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61-65 LUCUS AVE AND 36 MCKAY AVE, MOOREBANK

Acoustic Assessment for Development Application

5 May 2017

Mounir Tamer, Rabick Tamer, Fouad Hebous and Ahmed Tabbah

TJ187-01F02 Acoustic Report for DA (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

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Prepared for:	Mounir Tamer, Rabick Tamer, Fouad Hebous and Ahmed Tabbah
Address:	C/- A&K Engineering Pty Ltd 117 Waterloo Road Greenacre NSW 2190
Attention:	Abhishek Kashyap

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Executive summary

Renzo Tonin & Associates were engaged to conduct an environmental noise assessment of the proposed mixed-use residential development at 62-65 Lucus Avenue & 36 McKay Avenue, Moorebank to accompany an application for Development Application.

As a result of our assessment of the following potential acoustic issues were identified;

- Traffic noise associated with Lucus and McKay Avenue
- Noise associated with Nuwarra Public School
- Noise emission from proposed mechanical plant impacting onto neighbouring properties

This report presents an assessment of the above acoustic components in terms of Council's Development Control Plans, State Environmental Planning Policy (Infrastructure), Australian Standards and NSW Environment Protection Authority noise policies.

External Noise Intrusion into the Development

External noise intrusions into the development have been assessed in accordance with Council DCPs, ISEPP 2007, Australian Standard AS2107 and EPA Industrial Noise Policy. The major source of noise intrusion was identified as road traffic noise.

On the basis of the external noise impacting upon the development site, appropriate design of the building envelope is required to achieve a suitable indoor amenity for occupants. Our assessment has standard float glass will be required on the worst affected external building facades.

Noise Emission Generated by the Development

Noise from mechanical plant such as building exhaust systems and air-conditioning associated with the development has the potential to impact on nearby noise-sensitive premises. As details of mechanical plant are not available at this stage of the development in-principle noise control advice are present in this report.

Construction Noise

The major construction activities proposed on this site are excavation works, concrete pours and general building works. Construction and building work will be adequately managed so as to minimise disruption to the local community and the environment. As details of construction equipment and operating time are not available at this stage of the project, in-principle noise and vibration measures are provided in this report.

Contents

List of tables

1 Introduction

Renzo Tonin & Associates were engaged to assess noise impacts onto and the proposed residential development at 62-65 Lucus Avenue and 36 McKay Avenue, Moorebank.

This study examines the effects of external noise intrusion onto the proposed development from road traffic noise. A noise survey was carried out on site by Renzo Tonin & Associates from 24/04/17 to 01/05/17 to establish the existing levels of external noise affecting the development. These noise levels were used to predict noise levels inside the residential spaces and then assessed against the recommended internal noise criteria for the project.

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.

The following architectural drawings from Studio Rhizome were reviewed.

Table 1: Drawings Reviewed

Drawing No.	Issue	Date	Title
002	P1	11.04.17	Site Plan (Sheet - 01)
003	P1	11.04.17	Site Plan (Sheet - 02)
005	P1	11.04.17	Proposed Plan L01-05
006	P1	11.04.17	Proposed Section - A
005A	P1	21.04.17	Car park - 01 (Sheet - 01)
005A	P1	21.04.17	Car park - 01 (Sheet - 02)
006A	P1	21.04.17	Car park - 02 (Sheet - 01)
006A	P1	21.04.17	Car park - 02 (Sheet - 02)

2 Site and Surrounds

The site is located at 62-65 Lucus Avenue & 36 McKay Avenue, Moorebank and is currently occupied by single storey houses. To the north, east and west of site are single or double storey houses, south of site across McKay Avenue is Nuwarra Public School. The proposed development is a 5-storey residential building comprising 60 units and 2 levels of underground parking.

Long-term noise monitoring has been undertaken on site as indicated in Figure 1 below to determine existing acoustic environment.

Figure 1 - Noise Monitoring Location & Site Surrounds

3 Internal Noise Criteria

Long-term noise surveys were conducted on site from 24/04/17 to 01/05/17 to determine existing levels of ambient and background noise surrounding the site. These levels were used to predict noise levels within the residential spaces and assessed against the internal noise criteria recommended for this development.

3.1 Road Traffic Noise Criteria

The Standards, Government Policies, Guidelines and Council Development Control Plans (DCP) relevant to this development are as follows:

1. Liverpool City Council Development Control Plan 2008
2. State Environment Planning Policy (Infrastructure 2007) or ISEPP 2007
3. Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008
4. Australian Standard AS/NZS 2107:2000 "Acoustics – Recommended design sound pressure levels and reverberation times for building interior"

In the absence of specific noise criteria stipulated in Local Council DCP, design internal noise levels from the ISEPP2007, Department of Planning publication 2008 and AS/NZS 2107 has been recommended for this development and is outlined in Table 2 below.

Table 2: Recommended Maximum Internal Traffic Noise Level

Type of Occupancy	Windows Condition	Design Noise Level	
		Day, L_{Aeq} (15hour)	Night, L_{Aeq} (9hour)
Bedrooms	Closed	-	35dB(A)
	Open	-	45dB(A)
Open-plan Living/Dining/Kitchen	Closed	40dB(A)	40dB(A)
	Open	50dB(A)	50dB(A)
Bathrooms and en-suites	Closed	45dB(A)	45dB(A)
	Open	55dB(A)	55dB(A)

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

4 Measured Noise Levels

4.1 Long-term Noise Survey

The proposed development is potentially affected by traffic noise from the local roads surrounding the site namely Lucus Avenue and McKay Avenue, and noise associated with Nuwarra Public School south of the development. A long-term noise monitor was installed at 36 McKay Avenue as indicated in Figure 1 for an ambient and background noise survey from 24/04/17 to 01/05/17.

The noise logger records noise levels on a continuous basis and stores data every fifteen minutes. The noise loggers were 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 results of the background and ambient noise monitoring conducted on site are presented in APPENDIX D.

4.2 Measured Traffic Noise Level

The design traffic noise levels are taken from the representative L_{Aeq} for the week for both the day time (7am to 10pm) and night time (10pm-7am) periods. The design external traffic noise levels are presented Table 3 below.

Table 3: Representative Day and Night Traffic Noise Levels

Monitoring Location	Survey Period	Measured Traffic Noise Level $L_{Aeq, T}$ [1,2] at Monitoring Location	Predicted Traffic Noise Level $L_{Aeq, T}$ [1,2] at Worst Affected Residential Facade [3]
Front yard of 36 McKay Avenue, Moorebank	Day time (7am to 10pm) 24/04/17 to 01/05/17	52 dB(A)	52 dB(A)
	Night time (10pm to 7am) 24/04/17 to 30/04/17	45 dB(A)	45 dB(A)

Notes:

1. Noise levels presented are façade values.
2. Representative road traffic noise level in L_{Aeq} over 15 hour and 9 hour day and night period respectively.

4.3 Existing Noise Environment at Development Site

The results of the long-term noise monitoring have been summarised in accordance with Industrial Noise Policy requirements published by NSW Environment Protection Authority and are presented in Table 4 below.

Table 4: Measured Site Background Noise Level

Noise Monitoring		Representative L_{A90} Background Noise Levels in dB(A)		
Location	**Duration**	**Day[1]**	**Evening[2]**	**Night[3]**
Front yard of 36 McKay Avenue, Moorebank	Monday 24/04/17 to Monday 01/05/17	45	44	39

Notes:

Day, Evening & Night assessment periods are defined in accordance NSW EPA's Industrial Noise Policy 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

The representative background noise levels (L_{A90}) are used in defining external noise emission from the development such as mechanical ventilation and air-conditioning systems in accordance to the EPA Industrial Noise Policy.

4.4 Calculated Internal Noise Levels

Results from the noise surveys were used to calculate internal noise levels within the proposed development. Noise calculations were conducted using the OutsideIn Glazing Spreadsheet developed in this office 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 body of this report.

5 Recommendations

5.1 Glazing Design Requirements

Table 5 below presents recommended glazing treatment for the building facades to achieve compliance with the maximum noise levels nominated in Table 2 above.

Table 5: Recommended Glazing Treatment

Level	Facade	Occupancy Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly	Typical Compliance Glazing Thickness, Type and Configuration	Laboratory Test Reference
Ground to Level 4	All facades	Bedrooms	Rw27	6mm monolithic glass	ESTIMATE
		Open-plan living/dining/kitchen	Rw27	6mm monolithic glass	ESTIMATE
		Bathrooms and En-suites	Rw24	4mm monolithic 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.

5.2 Building Ventilation

Table 6 below shows the assessment of external noise intrusion to the "Windows Open" noise criteria nominated in Table 2 above.

Table 6: Noise Assessment to Windows Open Criteria at Worst Affected Facades

Period	Room/Occupancy	Predicted Noise Level in dB(A)		Windows Open Internal Noise Criteria $L_{Aeq,}$	Compliance (Yes/No)
		At facade	Inside Apartment with Windows Open, L_{Aeq}		
Day	Open-plan Living/Dining/Kitchen	58	48	50	Yes
	Bathrooms & en-suites	58	48	55	Yes
Night	Bedrooms	53	43	45	Yes
	Bathrooms & en-suites	53	43	55	Yes

Based on our long-term noise surveys, our calculations have shown the internal noise levels will comply with the "Windows Open" scenario outlined in Table 2 for worst affected habitable rooms, bathroom and en-suites. Therefore, all apartments within development can be naturally ventilated and achieving compliance with internal noise levels outlined in Table 2 above.

5.3 Facade & Roof Sound Insulation

In principle advice is provided below for the acoustic requirements of the roofs and external walls.

5.3.1 External Walls

All external walls shall have sound isolation ratings, $R_{w,}$ of at least 15dB higher acoustic performance than that of the acoustic glazing specified in Table 5 above.

5.3.2 Roof and Ceiling

Roof/ceiling construction shall have a sound isolation rating, R_w, at least 10dB higher than that of the acoustic glazing on its facade walls.

5.3.3 Glazing Assembly Requirements

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

s1. All operable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the R_w rating performance of the glazing to not be reduced.

s2. The glazing thicknesses outlined in Table 5 should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

s3. The glazing supplier shall ensure that installation techniques will not diminish the R_w performance of the glazing when installed on site. Sliding door meeting stiles should form an airtight seal when closed and locked.

s4. 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).

6 Internal Sound Insulation between Tenancies

Internal walls shall comply with the National Construction Code of Australia 2016 (formally Building Code of Australia). All services shall comply with the requirements of the NCC 2016. APPENDIX B presents a summary of acoustic provisions outlined in Part F5 of the NCC 2016.

7 External Noise Emission from Building Services

7.1 NSW Environment Protection Authority

Noise from building services will be controlled to comply with the Industrial Noise Policy (INP) outlined in NSW Environment Protection Authority (EPA). The applicable noise limits, according to the policy, are determined in the table below.

Table 7: Design Criterion for Noise Production (EPA INP)

Time of Day	Rating Background Level (RBL) L_{A90}	Intrusiveness Criterion (RBL+5)	Amenity Criterion (Acceptable)	Project Specific Design Criterion L_{Aeq}
Day (7am to 6pm)	45	50	55	50
Evening (6pm to 10pm)	44	49	45	45
Night (10pm to 7am)	39	44	40	40

Explanatory notes:

1. Recommended L_{Aeq} noise level based on 'Residence – suburban' area in Section 2.2, Table 2.1 Amenity Criteria (Recommended L_{Aeq} noise levels from industrial noise sources) of the EPA's INP.
2. Project Specific Design Criterion based on EPA's INP and is the lower of the Intrusiveness or Amenity Criterion

Where necessary, noise amelioration treatment will be incorporated in the design to ensure that noise levels comply with the EPA Industrial Noise Policy. Noise from air-conditioning and building services will be examined in the detail at the design stage.

7.2 Recommended Noise Control Measures for Mechanical Plant

Mechanical plant such as exhaust systems, air-conditioning, mechanical ventilation and refrigeration associated with the development has the potential to impact on nearby residential and commercial properties. As details of mechanical plant are not available at this stage of the development the following in principle noise control advice are provided.

- Acoustic assessment of mechanical services equipment will be require 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 established in Table 5.
- 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 roof and balcony plant equipment away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises

- installation of commercially available silencers or acoustic attenuators for air discharge and air intakes of plant
- acoustically lined and lagged ductwork
- provide acoustic screens and/or acoustic louvres between plant and sensitive neighbouring premises
- provide partially enclosed or fully enclosed acoustic enclosure over plant
- Mechanical plant shall have their noise specifications and proposed locations checked prior to installation
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 "Rotating and Reciprocating Machinery - Mechanical Vibration"

8 Construction Noise

The nature of the construction processes proposed for the development does not present difficulties in ensuring that the associated noise limits at surrounding properties are achieved. The major construction activities proposed on this site are excavation works, concrete pours and general building works.

Construction and building work will be adequately managed so as to minimise disruption to the local community and the environment.

Noise generated by construction activities will comply with the Department of Environment Climate Change & Water's Interim Construction Noise Guide (ICNG). APPENDIX C presents a summary ICNG's standard construction times and conditions.

9 Conclusion

Renzo Tonin & Associates have completed an acoustic assessment of external noise impacts onto the proposed residential development at 62-65 Lucus Avenue and 36 McKay Avenue, Moorebank.

The study of external noise intrusion into the subject development has found that appropriate controls can be incorporated into the building design to achieve a satisfactory accommodation environment consistent with the intended quality of the building and relevant standards.

Recommendations have been made in Section 5 of this report to comply with the nominated internal noise criteria.

APPENDIX A Assessment and Design Methodology

A.1 Liverpool City Council Development Control Plan

Liverpool City Council is the regulatory authority for the proposed development. Relevant sections of Council's DCP are re-iterated below.

"Part 3.2 of DCP 2008, Section 8. Amenity and Environment Impact

…

Acoustic Privacy

Objective

To ensure appropriate noise and vibration attention measures are incorporated into residential development.

Controls

1. Noise attenuation measures should be incorporated into building design to ensure acoustic privacy between on-site and adjoining buildings.

2. Developments in areas adversely impacted upon by rail or traffic related noises must incorporate the appropriate noise and vibration mitigation measures into the design in terms of the site layout, building materials and design, orientation of the buildings and location of sleeping and recreation areas.

3. Where party walls are provided they must be carried to the underside of the roof and be constructed in accordance with Part F5 of the Building Code of Australia.

4. The proposed buildings must comply with the Environment Protection Authority criteria and the current relevant Australian Standards for noise and vibration and quality assurance. "

A review of Council's DCP has found that it does not stipulate specific internal noise goals for residential developments, therefore design noise levels from State Environment Planning Policy and Australian Standards AS2107 has been adopted for this assessment.

A.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:

c. a building for residential use,

d. a place of public worship,

e. a hospital,

f. 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.

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

A.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.

A.2.2 Clarification of ISEPP noise limits

The Guideline clarifies the time period of measurement and assessment. Section 3.4 '*What Noise and Vibration Concepts are Relevant*' and Table 3.1 of Section 3.6.1 confirms that noise assessment is based over the following time periods:

- Daytime 7:00am - 10:00pm $L_{Aeq(15hr)}$
- Night-time 10:00pm - 7:00am $L_{Aeq(9hr)}$

The noise criteria nominated in the ISEPP apply to internal noise levels with windows and doors closed. However as the preliminary noise assessment is based on measurements/predictions at external locations, equivalent external noise criteria has been established. The equivalent external noise criterion is used to determine which areas of the development may require acoustic treatment in order to meet the internal noise requirements of the ISEPP. The equivalent external goals have been determined on the following basis:

- The ISEPP states: "*If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia*." The internal criteria with windows open is therefore 10dB(A) above the criteria explicitly outlined in the ISEPP.
- The generally accepted noise reduction through an open window from a free-field external position is 10dB(A). Windows/doors are assumed to be open no more than 5% of room floor area, in accordance with the Building Code of Australia (BCA) ventilation requirements.

Table 8 presents the ISEPP internal noise criteria along with the equivalent external noise criteria for residential premises.

Table 8: ISEPP noise criteria for new residential development

Room	Location	$L_{Aeq,\ 15hr}$ Day 7am – 10pm	$L_{Aeq\ 9hr}$ Night 10pm – 7am
Living rooms*	Internal, windows closed	40	40
	Internal, windows open	50	50
	External free-field (allowing windows to remain open)^	60	60
Bedrooms*	Internal, windows closed	40	35
	Internal, windows open	50	45
	External free-field (allowing windows to remain open)^	60	55

Notes: * Requisite for 40,000AADT Roads only under ISEPP 2007.

^ ISEPP Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open mechanical ventilation is required. External goals have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA requirements.

A.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, and has been found to accurately describe the level of annoyance caused by traffic noise.

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

Type of occupancy/ activity	Design sound level, ($L_{Aeq,t}$) dB(A)	Recommended reverberation time (T), s
7 RESIDENTIAL BUILDINGS (see Note 5 and Clause 5.2)		
Houses and apartments in inner city areas or entertainment districts or near major roads -		
Apartment common areas (e.g. foyer, lift lobby)	45 to 50	-
Living areas	35 to 45	-
Sleeping areas (night time)	35 to 40	-
Work areas	35 to 45	-
Houses and apartments in suburban areas or near minor roads -		
Apartment common areas (e.g. foyer, lift lobby)	45 to 50	-
Living areas	30 to 40	
Sleeping areas (night time)	30 to 35	
Work areas	35 to 40	-
Houses in areas with negligible transportation -		
Sleeping areas (night time)	25 to 30	-

Type of occupancy/ activity	Design sound level, ($L_{Aeq,t}$) dB(A)	Recommended reverberation time (T), s

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 B Internal Sound Insulation

B.1 National Construction Code of Australia 2016

The National Construction Code of Australia (NCC) outlines minimum requirements for inter-tenancy (party) walls and ceiling/ floors to maintain privacy. This includes the incorporation of penetration of a service through a floor or through more than one sole-occupancy unit.

NCC nominates required Weighted Sound Reduction Indexes (R_w) and spectrum adaptation factor (C_{tr}) for partition constructions, of different space/ activity types in adjoining units. The R_w and $R_w + C_{tr}$ are single number descriptors for quantifying the attenuating performance of partitions for typical intrusive noises produced inside residences. The higher the rating, the greater the isolation provided by the partition.

Spectrum adaptation factors are commonly used to compensate for the fact that certain kinds of sounds are more readily transmitted through insulating materials than others insulate.

The adaptation factor C_{tr} has now been introduced for most building elements which require an airborne sound insulation rating. The only exception is a wall which separates a dwelling from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification. Therefore, both the C_{tr} factor and the R_w of the building element will need to be considered in most cases.

The C_{tr} factor takes into account lower frequency level sounds, and has been chosen in large part, in recognition of the problem of the high bass frequency outputs of modern home theatre systems and music reproduction equipment.

The Deemed-to-Satisfy Provisions also have impact sound insulation requirements for floors. The terms to describe the impact sound insulation of the floor is the weighted normalised impact sound pressure level ($L_{n,w}$). The lower the $L_{n,w}$ of the floor, the better the performance of the floor in terms of impact sound insulation.

The following section represents a summary of acoustic provisions outlined in the Part F5 of the NCC.

B.2 Sound Insultion Provision of NCC of Australia

The acoustic provisions for inter-tenancy walls in Class 2 buildings are outlined in the National Construction Code of Australia and the following is an extract from the NCC:

F5.2 Determination of airborne sound insulation ratings

A form of construction required to have an airborne sound insulation rating must –

c. have the required value for weighted sound reduction index (Rw) or weighted sound reduction index with spectrum adaptation term (Rw + Ctr) determined in accordance with AS/NZS 1276.1 or ISO 717.1 using results from laboratory measurements; or

d. comply with Specification F5.2.

F5.3 Determination of impact sound insulation ratings

e. A floor in a building required to have an impact sound insulation rating must –

i. have the required value for weighted normalised impact sound pressure level (Ln,w) determined in accordance with AS/ISO 717.2 using results from laboratory measurements; or

ii. comply with Specification F5.2.

f. A wall in a building required to have an impact sound insulation rating must –

iii. for a Class 2 or 3 building be of discontinuous construction;

g. For the purposes of this part, discontinuous construction means a wall having a minimum 20 mm cavity between 2 separate leaves, and

iv. for masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and

v. for other than masonry, there is no mechanical linkage between leaves except at the periphery.

F5.4 Sound insulation rating of floors

h. A floor in a Class 2 or 3 building must have an Rw + Ctr (airborne) not less than 50 and an Ln,w (impact) not more than 62 if it separates –

vi. sole-occupancy units; or

vii. a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.

F5.5 Sound insulation rating of floors

i. A wall in a Class 2 or 3 building must –

viii. have an Rw + Ctr (airborne) not less than 50, if it separates sole-occupancy units; and

ix. have an Rw (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and

x. comply with F5.3(b) if it separates:

a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or

xi. *a sole-occupancy unit from a plant room or lift shaft.*

j. A door may be incorporated in a wall in a Class 2 or 3 building that separates a sole-occupancy unit from a stairway, public corridor, public lobby or the like, provided the door assembly has an Rw not less than 30.

k. Where a wall required to have sound insulation has a floor above, the wall must continue to –

xii. *the underside of the floor above; or*

xiii. *a ceiling that provides the sound insulation required for the wall.*

F5.6 Sound insulation rating of services

l. If a duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with an Rw + Ctr (airborne) not less than –

xiv. *40 if the adjacent room is a habitable room (other than a kitchen); or*

xv. *25 if the adjacent room is a kitchen or non-habitable room.*

m. If a storm water pipe passes through a sole-occupancy unit it must be separated in accordance with (a).

APPENDIX C Construction Noise

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.

  NSW noise policies, including the INP, RNP and RING have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

- 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 for 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 a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Table 10 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied for residential receivers. The guideline intends to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 10: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	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 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Sensitive Land Use

Table 11 below (reproduced from Table 3 of the ICNG) sets out the noise management levels for various sensitive land use developments.

Table 11: Noise management levels at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)

Notes: Noise management levels apply when receiver areas are in use only.

APPENDIX D Results of Noise Survey

D.1.1 Ambient and Background Noise Survey

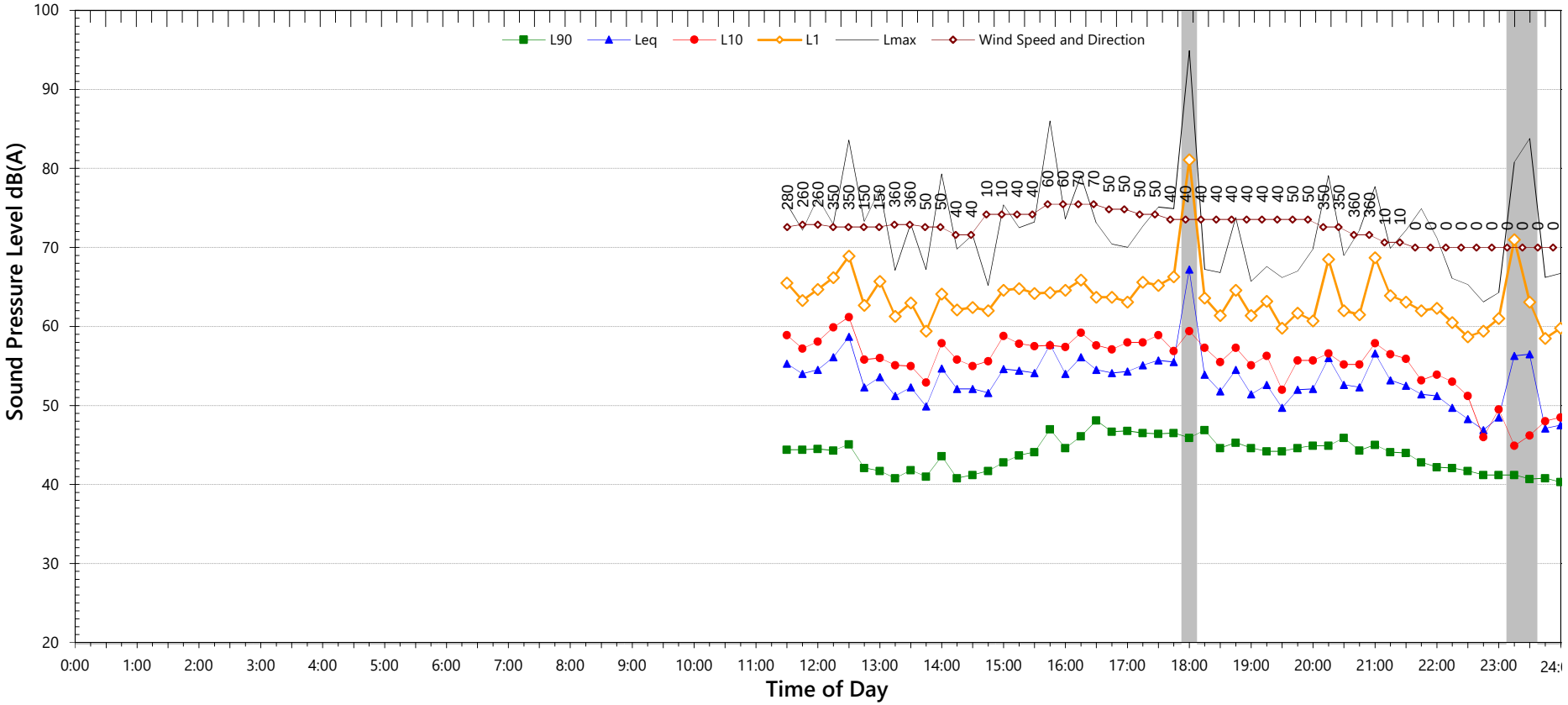
Unattended noise monitoring location: Front yard of 36 McKay Avenue, Moorebank.

Survey Period: Monday 24/04/17 to Monday 01/05/17

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Monday, 24 April 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	-	42.8	35.7
LAeq	-	53.1	46.5

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66.1	to	78.0
L_{Max} - L_{eq} (Range)	17.6	to	26.1

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	56.6	49.0
$L_{eq\ 1hr}$ upper 10 percentile	58.3	54.4
$L_{eq\ 1hr}$ lower 10 percentile	54.3	42.9

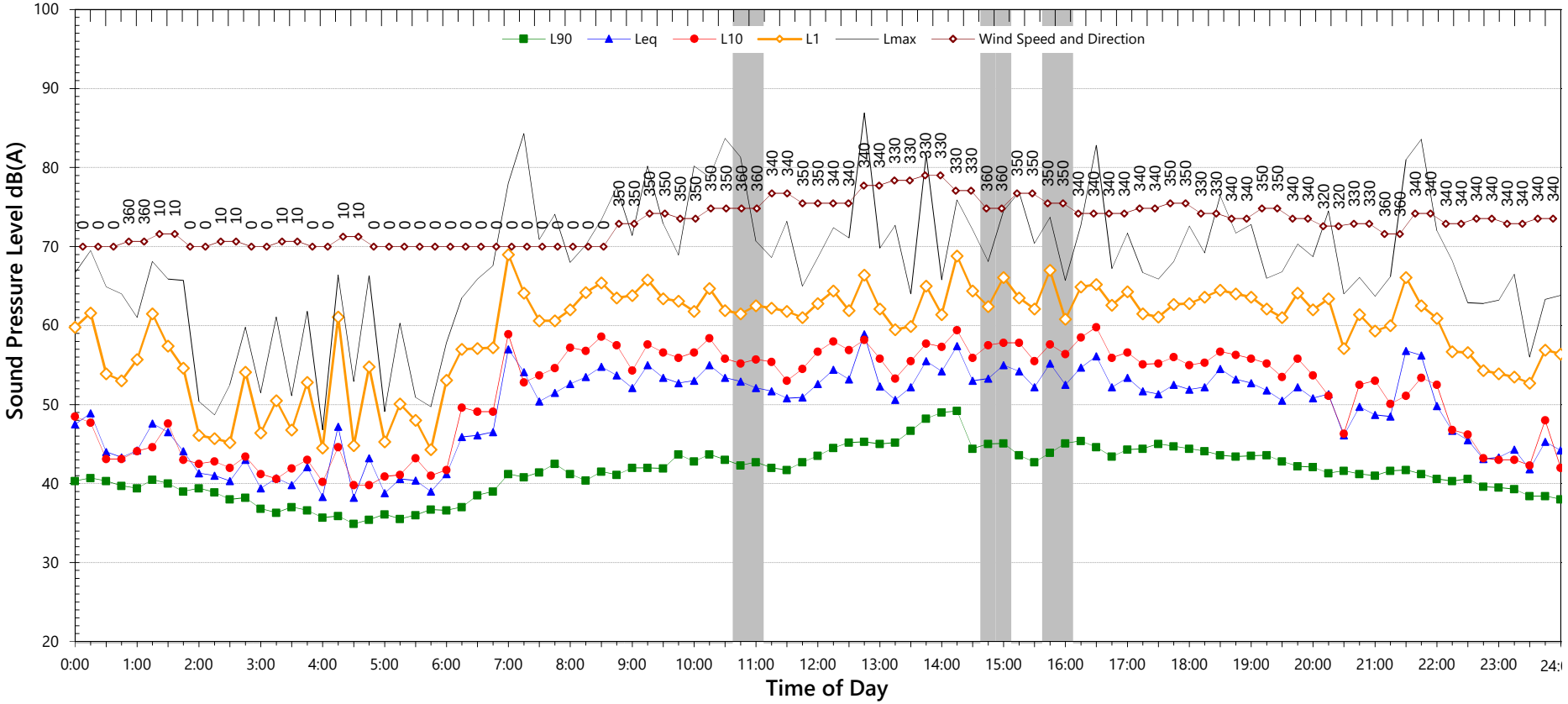
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Tuesday, 25 April 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	41.2	41.0	36.9
LAeq	53.7	52.4	49.4

Night Time Maximum Noise Levels			**(see note 7)**
L_{Max} (Range)	66.5	to	78.2
L_{Max} - L_{eq} (Range)	15.0	to	25.2

NSW Road Noise Policy (1m from facade)		**(see note 6)**
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	55.8	51.9
$L_{eq\ 1hr}$ upper 10 percentile	58.1	58.7
$L_{eq\ 1hr}$ lower 10 percentile	53.0	42.3

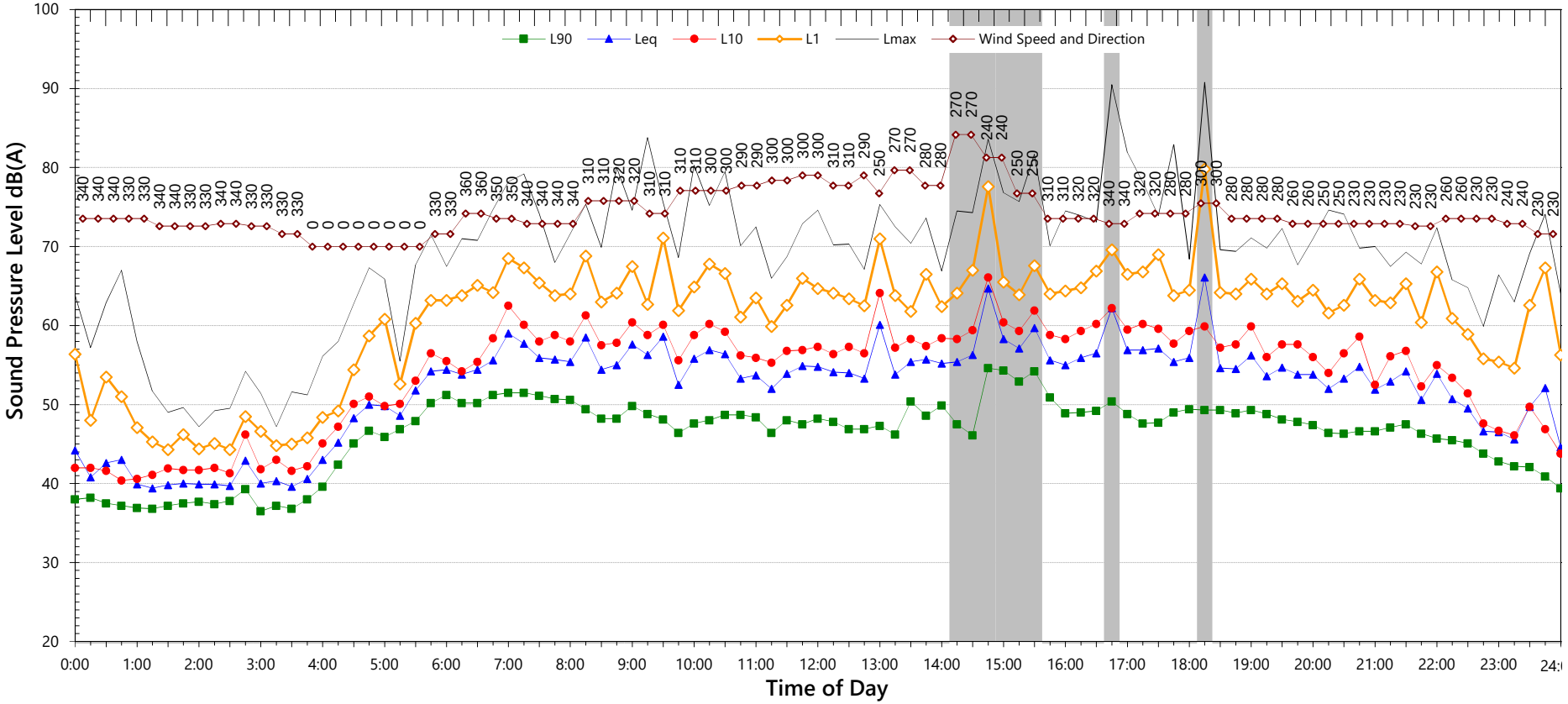
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Wednesday, 26 April 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	46.9	46.3	38.4
LAeq	55.9	53.8	51.2

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65.6	to	77.5
L_{Max} - L_{eq} (Range)	17.5	to	26.9

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	57.9	53.7
$L_{eq\ 1hr}$ upper 10 percentile	59.1	60.1
$L_{eq\ 1hr}$ lower 10 percentile	55.6	44.5

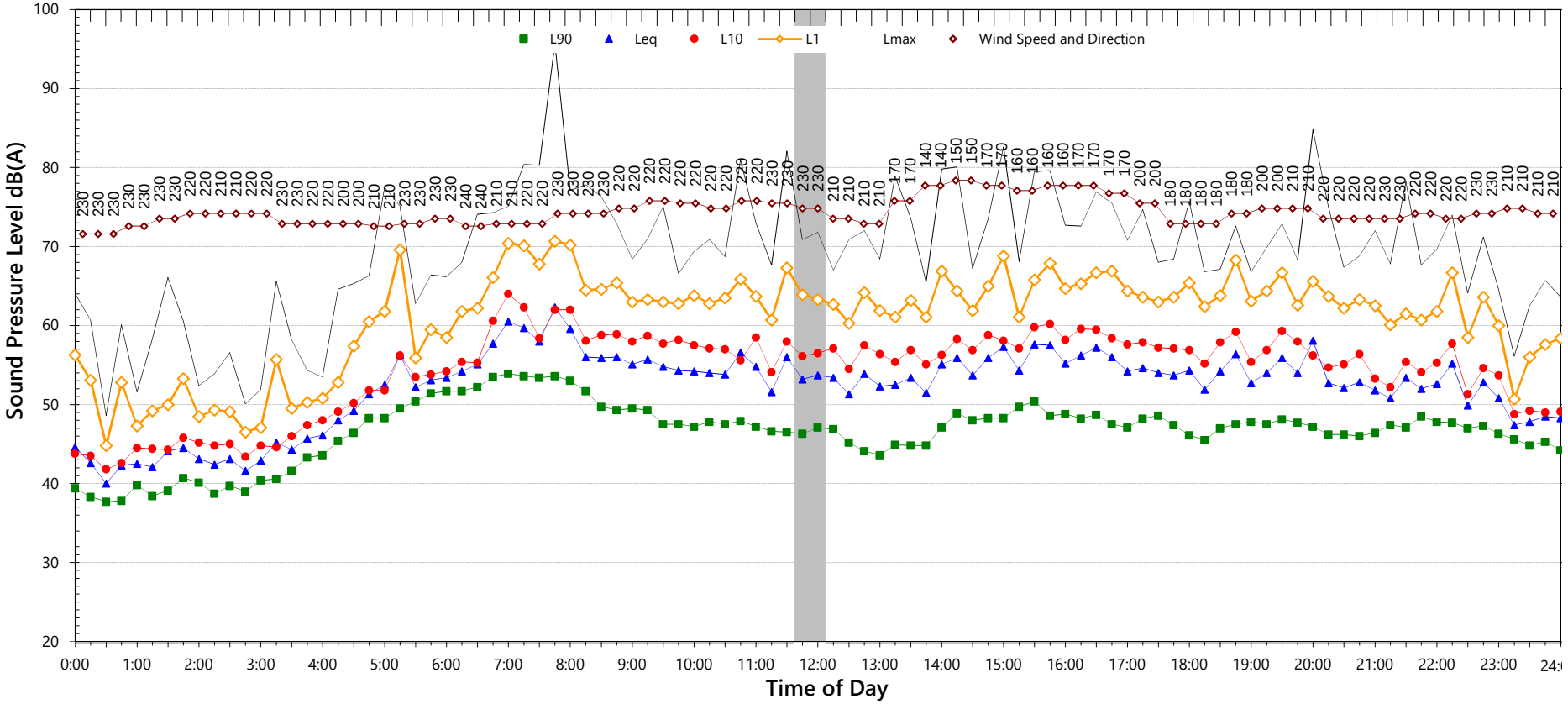
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Thursday, 27 April 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	44.9	46.0	42.5
LAeq	55.9	53.9	52.3

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	57.9	54.8
$L_{eq\ 1hr}$ upper 10 percentile	61.2	60.2
$L_{eq\ 1hr}$ lower 10 percentile	54.8	48.3

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65.7	to	80.3
L_{Max} - L_{eq} (Range)	17.1	to	27.2

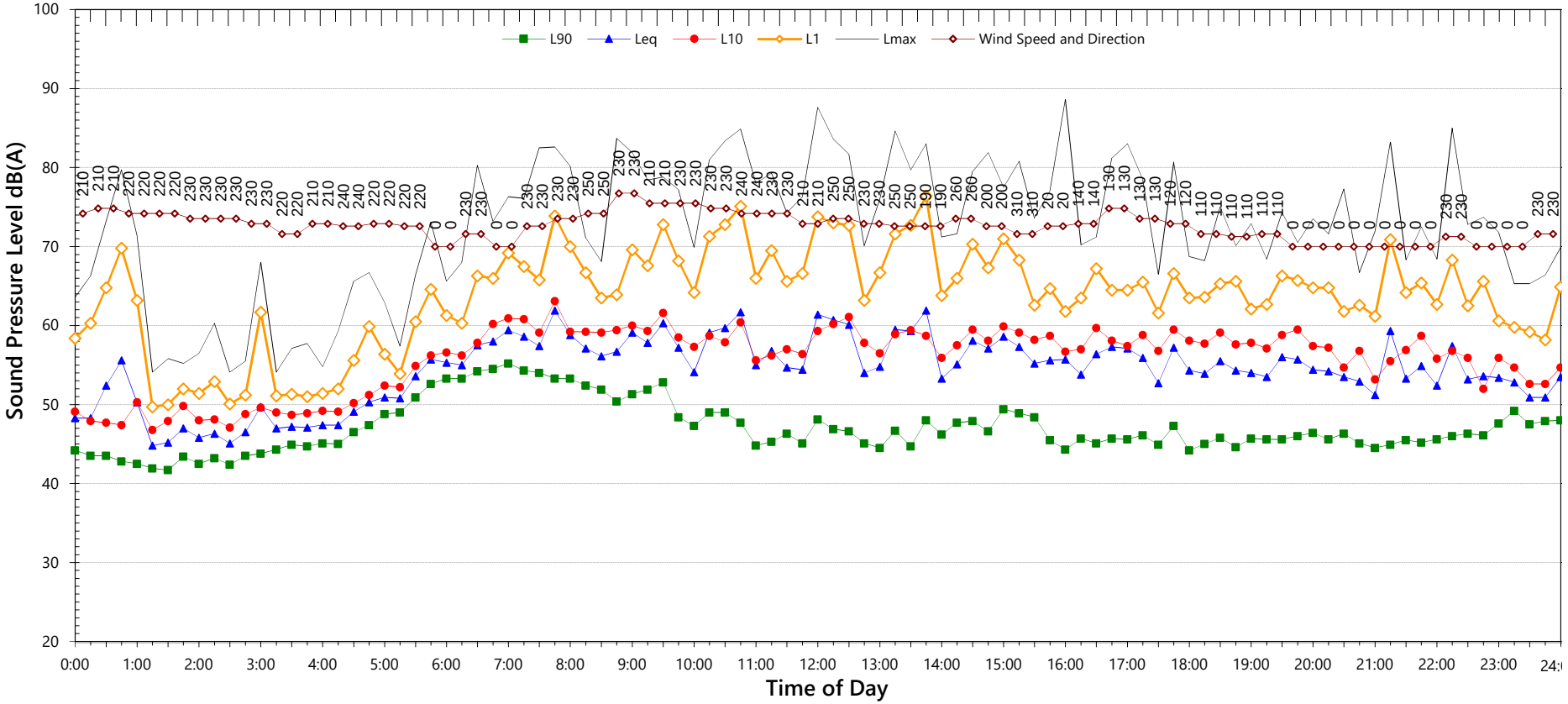
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Friday, 28 April 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	44.8	44.6	43.1
LAeq	57.9	54.7	51.3

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	65.9	to	85.0
L_{Max} - L_{eq} (Range)	15.0	to	30.2

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.8	53.8
$L_{eq\ 1hr}$ upper 10 percentile	62.0	57.3
$L_{eq\ 1hr}$ lower 10 percentile	56.3	48.9

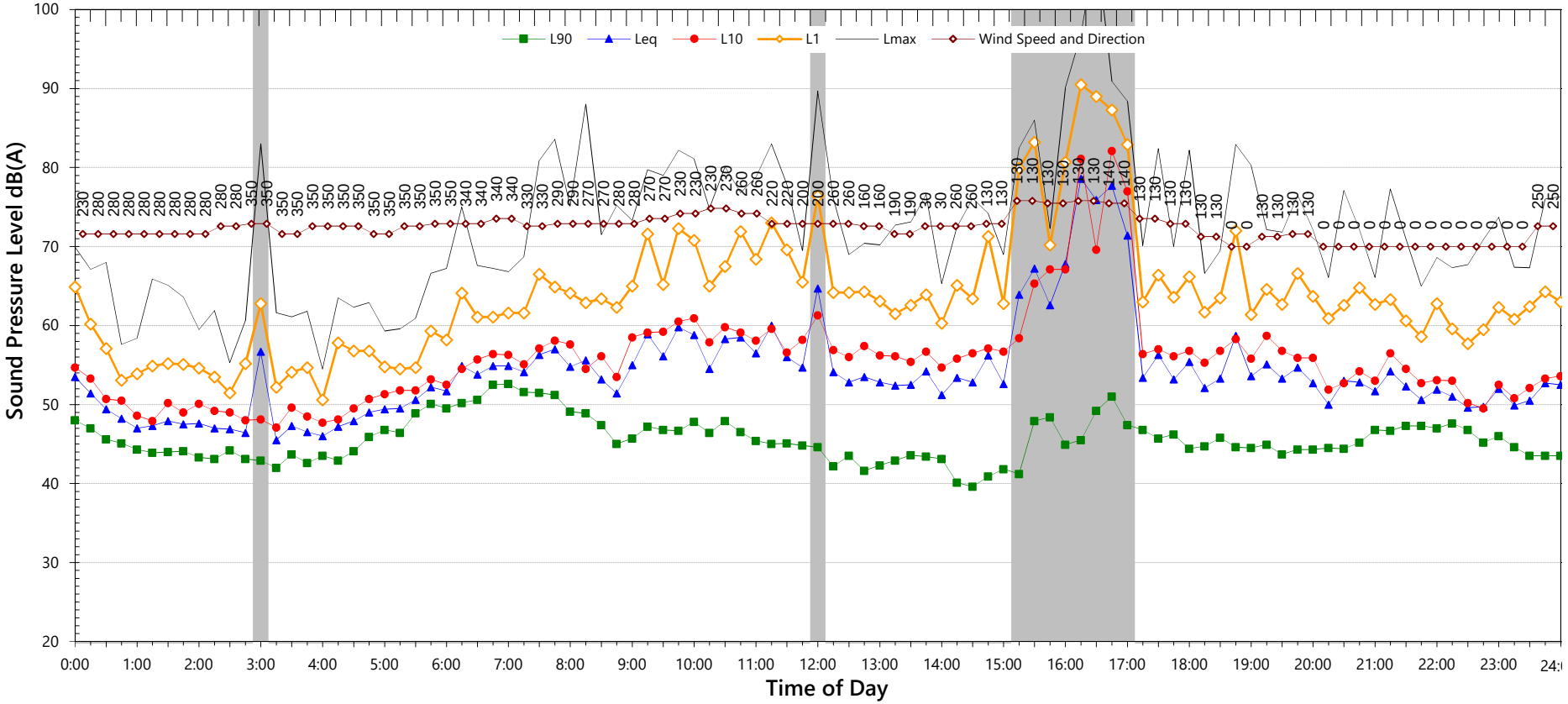
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Saturday, 29 April 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	-	44.3	40.4
LAeq	-	53.6	48.7

Night Time Maximum Noise Levels			**(see note 7)**
L_{Max} (Range)	66.6	to	76.3
L_{Max} - L_{eq} (Range)	16.3	to	25.5

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	57.7	50.6
$L_{eq\ 1hr}$ upper 10 percentile	60.8	54.1
$L_{eq\ 1hr}$ lower 10 percentile	54.7	46.7

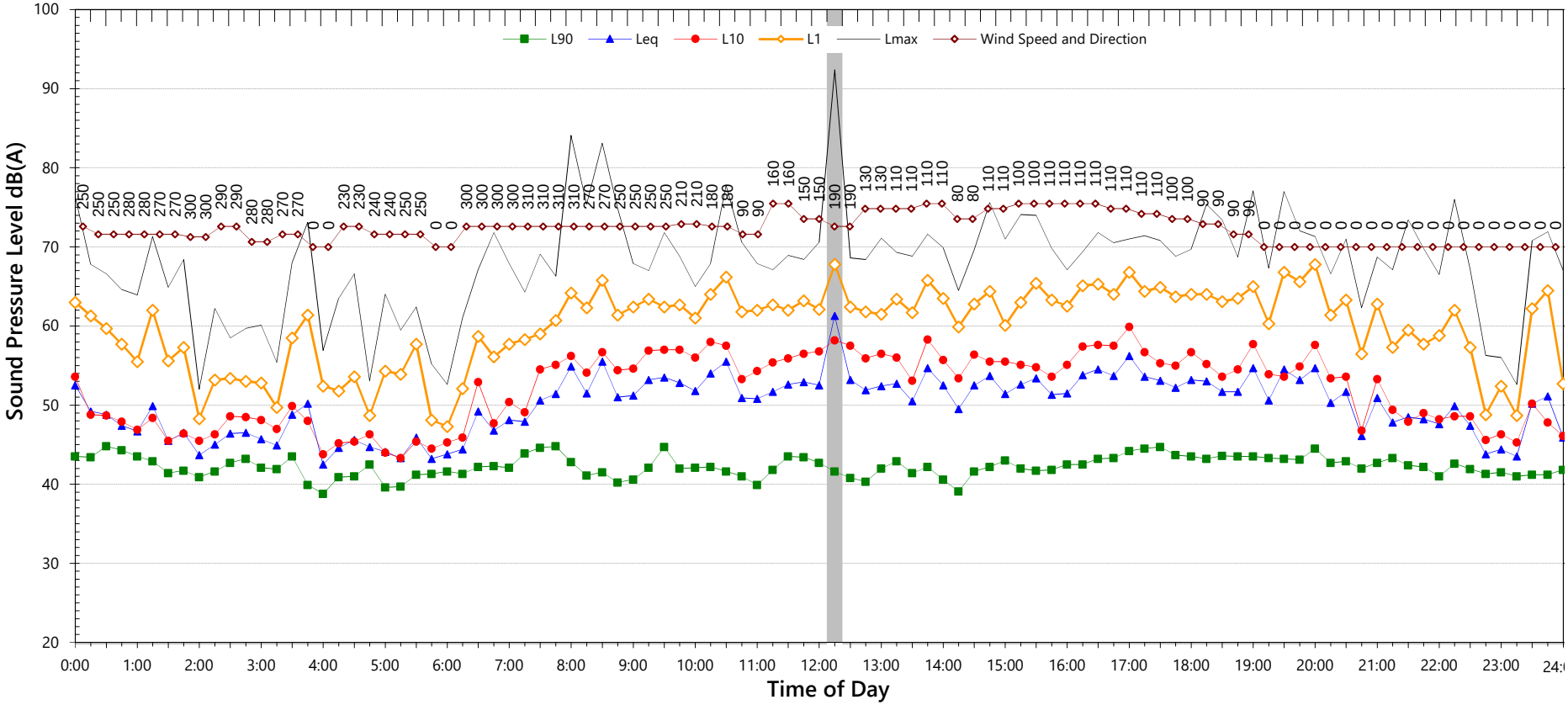
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Sunday, 30 April 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{90}	40.3	42.0	38.9
LAeq	52.9	51.7	51.5

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	55.1	54.0
$L_{eq\ 1hr}$ upper 10 percentile	56.6	61.7
$L_{eq\ 1hr}$ lower 10 percentile	51.8	45.0

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	66.0	to	81.5
L_{Max} - L_{eq} (Range)	18.7	to	28.9

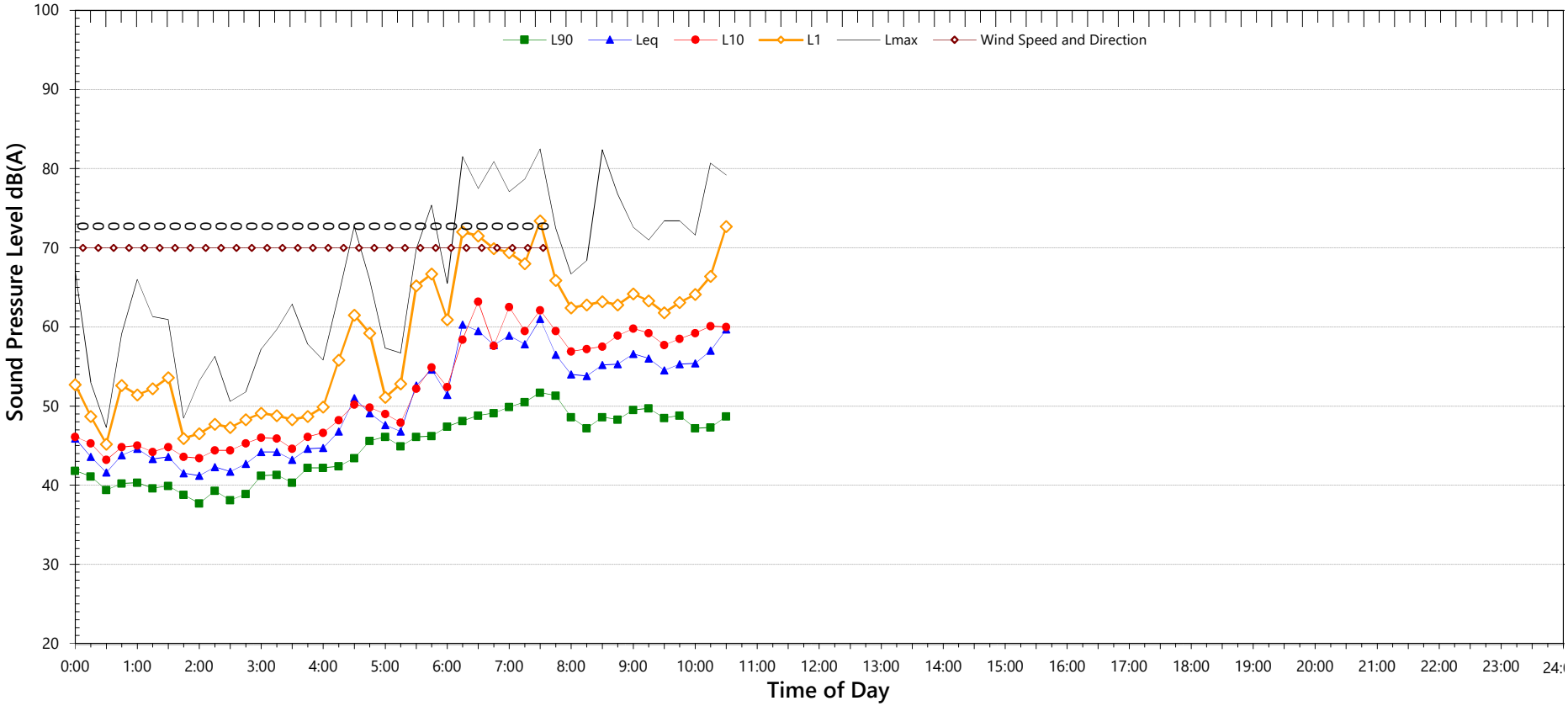
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)

Unattended Noise Monitoring Results

36 McKay Ave, Moorebank

Monday, 1 May 2017



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	-	-	-
LAeq	-	-	-

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	-	to	-
L_{Max} - L_{eq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.3	-
$L_{eq\ 1hr}$ upper 10 percentile	61.1	-
$L_{eq\ 1hr}$ lower 10 percentile	57.8	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am til 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. Night time L_{Max} values are shown only where L_{Max} >65dB(A) and where L_{Max}- Leq ≥15dB(A)