads -		
Living areas	35 to 45	-
Sleeping areas	35 to 40	-
Work areas	35 to 45	-
Apartment common areas (e.g. foyer, lift lobby)	45 to 50	-
8 SHOP BUILDINGS		
Enclosed carparks	<65	-
Show rooms	<50	See Note 3
Small retails stores (general)	<50	See Note 3
Specialty Shops (where detailed discussion is necessary in transactions)	<45	See Note 3

NOTES:

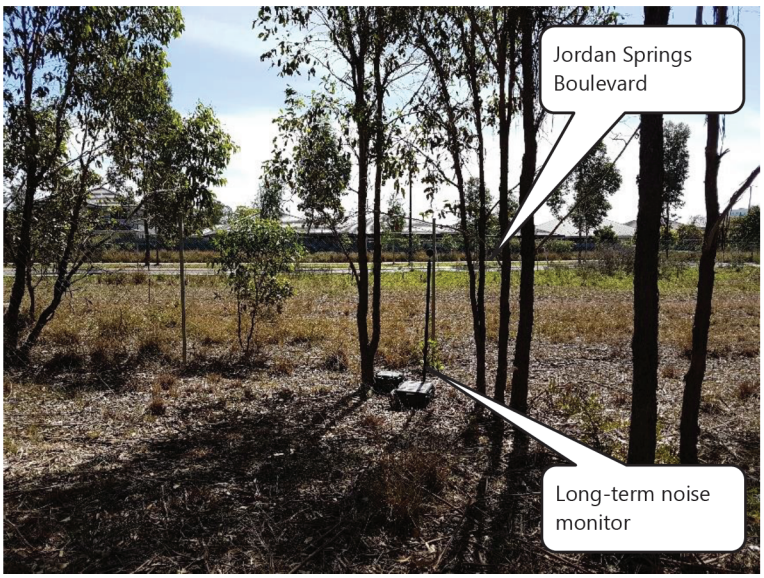
1. The recommended design sound levels are for a fully fitted out and completed building. Attention is drawn to the additive noise effect of many machines within the same area and adjacent areas. Allowance for the total number and type of noise sources should therefore be made in the selection of equipment and in the design of building spaces. A building owner or developer may consider an allowance of 3-5 dB(A) to be appropriate.
2. Recommended reverberation time is 10 percent to 20 percent higher than Curve 1 of Appendix A.
3. Reverberation time should be minimized as far as practicable for noise control.
4. Certain teaching spaces, including those intended for students with learning difficulties and students with English as a second language, should have reverberation times at the lower end of the specified range.
5. Specialist advice should be sought for these spaces.
6. A very wide range of noise levels can occur in the occupied state in spaces housing manufacturing processes, and the levels are primarily subject to control as part of a noise management program (see AS/NZS 1269.2). The possibilities for segregating very noisy processes from quieter ones by partitioning vary between particular industries and plants. For reasons such as these, it is difficult to make generalized recommendations for desirable, or even maximum, design levels for the unoccupied state, but one guiding principle may still be observed - when the activity in one area of a manufacturing plant is halted, it is desirable that the local level should if possible drop to 70 dB(A) or lower to permit speech communication without undue effort.
7. In situations where traffic noise levels may vary widely over a 24-hour period, measurements to assess compliance with this Standard should be taken at the relevant time and for an appropriate measurement period according to the area of occupancy or activity in the building. Where traffic noise fluctuates rapidly with the passage of individual vehicles, the community reaction may not correlate well with the equivalent continuous noise level as measured.
8. The overall sound pressure level in dB(A) should conform to the recommended design sound level given in Table 1. In these spaces, a balanced sound pressure level across the full frequency range is essential. These spaces should therefore be evaluated in octave bands across the full frequency spectrum. The recommended maximum sound pressure levels for the individual octave bands corresponding to the overall dB(A) value are given in Appendix C.
9. In spaces in which high quality sound recordings are to be made, the levels set for low frequency octave bands should not be exceeded (see Appendix C). Subsequent replay of the recordings may cause an amplification of the ambient sound resulting in an overemphasis of its low-frequency components. Specialist advice should always be sought when these spaces are being designed. In some circumstances, for purposes of very high quality recording, lower levels than those specified in Table 1 may be required.

APPENDIX C Locations and results of noise surveys

C.1 Long-term noise monitoring - Location L1

Location L1: Unattended long-term noise monitor installed approximately 26m south of Jordan Springs Boulevard.

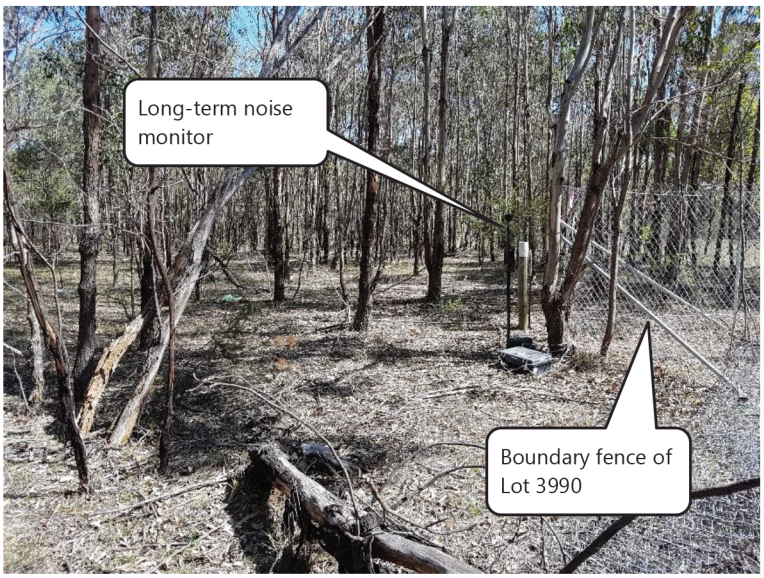
Survey Period: 20/03/2018 to 29/03/2018

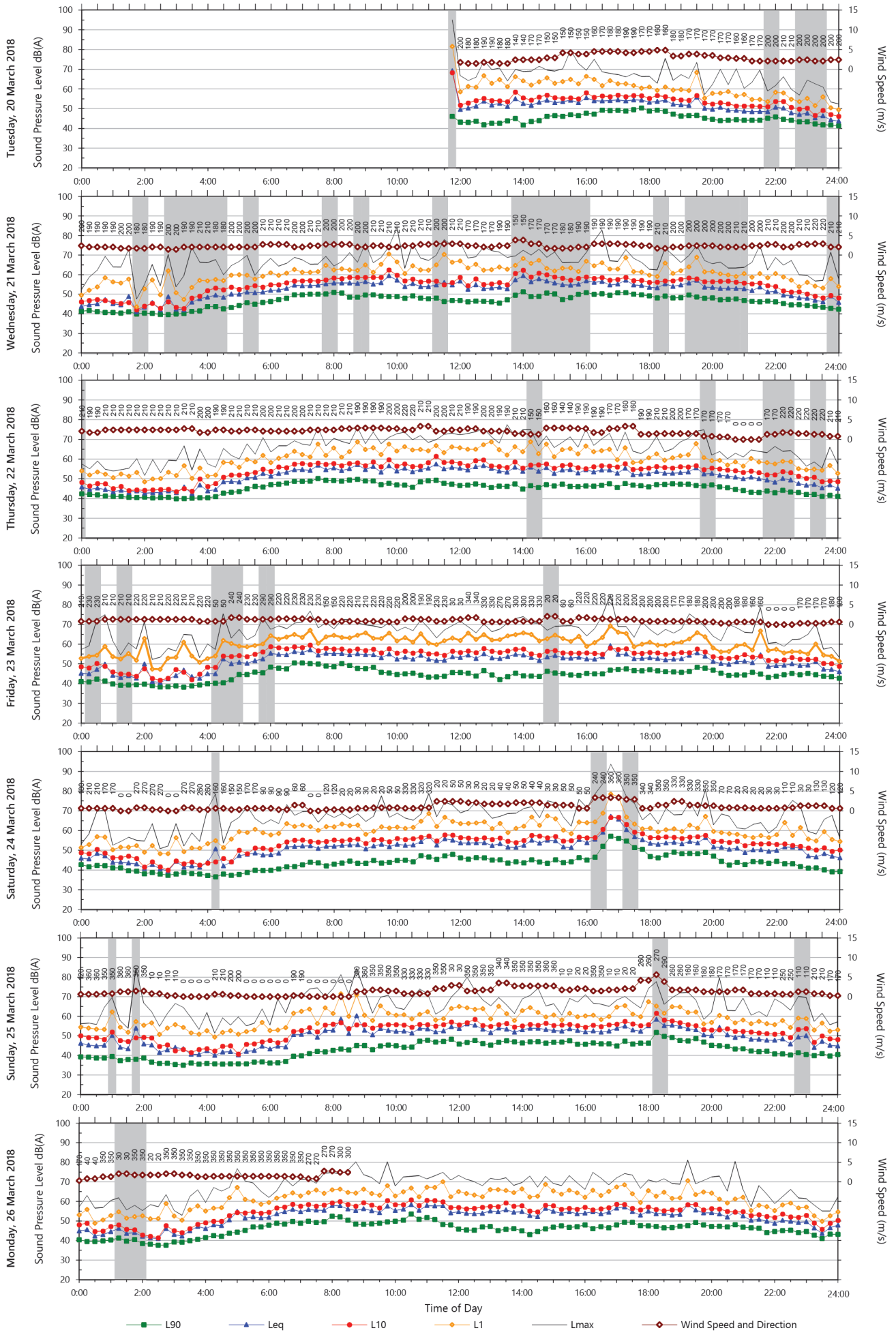


C.2 Long-term noise monitoring - Location L2

Location L2: Unattended long-term noise monitor installed approximately 150m east of The Northern Road.

Survey Period: 20/03/2018 to 29/03/2018

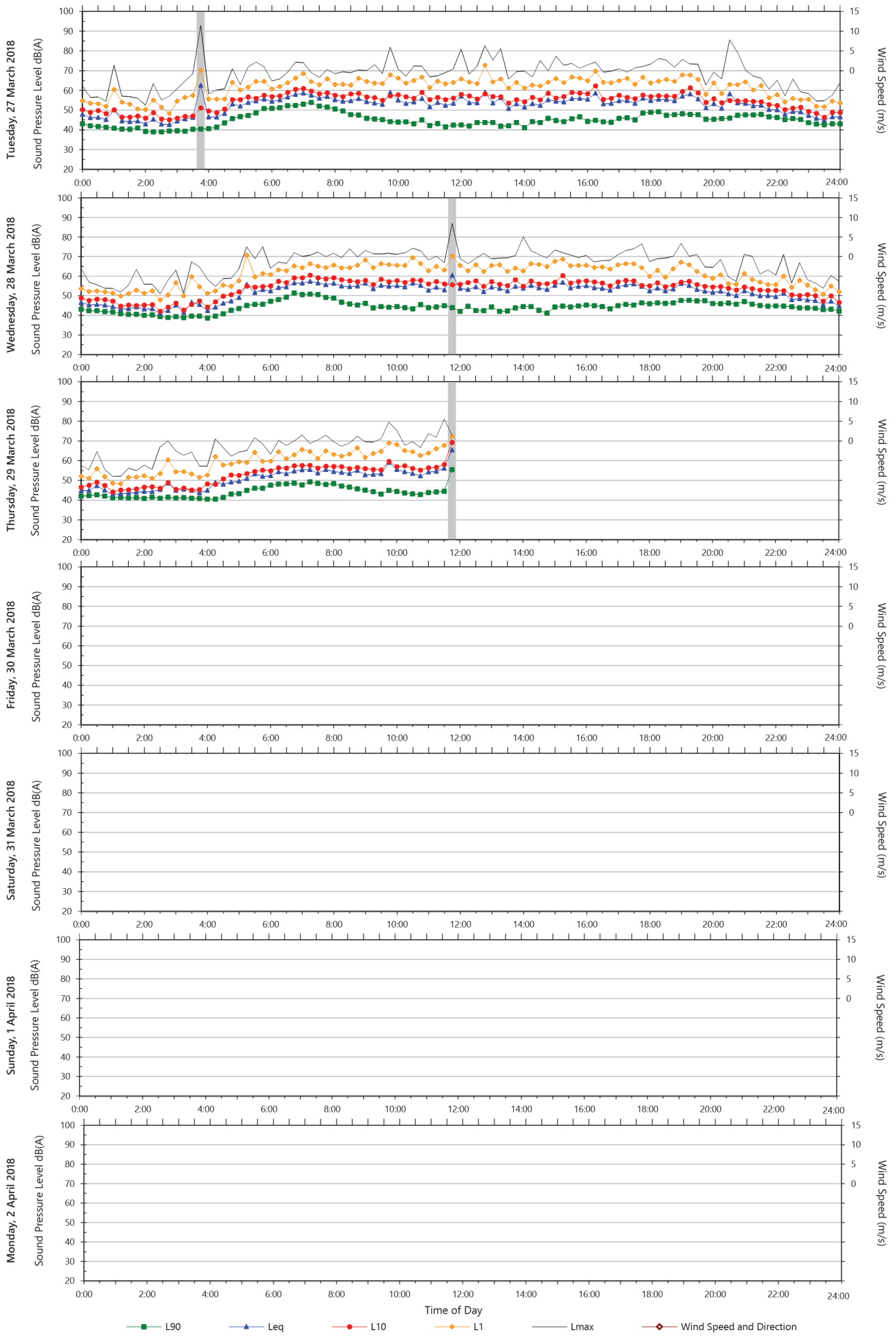




Data File: 2018-03-20_SLM_000_123_Rpt_Report.txt

Template: QTE-26 (rev 17) Logger Graphs Program

Unattended Monitoring Results Location: Lots 3390 & 3391 Jordan Springs Boulevard, Jordan Springs - Location L01



Data File: 2018-03-20_SLM_000_123_Rpt_Report.txt

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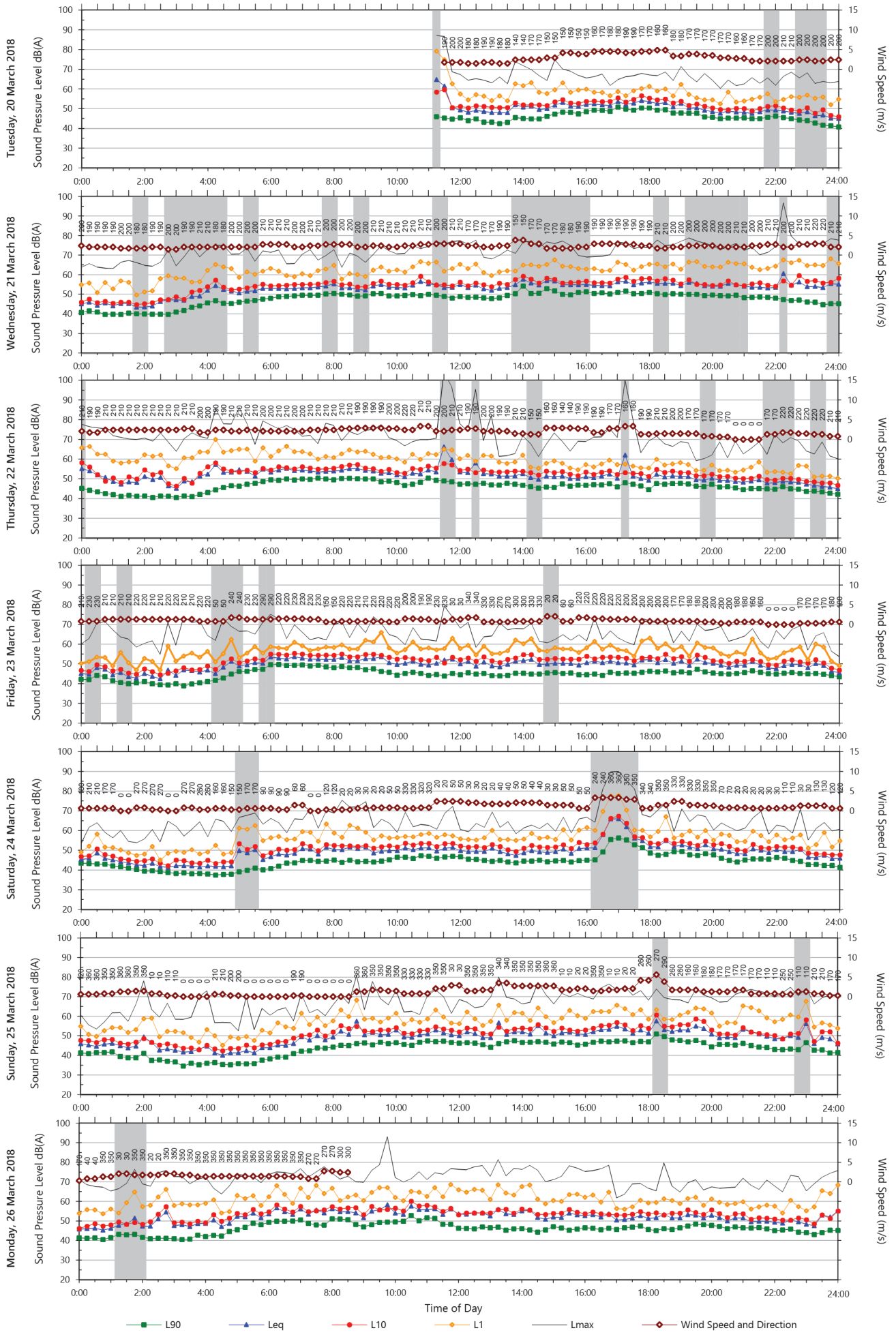
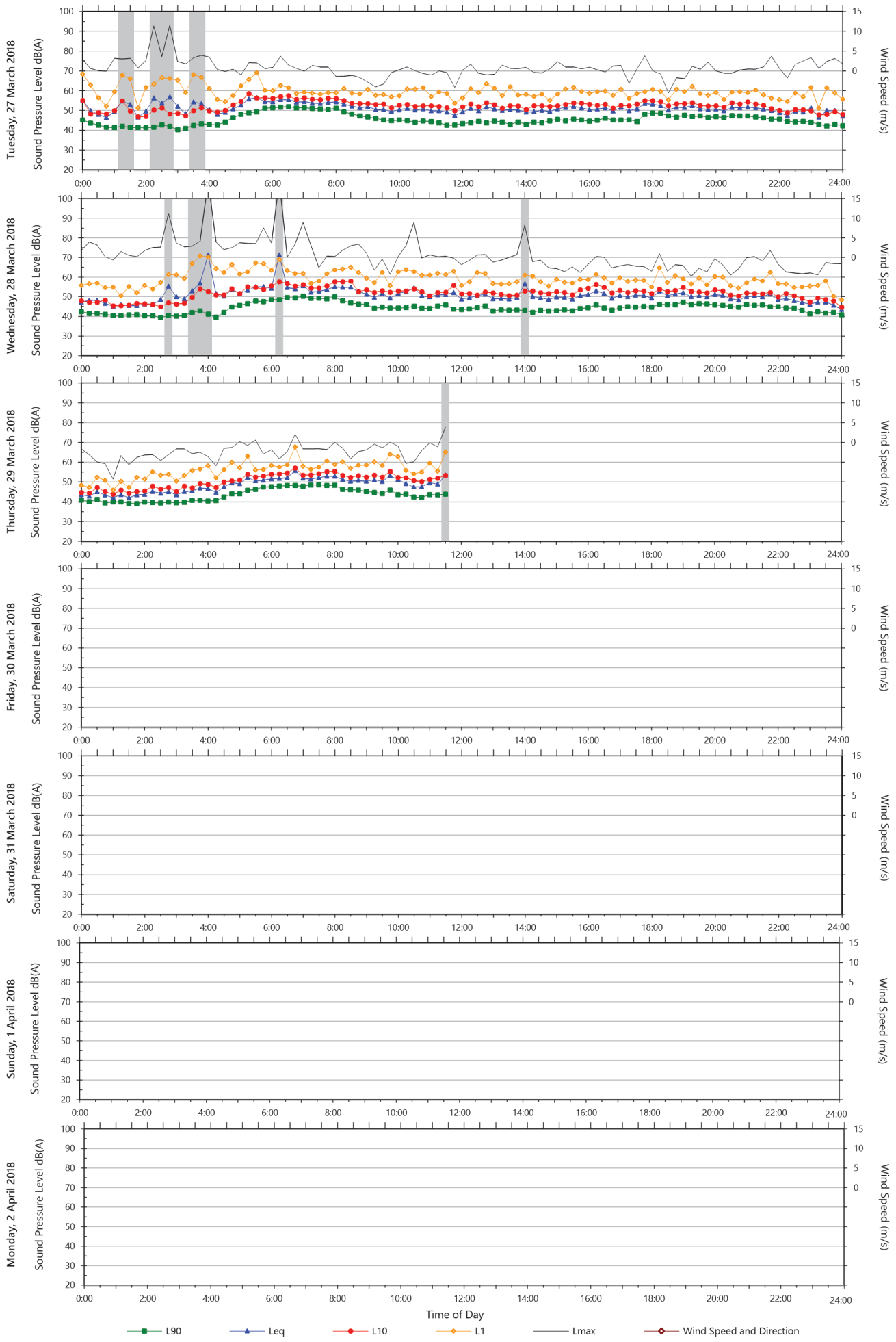


Data File: 2018-03-20_SLM_000_123_Rpt_Report.txt

Template: QTE-26 (rev 17) Logger Graphs Program

Unattended Monitoring Results Location: Lots 3390 & 3391 Jordan Springs Boulevard, Jordan Springs - Location L02



Data File: 2018-03-20_SLM_000_123_Rpt_Report.txt

Template: QTE-26 (rev 17) Logger Graphs Program