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Acoustics
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871-877 PACIFIC HIGHWAY, CHATSWOOD

Acoustic Assessment for Development Application

25 August 2015

Megland Group Pty Ltd c/- PBD Architects

TH238-01F02 Acoustic Assessment for DA (r2)

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1 Introduction

Renzo Tonin & Associates was engaged to conduct a noise assessment for the proposed mixed-use development at 871-877 Pacific Highway, Chatswood from existing road traffic along the Pacific Highway and rail noise and vibration associated with the North Shore passenger rail line.

Noise surveys have been conducted by Renzo Tonin & Associates between 20th February and 27th February 2015 at the development site to determine the existing levels of traffic and rail affecting the site. These levels were used to predict noise levels within the residential dwellings, and then assessed against the recommended internal noise and vibration criteria for the project.

From our assessment of the proposed development, the following potential acoustic and vibration issues were identified:

- Traffic noise associated with Pacific Highway,
- Through traffic noise associated with Wilson Street.
- Rail Noise and Vibration associated with the CityRail North Shore Line.
- Operation of existing commercial premises.

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 Location and Surrounds

The proposed development at 871-877 Pacific Highway, Chatswood is to consist of a single multi-storey building. The building is bounded to the east by the rail corridor, and to the west by Pacific Highway. To the South is Wilson Street, including a rail overpass. To the north of the site is a petrol station. The development is to consist of 6 floors of apartments, one floor of Retail Space on the Ground Floor, and a Communal Outdoor area on the rooftop.

The site location is predominantly surrounded by infrastructure, residential buildings and existing commercial premises.

Long term noise monitoring has been undertaken at the site to determine the existing acoustic environment.

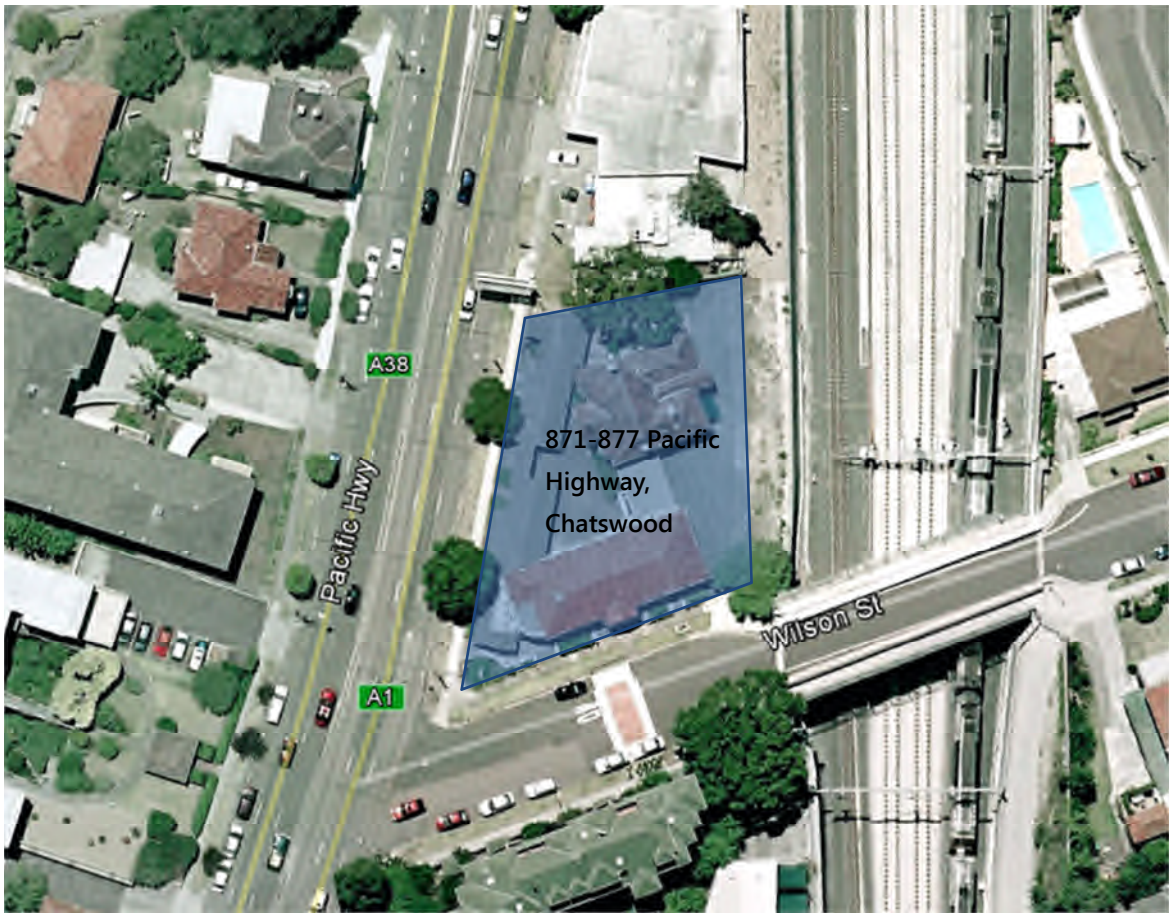


Figure 1 – Site location and surrounds

3 Criteria

3.1 Airborne Traffic Noise

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

- State Environment Planning Policy (Infrastructure 2007), "ISEPP"
- Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008

The Annual Average Daily Traffic (AADT) volume for the Pacific Highway, according to RMS ISEPP Maps is greater than AADT 40,000 vehicles per day.

Therefore an acoustic assessment in accordance with the ISEPP is mandatory (>40,000 AADT), in accordance with the RMS Traffic Volume Maps for Infrastructure SEPP and the criteria set out in Clause 102 of the ISEPP has used when determining suitable internal traffic noise limits for the proposed development.

Table 1 below summaries the airborne traffic noise criteria recommended for the proposed developments.

Table 1 – Recommended Internal Noise Criteria for Road Traffic Noise

Occupancy	Windows & Doors Condition	Design Noise Level	
		Day, LAeq (15hour)	Night, LAeq (9hour)
Bedrooms	Closed	-	35
	Open	-	45
All Other Habitable Areas	Closed	40	40
	Open	50	50

Notes:

Day and Night assessment periods are defined as follows.

1. Day is defined as 7:00am to 10:00pm
2. Night is defined as 10pm to 7am

3.2 Airborne Rail Noise

The existing rail line impacting on the proposed development is the CityRail North Shore Line. This is a dedicated line passenger train with no freight rail. The site is located between Chatswood and Roseville Stations.

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

- State Environment Planning Policy (Infrastructure 2007) "ISEPP"
- Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008

The noise criteria outlined in the documents listed were considered and Table 2 below summaries the airborne traffic noise criteria determined suitable for this development.

Table 2 – Recommended Internal Noise Criteria for Rail Noise

Occupancy	Windows & Doors Condition	Design Noise Level	
		Day, LAeq (15hour)	Night, LAeq (9hour)
Bedrooms	Closed	-	35
	Open	-	45
All Other Habitable Areas	Closed	40	40
	Open	50	50

Notes:

Day and Night assessment periods are defined as follows.

1. Day is defined as 7:00am to 10:00pm
2. Night is defined as 10pm to 7am

3.2.1 Rail Vibration

The Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline", Section 3.6.3 outlines the following documents which recommend train vibration criteria for residential buildings.

- Assessing Vibration: A technical guideline (EPA 2006)
- German Standard DIN 4150, Part 3 1999
- British Standard BS 7385 Part 2 1993
- Australian Standard AS2670.2 1990

The above documents have been reviewed and the criterion for assessment of vibration from train pass-bys affecting the proposed development is quantified using the following Standard:

- Assessing Vibration: A technical guideline (EPA 2006)

Table 2.4 of the Department of Environment Climate Change and Water's document "Assessing Vibration: A technical guideline (EPA 2006)" presents acceptable vibration dose values for intermittent vibration.

Table 3 – Acceptable VDVs for intermittent vibration m/s1.75

Period	Preferred VDV m/s1.75
Day time (7am – 10pm)	0.2
Night time (10pm – 7am)	0.13

3.3 Operation Noise from the existing petrol station

Noise levels from the operation of the existing petrol station to the north of the proposed development site, including mechanical plant and equipment associated with the use of the site, have been included in the determination of design external noise levels impacting on the development site and the acoustic design of the northern facade of the proposed development.

Noise generated by the petrol station, including cars entering and exiting the site and noise events from the closing of car doors have been measured during both the long-term noise survey and short-term measurements in conjunction with traffic and rail noise to determine noise impacts on the proposed development site.

Recommendations for acoustic treatment have been made in Section 5 of this report.

4 Existing Measured Noise Levels

4.1 Existing Traffic Noise Levels

4.1.1 Long-term Noise Survey

Two RTA Technology Environmental Noise Loggers were set up for the ambient noise survey from Friday 20th February to Friday 27th February 2015. One logger was installed in the front courtyard of 871-877 Pacific Highway, Chatswood, midway along the building behind an exposed gate. The second logger was installed in the rear carpark along the boundary fence facing the railway line, at a distance of 10m from the petrol station boundary.

The noise loggers record noise levels on a continuous basis and store data every fifteen minutes. The dates of measurement and the results obtained from the logger surveys are shown in Appendix C.

The development is located on the Pacific Highway. This road has an annual average daily traffic (AADT) volume of greater than 40,000 units, thus invoking the ISEPP.

The noise levels were used to predict traffic noise levels at the facade of the development facing Pacific Highway. Results from the second logger were used to predict rail noise along the facade facing the rail line.

The design external traffic noise levels are presented below.

Table 4 – Predicted External Traffic Noise Levels

Facade	Time Period, T	Traffic Noise Level LAeq,T
Western Facade (Pacific Highway)	Day time (7am to 10pm)	72
	Night time (10pm to 7am)	69

4.1.2 Calculated Noise Levels

Results from the noise surveys were used to calculate internal noise levels within the proposed development. Noise calculations were performed using glazing design software developed in this office which takes into account external noise levels, facade transmission loss and room sound absorption characteristics.

4.2 Train Noise and Vibration Measurements

The North Shore railway line is located approximately 10m from the eastern boundary of the site. Train noise and vibration levels were recorded at location of the proposed eastern boundary of the site at 871-877 Pacific Highway, Chatswood. Operator-attended noise and vibration measurements were conducted on site on Friday 20th February, 2015. The noise logger was also set up behind the existing building, along the site boundary facing the railway line.

Weather conditions were fine and mostly sunny during the operator-attended surveys with negligible wind speeds at the monitoring locations. All instruments were calibrated before and after measurement. No significant drift in calibration was observed.

The design external train noise levels are presented below.

Table 5 – Predicted External Train Noise Levels

Facade	Time Period, T	Design Train Noise Level LAeq,T
Eastern Facade (Railway corridor)	Day time (7am to 10pm)	65
	Night time (10pm to 7am)	61

4.3 Rail Vibration Survey

Train vibration levels were measured using the Sinus SoundBook multi-channel analyser and Endevco accelerometers. An accelerometer was fixed to a steel spike hammered into the ground along the site boundary at the entrance to the existing rear carpark, corresponding to the worst effected boundary of the development (Location 1) as shown in Appendix C.

The table below shows the measured Vibration Dose Value (VDV) measured at the proposed development site due to existing operations.

Table 6 – Calculated Vibration Dose Value (VDV)

Location	Assessment Period	Calculated VDV m/s1.75
At the corner of the Eastern and Southern site boundaries, near the entrance to the rear carpark along the rail corridor.	Day time (7am - 10pm)	0.1023
	Night time (10pm - 7am)	0.0895

The measured VDV at the boundary of the site is below both the daytime and night time criteria as presented in Table 3.

Details of location and survey periods are included in Appendix C.

4.4 Calculated Noise Levels

Results from the noise surveys were used to calculate internal noise levels within the proposed development. Noise calculations were performed using glazing design software developed in this office which take into account external noise levels, facade transmission loss and room sound absorption characteristics.

5 Acoustic Treatment - Glazing

The following table presents the recommended glazing selections for facades of the proposed development at 871-877 Pacific Highway, Chatswood. The required acoustic rating of the glazing assembly presented in the table below represents the required acoustic rating of the glazed system as a whole. This includes glass, frames, junctions and seals.

Table 7 – Recommended Glazing Treatment

Facade	Floor	Occupancy	Required Acoustic Rating of Glazing Assembly
North Façade (Shell Garage)	Levels 1-6	Sleeping Areas	Rw 35
		Other Habitable Spaces	Rw 32
East Façade (North Shore Railway)	Levels 1-6	Sleeping Areas	Rw 35
		Other Habitable Spaces	Rw 32
West Façade (Pacific Highway)	Levels 1-6	Sleeping Areas	Rw 38
		Other Habitable Spaces	Rw 33
South Façade (Wilson Street)	Levels 1-6	Sleeping Areas	Rw 35
		Other Habitable Spaces	Rw 32

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.

NOTES FOR GLAZING CONSTRUCTIONS:

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.

The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.

The glazing supplier shall ensure that installation techniques will not diminish the Rw performance of the glazing when installed on site.

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.

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

The information provided in this table is subject to modification and review without notice.

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.

5.1 Typical Glazing Constructions to Achieve Acoustic Ratings

The following table presents typical glazing constructions to achieve the minimum acoustic ratings presented in Table 7, above.

Table 8 – Typical Glazing Constructions to Achieve Acoustic Ratings

Rw Rating	Typical Glazing System
Rw 32	Minimum 6.38mm laminated glass in an aluminium sliding window frame. Q-lon seals perimeter seals are installed
RW 33	10mm toughened glass in a commercial grade aluminium frame with acoustic fin or bulb seals

Rw Rating	Typical Glazing System
Rw 35	Minimum 10.38mm laminated glass in a commercial grade aluminium frame with acoustic fin or bulb seals
Rw 38	Minimum 10.5mm specialist acoustic glass similar to CSR Viridian V-Lam Hush glass in a commercial grade aluminium frame with acoustic fin or bulb seals.

The table presented above is intended as a guide only and should not be used for construction.

It is the responsibility of the sub-contractor to provide laboratory test reports for the glazed systems proposed for installation at the development site to show compliance with the acoustic ratings presented in Table 7.

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.

5.2 Ventilation

In accordance with the Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008:

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

However, the Department of Planning's Apartment Design Guide, July 2015 Objective 4B-1 requires that all habitable rooms are naturally ventilated, within an apartment complex.

Section 4J, *Noise and Pollution*, of the Apartment Design Guide nominates design solutions that may assist with delivering both the natural ventilation requirements and the internal noise levels (windows open) through careful design solutions. These may include wintergardens with operable facades, partially shielded and insulated balconies, building design and orientation, apartment setbacks and selection of acoustic materials for the building construction.

Shielding and screening to balconies, wintergardens, absorptive treatments and strategically positioned ventilation windows are being considered for facades along noise affected facades along with fresh air intakes for rooms heavily impacted on by road traffic and rail noise to meet the natural ventilation requirements of the Department of Planning's Apartment Design Guide and the Building Code of Australia. Further assessment of internal noise levels with windows opened is required at detailed design to consider facade design, opening sizes, balcony materials, room volumes, room finishes and shielding.

6 External noise emission from building services

The NSW Environment Protection Authority (EPA sets out noise criteria in its Industrial Noise Policy (INP) to control the noise emission from industrial sources. The applicable noise limits, according to the policy, are determined as follows:

Table 9– LAeq Design Criterion for Noise Production (EPA INP)

Time of Day	Column 1	Column 2	Column 3	Column 4
	Rating Background Level (RBL) L90	Instrusiveness Criterion (RBL+5)	Amenity Criterion (Acceptable)	Project Specific Design Criterion LAeq
Day (7am to 6pm)	60	65	60	**60**
Evening (6pm to 10pm)	54	59	50	**50**
Night (10pm to 7am)	41	46	45	**45**

Explanatory notes:

Column 3 – Recommended LAeq noise level based on 'Urban' area in Section 2.2, Table 2.1 Amenity Criteria (Recommended LAeq noise levels from industrial noise sources) of the EPA's INP.

Column 4 – Project Specific Design Criterion based on EPA's INP. Lower of Columns 2 and 3.

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

Mechanical plant has the potential to impact on surrounding existing commercial/retail premises, proposed residential premises, including other buildings within the proposed development.

Although at this stage details of mechanical plant have not been finalised, the following in-principal advice 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 Industrial Noise Policy;

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;

- 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 noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following:

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".

7 Internal Sound Insulation

As a minimum requirement, walls and floors of the residential development shall comply with Building Code of Australia (BCA). Soil and waste pipes shall comply with the minimum requirements of the Building Code of Australia (BCA). Appendix B presents a summary of acoustic provisions outlined in Part F5 of the BCA.

7.1 Acoustic Criteria

7.1.1 BCA 2015 Requirements

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

F5.2 Determination of airborne sound insulation ratings

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

a. 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

b. comply with Specification F5.2.

F5.3 Determination of impact sound insulation ratings

a. 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 with spectrum adaptation term (Ln,w+CI) determined in accordance with AS/ISO 717.2 using results from laboratory measurements; or

ii. comply with Specification F5.2.

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

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

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

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

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

F5.4 Sound insulation rating of floors

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

i. sole-occupancy units; or

ii. 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 walls

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

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

iv. 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

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

1. 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

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

b. 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.

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

vi. the underside of the floor above; or

vii. a ceiling that provides the sound insulation required for the wall.

F5.6 Sound insulation rating of services

d. 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 –

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

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

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

8 Conclusion

Renzo Tonin & Associates have completed an assessment of the potential traffic noise and rail noise impacts on the proposed mixed-use development site at 871-877 Pacific Highway, Chatswood.

The study of external noise and vibration 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.

In order to control airborne traffic and train noise intrusion and comply with the nominated criteria, glazing recommendations have been made in Section 5 above.

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 ear is not as effective in hearing low frequency sounds as it is 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.
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 Assessment and Design Methodology

B.1 SEPP (Infrastructure) 2007

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

2. 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:

f. a building for residential use,

g. a place of public worship,

h. a hospital,

i. an educational establishment or child care centre.

3. 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.

4. 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:

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

k. 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

5. 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:

l. a building for residential use,

m. a place of public worship,

n. a hospital,

o. an educational establishment or child care centre.

6. 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.

7. *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:*

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

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

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

8.1.1 Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline'

The Guideline provides direction for developments that may be impacted by rail corridors and/or busy roads and consideration for the Guideline is a requirement for development specified under the Infrastructure SEPP.

The Guideline recommends an acoustic traffic assessment be undertaken for roads having an AADT of greater than 20,000 and less than 40,000 vehicles per day and states an assessment is mandatory for roads having an AADT of greater than 40,000 vehicles per day. It also identifies assessment zones in which a rail noise and vibration assessment is required.

Table 3.1 of the Guideline summaries noise criteria for noise sensitive developments

Residential Buildings		
Type of occupancy	**Noise Level dBA**	**Applicable time period**
Sleeping areas (bedroom)	35	Night 10 pm to 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways	40	At any time

Note: airborne noise is calculated as Leq (9h) (night) and Leq (15h)(day). Ground-borne noise is calculated as Lmax (slow) for 95% of rail pass-by events.

APPENDIX C Noise Survey Results

C.1 Location and Results of the Short-term Noise Surveys

Results of short-term train noise measurements along the North Shore Railway line are presented below.

Table 10 – Short-term Rail Noise Measurements - Train Passbys

Location	Date	Time	Train	Measured SEL
871-877 Pacific Highway, Chatswood	27th February 2015	12.20pm	Passenger	80 dB(A)
		12.23pm	Passenger	77 dB(A)
		12.25pm	Passenger	82 dB(A)
		12.31pm	Passenger	82 dB(A)
		12.32pm	Passenger	82 dB(A)
		12.36pm	Passenger	80 dB(A)
		12.40pm	Passenger	83 dB(A)
		12.45pm	Passenger	83 dB(A)
		12.46pm	Passenger	82 dB(A)
		12.50pm	Passenger	80dB(A)

C.2 Location and Results of the Long-term Noise Surveys

Unattended noise monitoring location 1: Front courtyard of 871-877 Pacific Highway, Chatswood. Positioned approximately 40m from Wilson Street kerbside, and 7m from Pacific Highway.

Unattended noise monitoring location 2: Rear carpark of 871-877 Pacific Highway, Chatswood. Positioned approximately 5m from the train line, and 30m from Wilson Street kerbside.

Survey Period: 20th February to 27th February 2015

APPENDIX D Figures

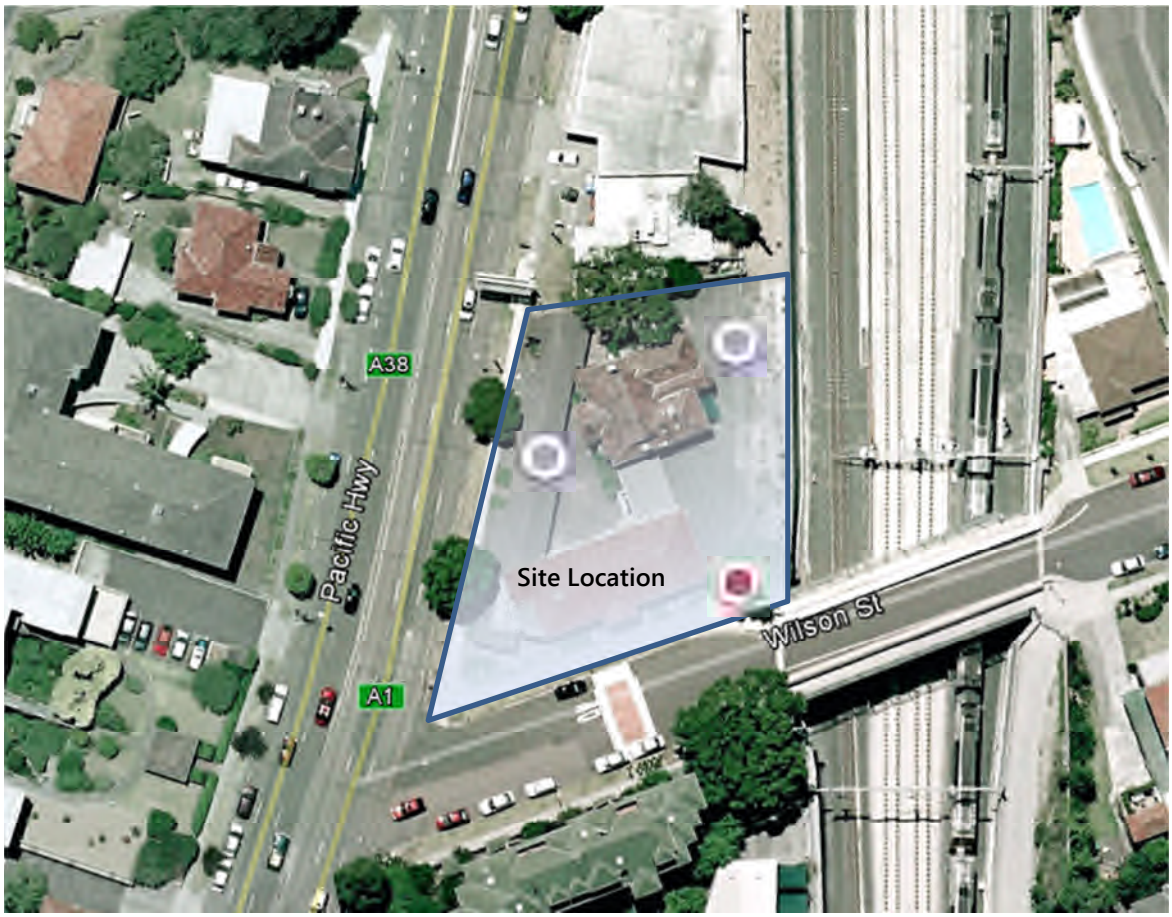


Figure 2 - Site Location and Measurement Locations

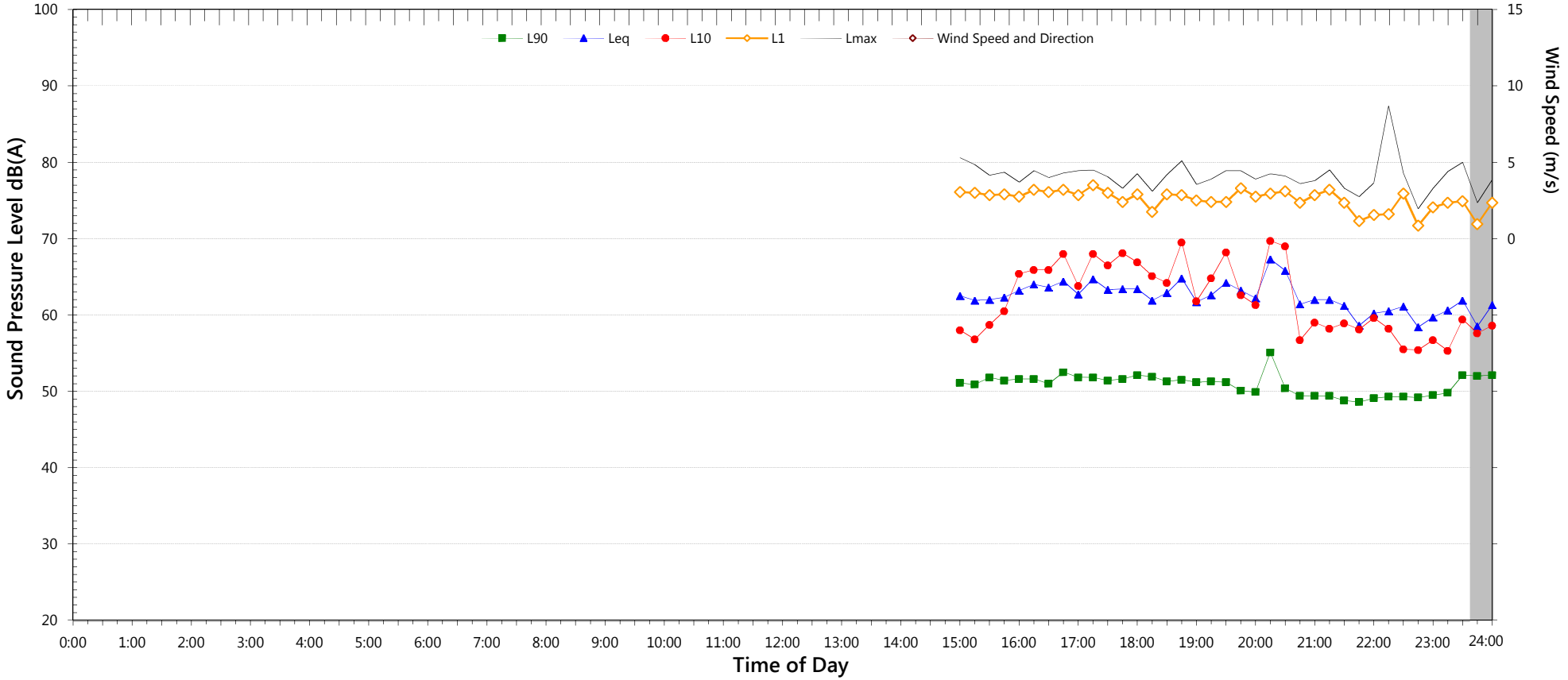
Long Term monitoring location

Short Term train monitoring locations

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Friday, 20 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	48.8	-
Leq	-	63.1	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

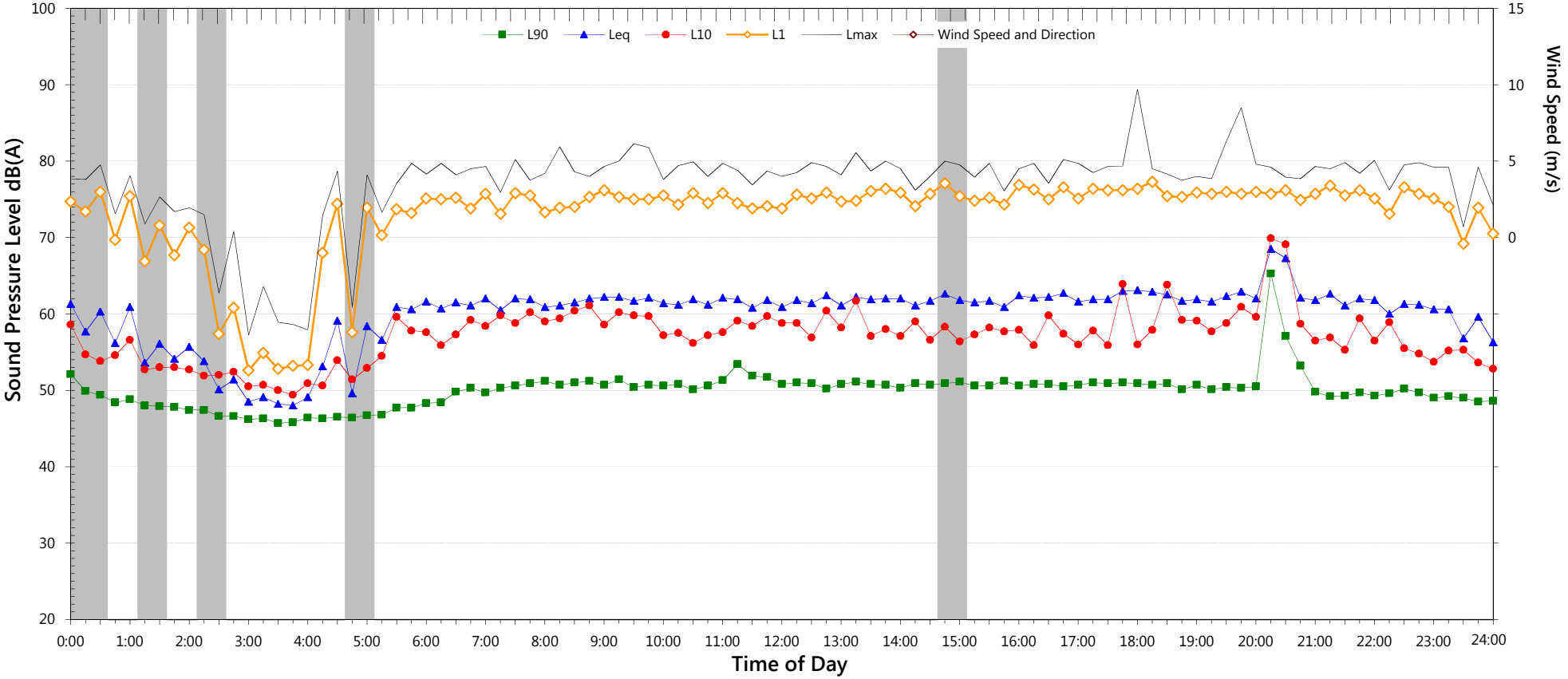
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.7	61.4
$L_{eq\ 1hr}$ upper 10 percentile	67.3	63.9
$L_{eq\ 1hr}$ lower 10 percentile	63.2	51.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.8	to	87.4
Lmax - Leq (Range)	18.3	to	27.4

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Saturday, 21 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.4	49.3	46.4
Leq	61.8	63.4	58.9

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

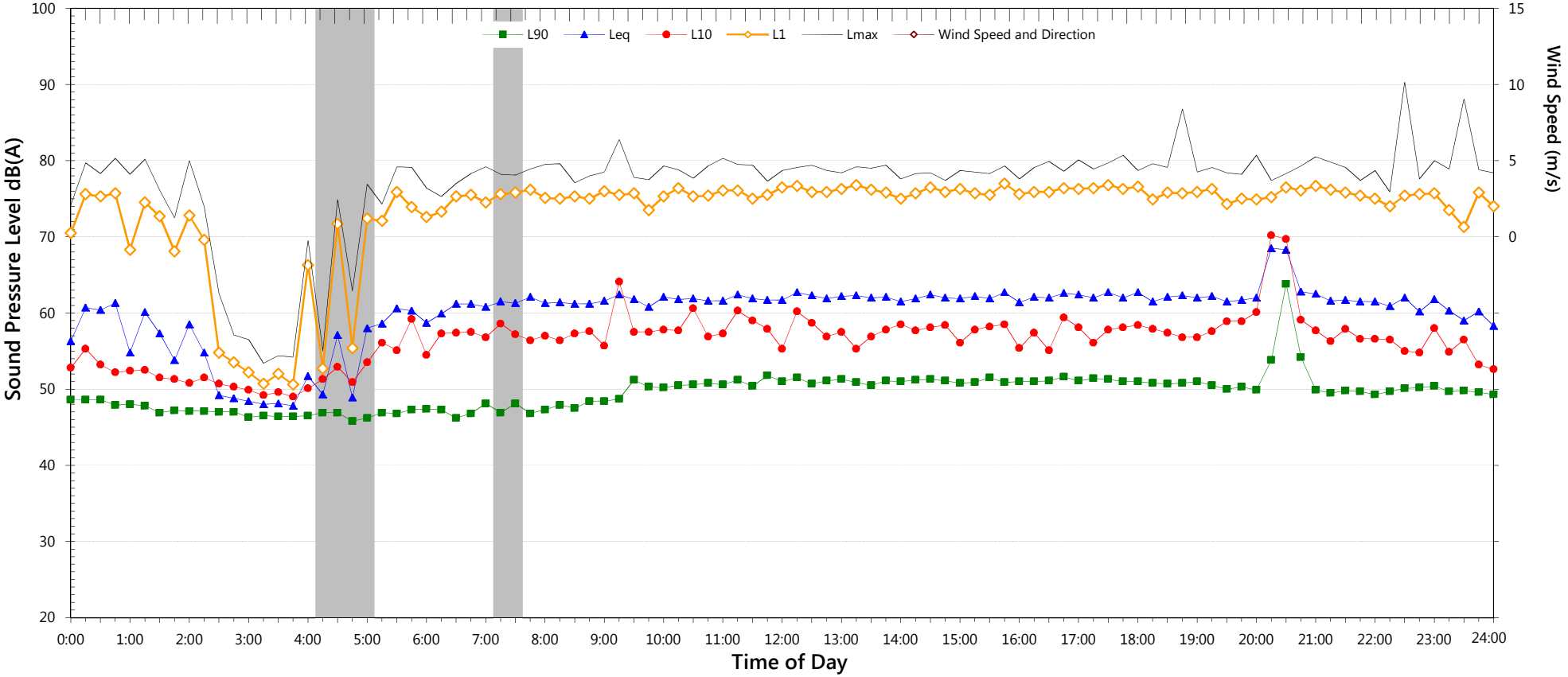
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.8	61.4
$L_{eq\ 1hr}$ upper 10 percentile	67.0	63.3
$L_{eq\ 1hr}$ lower 10 percentile	63.9	51.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	69.5	to	80.3
Lmax - Leq (Range)	18.4	to	22.8

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Sunday, 22 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	48.6	49.5	48.8
Leq	62.0	63.5	58.9

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

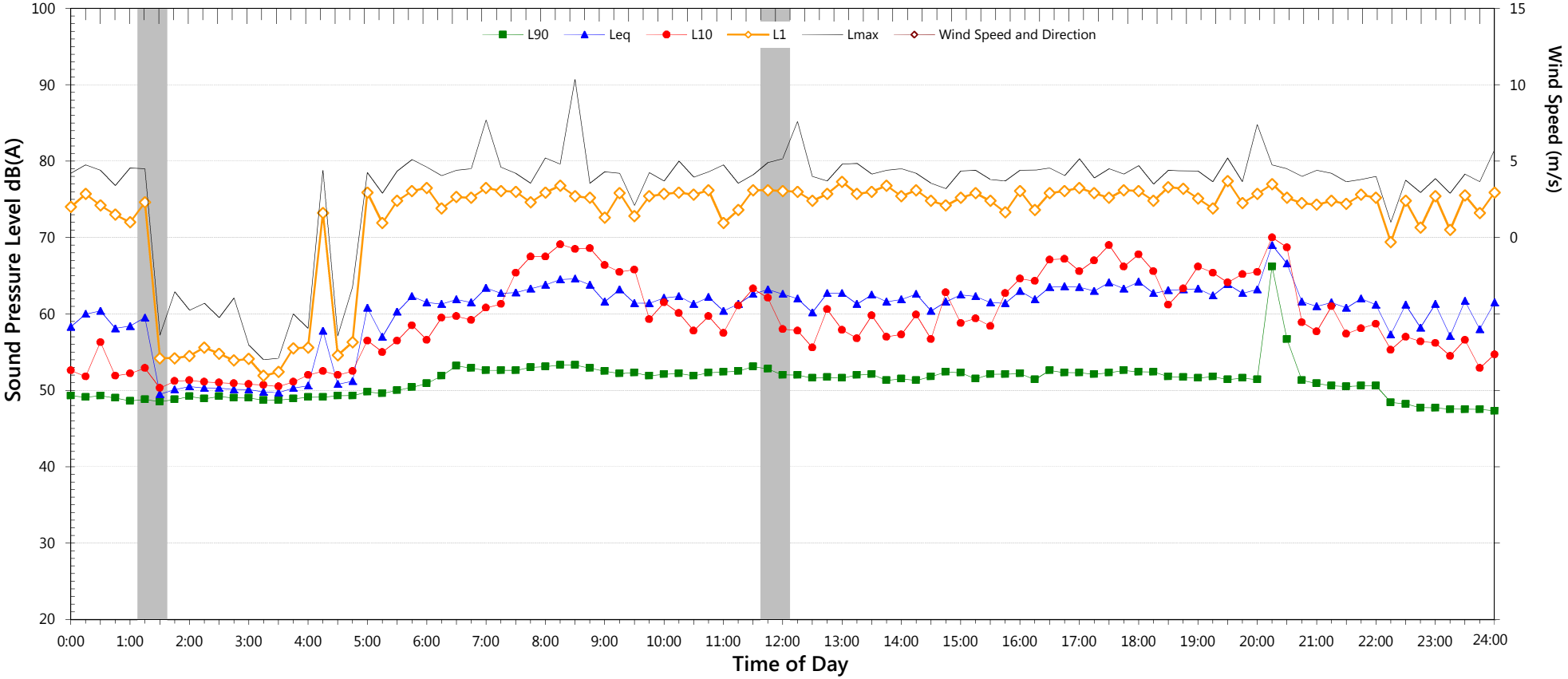
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.0	61.4
$L_{eq\ 1hr}$ upper 10 percentile	67.3	64.6
$L_{eq\ 1hr}$ lower 10 percentile	64.0	52.6

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	78.8	to	90.3
Lmax - Leq (Range)	19.5	to	29.0

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Monday, 23 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	51.5	50.6	46.0
Leq	62.6	63.6	57.7

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

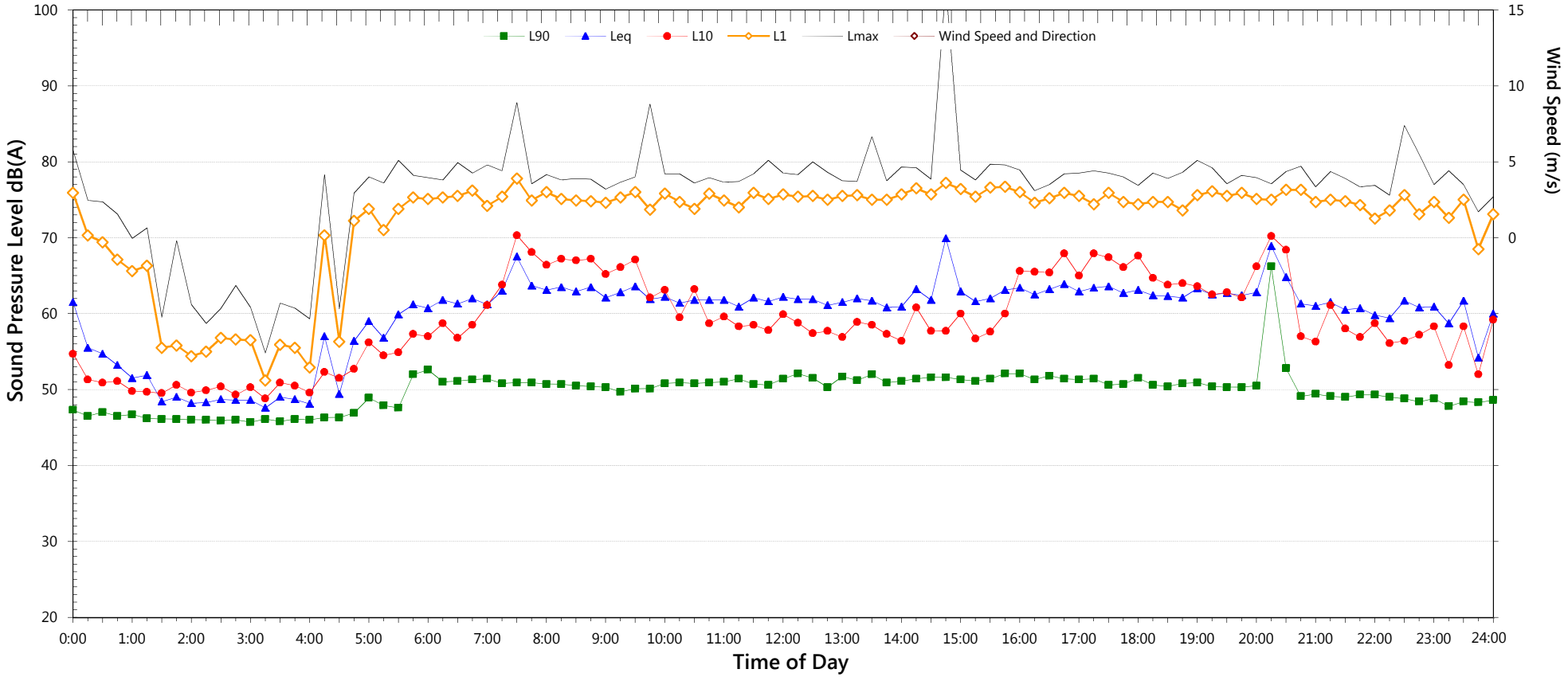
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.4	60.2
$L_{eq\ 1hr}$ upper 10 percentile	67.4	64.1
$L_{eq\ 1hr}$ lower 10 percentile	64.0	50.9

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	71.3	to	81.5
Lmax - Leq (Range)	15.1	to	21.7

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Tuesday, 24 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.3	49.1	47.0
Leq	63.1	63.1	58.0

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

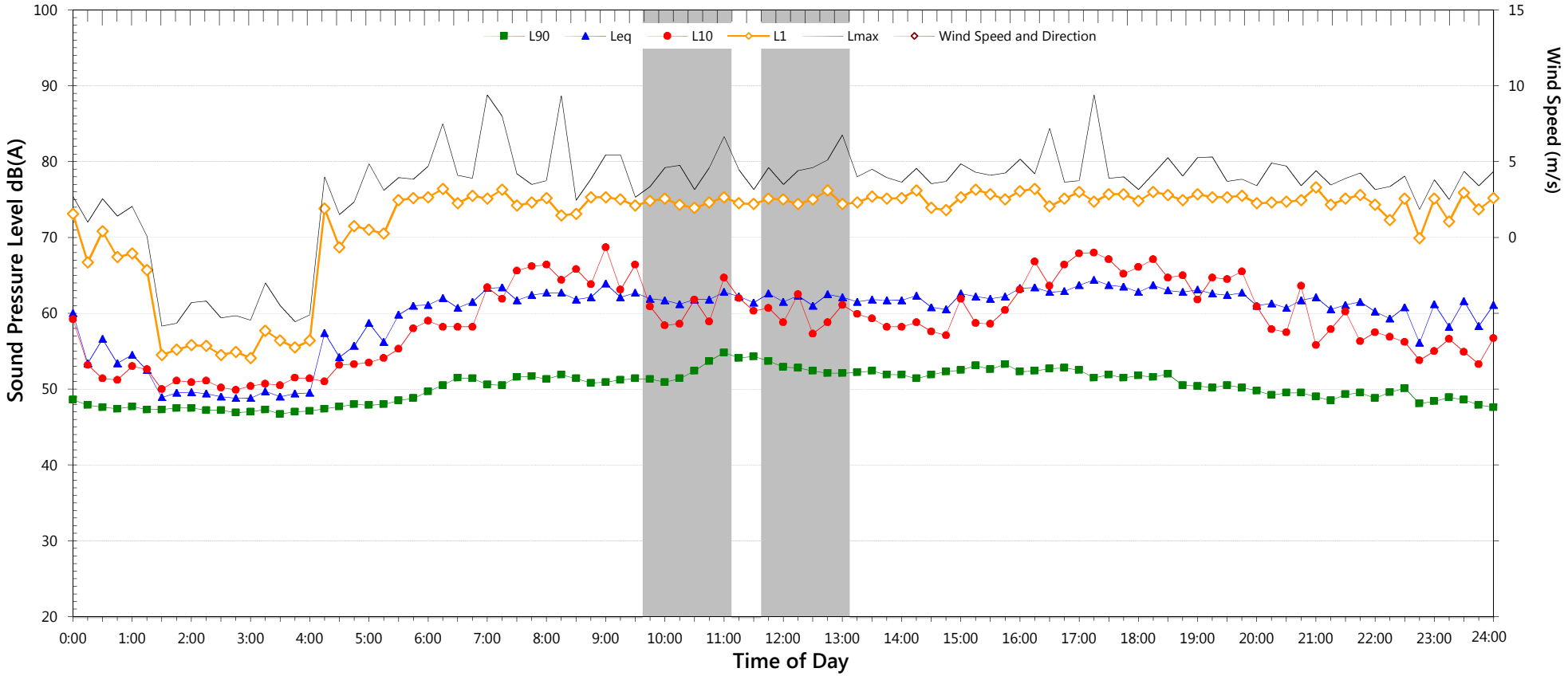
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.6	60.5
$L_{eq\ 1hr}$ upper 10 percentile	68.1	64.5
$L_{eq\ 1hr}$ lower 10 percentile	63.5	51.5

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.2	to	88.8
Lmax - Leq (Range)	19.4	to	26.8

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Wednesday, 25 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	48.8	46.5
Leq	-	62.0	57.9

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

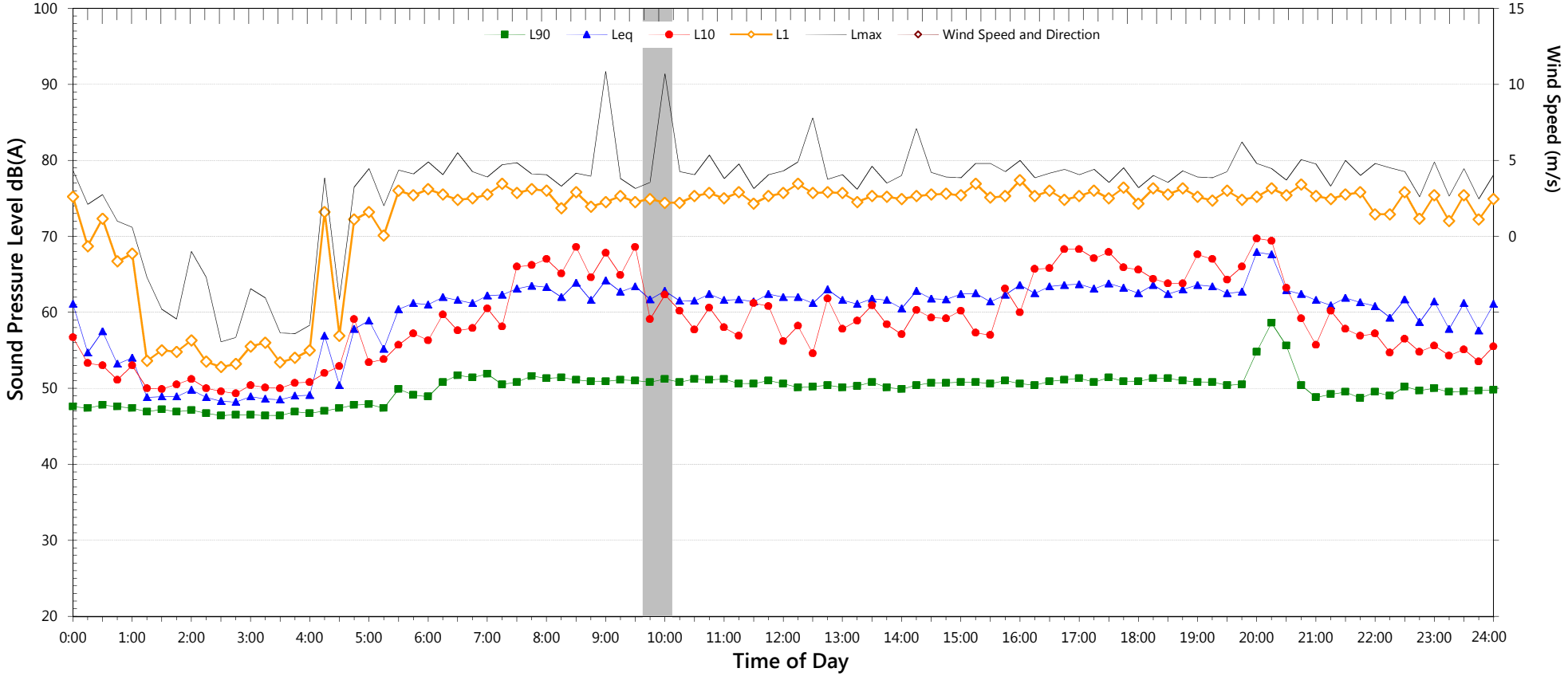
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.9	60.4
$L_{eq\ 1hr}$ upper 10 percentile	66.0	64.3
$L_{eq\ 1hr}$ lower 10 percentile	63.6	51.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.0	to	81.0
Lmax - Leq (Range)	16.0	to	22.0

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Thursday, 26 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.2	48.8	48.5
Leq	62.5	63.6	58.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

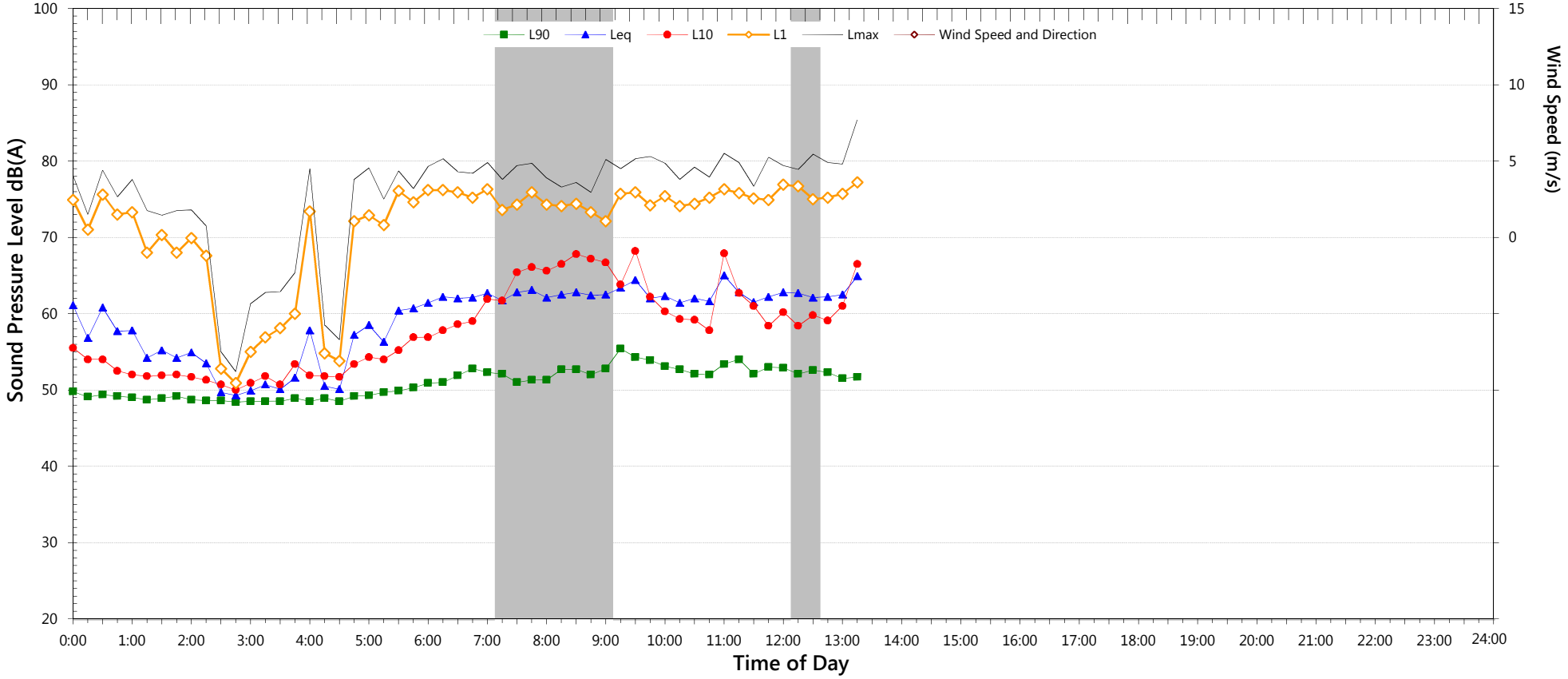
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.3	61.1
$L_{eq\ 1hr}$ upper 10 percentile	67.1	64.8
$L_{eq\ 1hr}$ lower 10 percentile	63.8	53.5

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	71.5	to	80.3
Lmax - Leq (Range)	18.0	to	25.2

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at rear carpark

Friday, 27 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

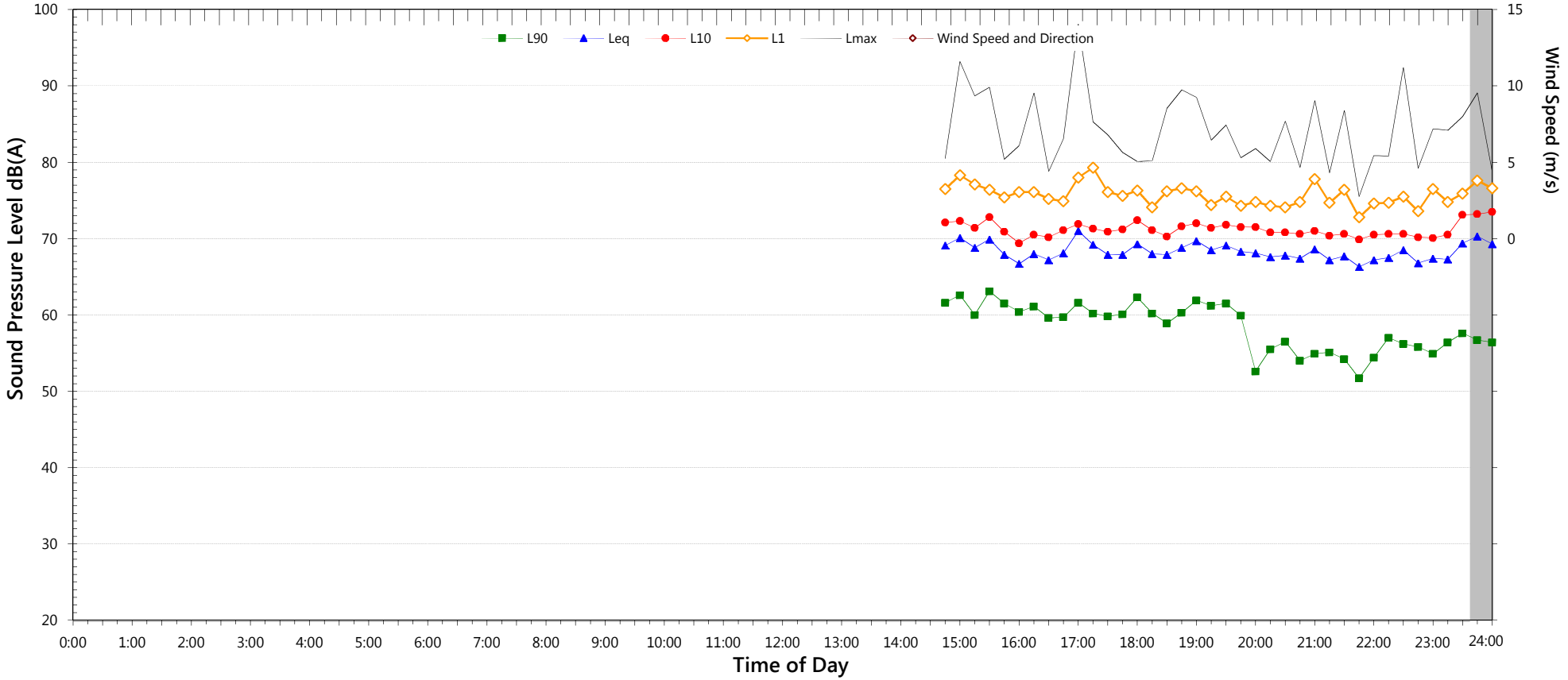
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.4	-
$L_{eq\ 1hr}$ upper 10 percentile	67.4	-
$L_{eq\ 1hr}$ lower 10 percentile	64.9	-

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Friday, 20 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	52.6	-
Leq	-	68.1	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

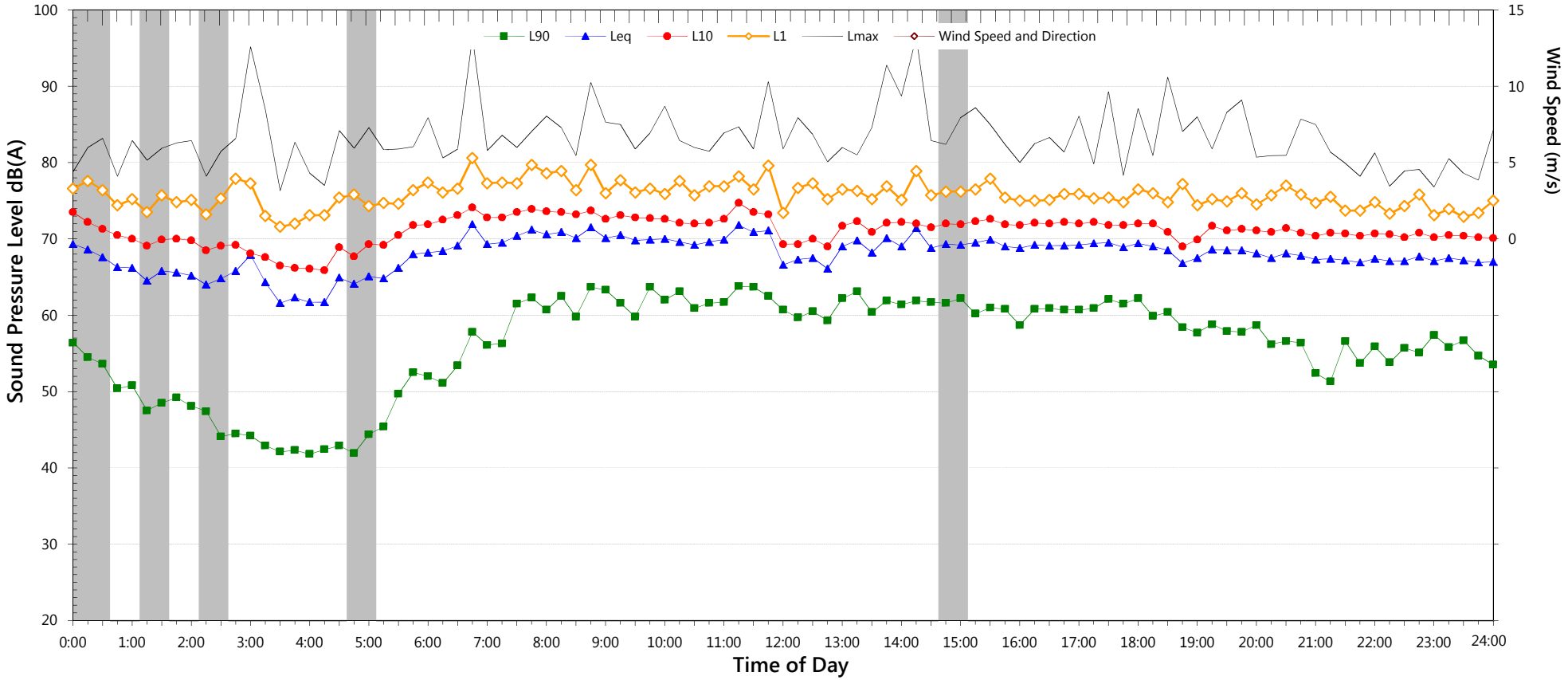
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	70.9	69.6
$L_{eq\ 1hr}$ upper 10 percentile	72.1	72.4
$L_{eq\ 1hr}$ lower 10 percentile	69.6	65.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	82.9	to	96.4
Lmax - Leq (Range)	16.6	to	28.2

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Saturday, 21 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	59.8	52.4	44.0
Leq	69.7	67.9	66.4

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

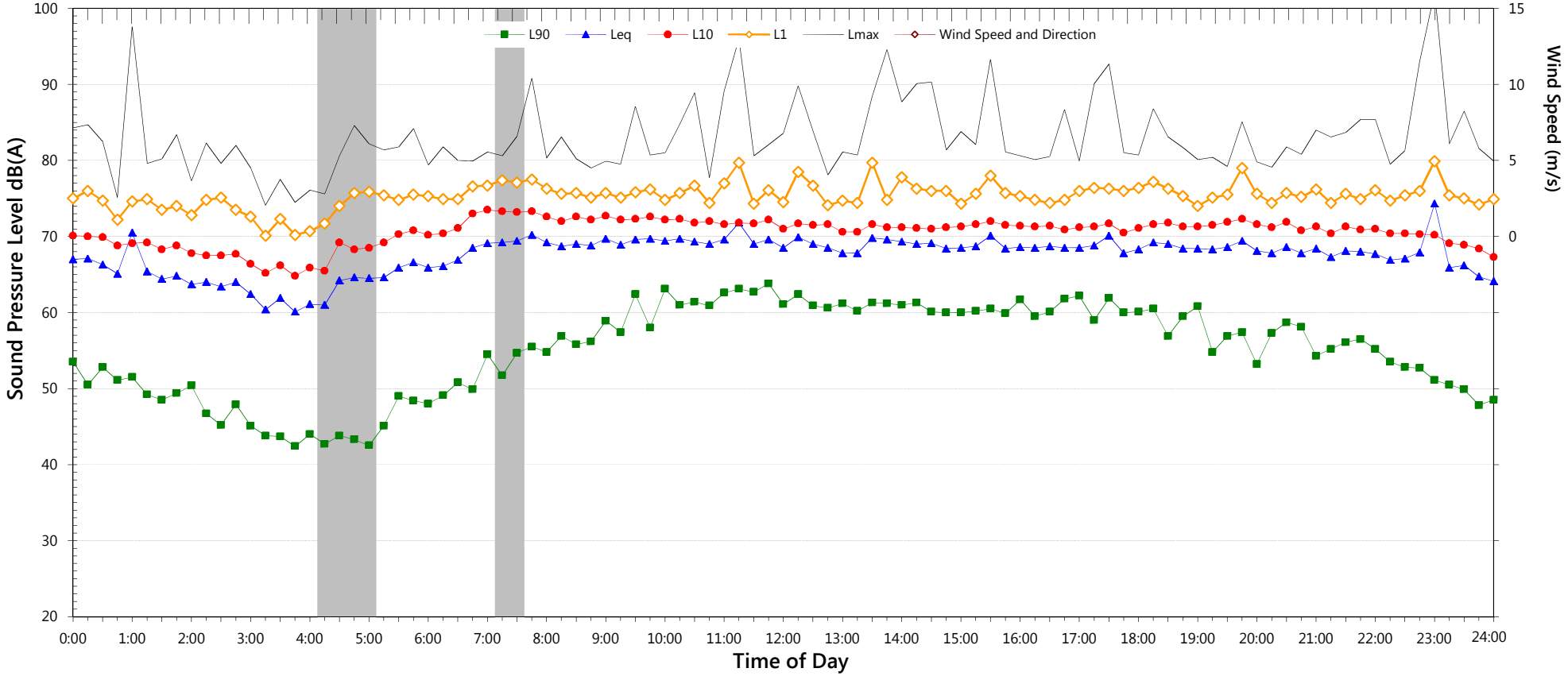
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	71.8	68.9
$L_{eq\ 1hr}$ upper 10 percentile	73.1	70.3
$L_{eq\ 1hr}$ lower 10 percentile	69.9	63.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	77.5	to	97.6
Lmax - Leq (Range)	16.6	to	29.8

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Sunday, 22 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	57.7	54.3	40.9
Leq	69.1	68.4	67.2

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

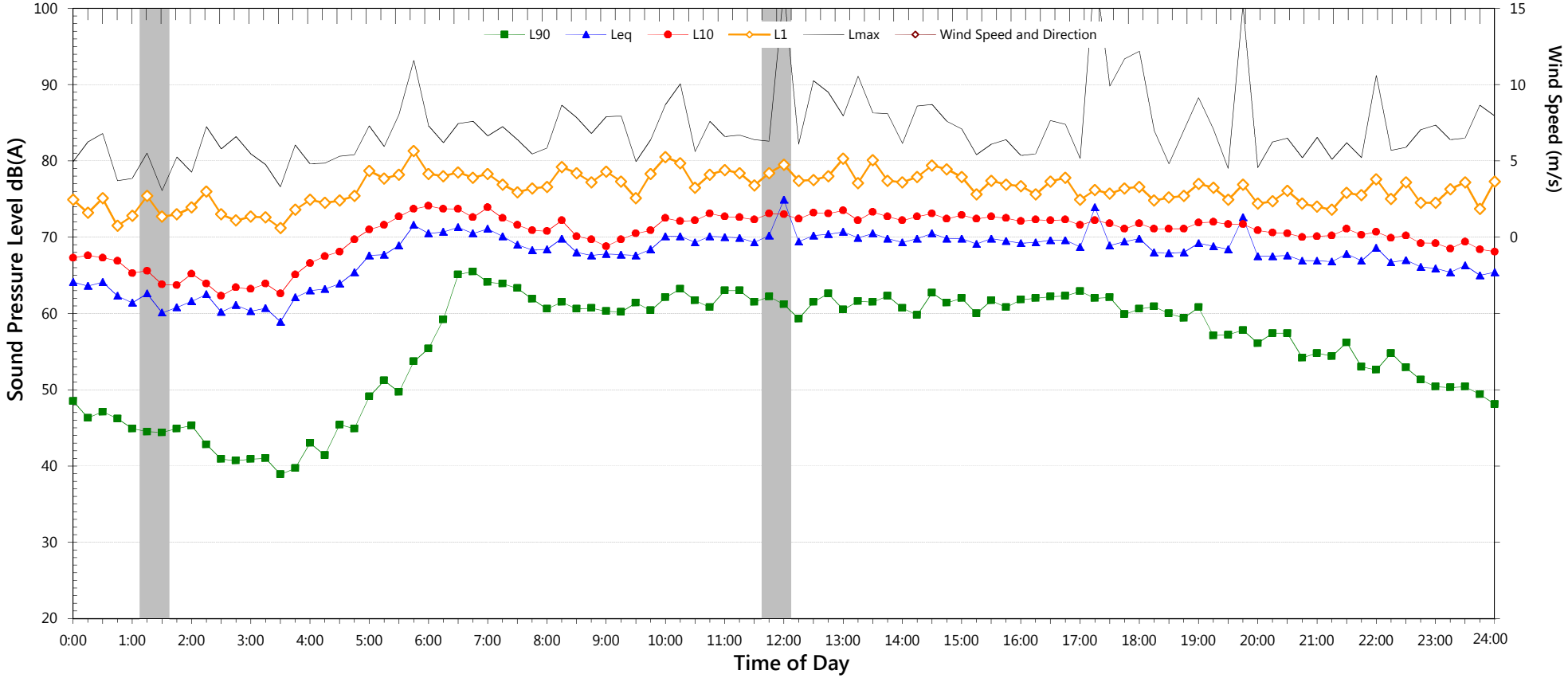
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	71.4	69.7
$L_{eq\ 1hr}$ upper 10 percentile	72.3	73.4
$L_{eq\ 1hr}$ lower 10 percentile	70.5	63.6

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	80.5	to	102.1
Lmax - Leq (Range)	19.2	to	31.8

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Monday, 23 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	60.2	53.0	42.3
Leq	69.6	68.4	67.1

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

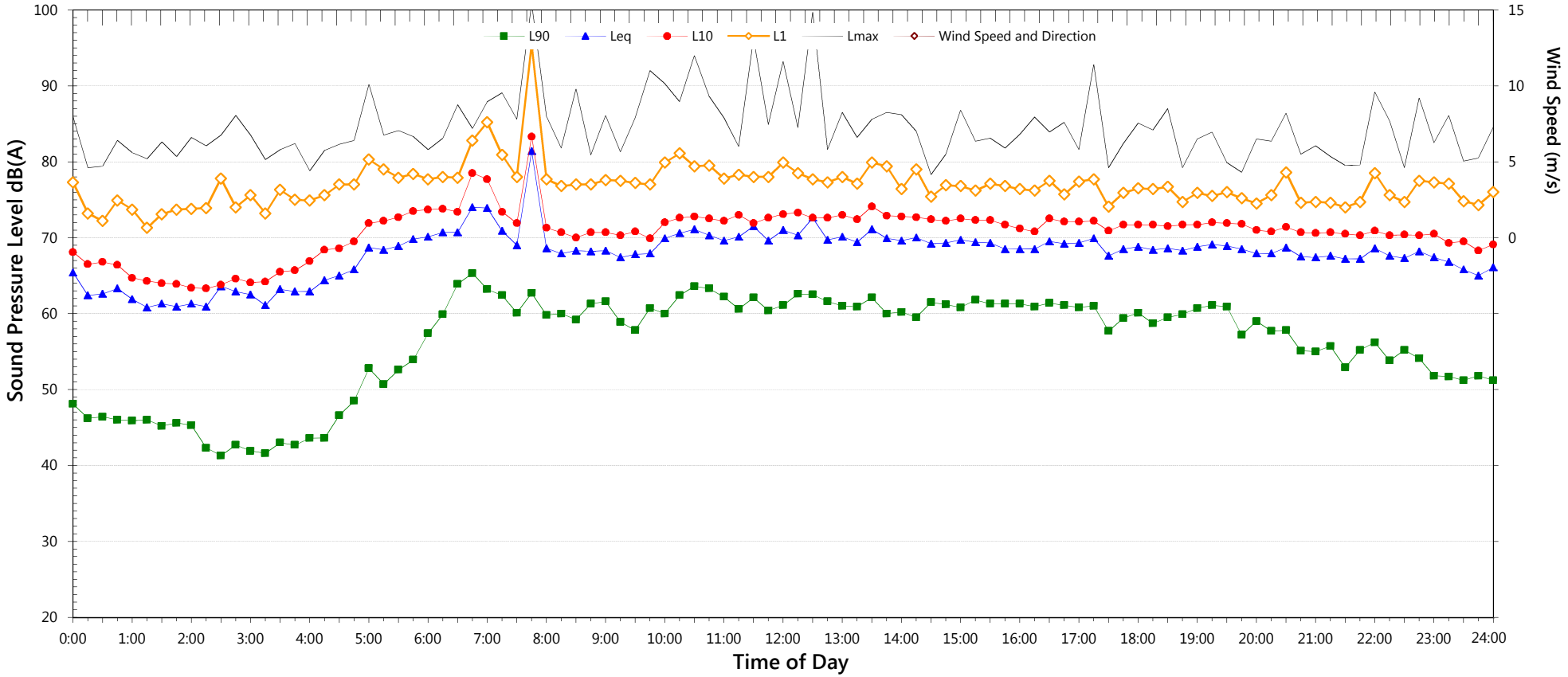
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	71.8	69.6
$L_{eq\ 1hr}$ upper 10 percentile	73.1	75.1
$L_{eq\ 1hr}$ lower 10 percentile	69.9	63.6

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	82.4	to	90.2
Lmax - Leq (Range)	15.3	to	23.9

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Tuesday, 24 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	59.4	55.0	41.0
Leq	70.8	68.2	66.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

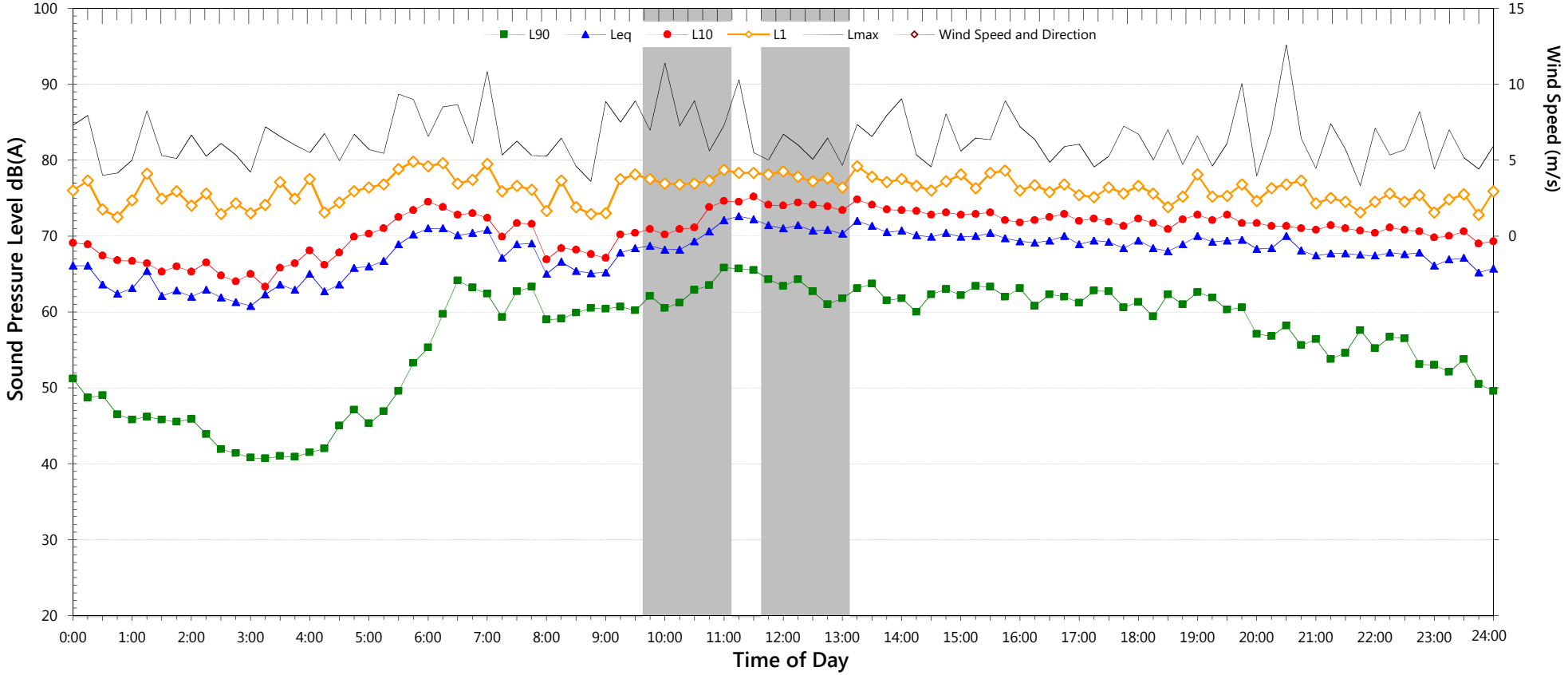
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	72.7	69.1
$L_{eq\ 1hr}$ upper 10 percentile	76.8	73.1
$L_{eq\ 1hr}$ lower 10 percentile	70.3	64.3

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	82.2	to	91.7
Lmax - Leq (Range)	18.8	to	23.2

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Wednesday, 25 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	54.6	40.3
Leq	-	68.6	66.8

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

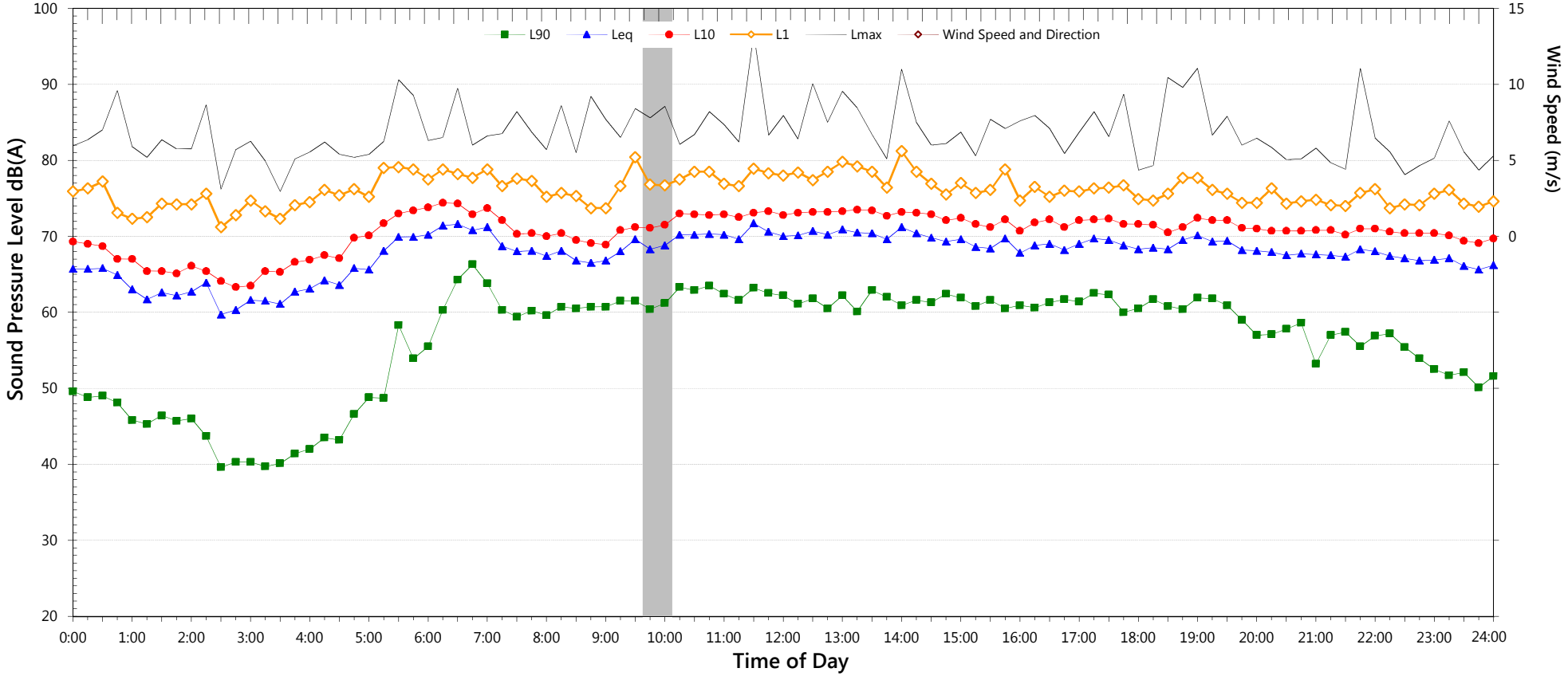
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	71.7	69.3
$L_{eq\ 1hr}$ upper 10 percentile	74.6	73.8
$L_{eq\ 1hr}$ lower 10 percentile	68.8	64.2

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	81.1	to	90.6
Lmax - Leq (Range)	17.5	to	25.6

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Thursday, 26 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	60.2	55.5	40.6
Leq	69.4	68.4	66.7

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

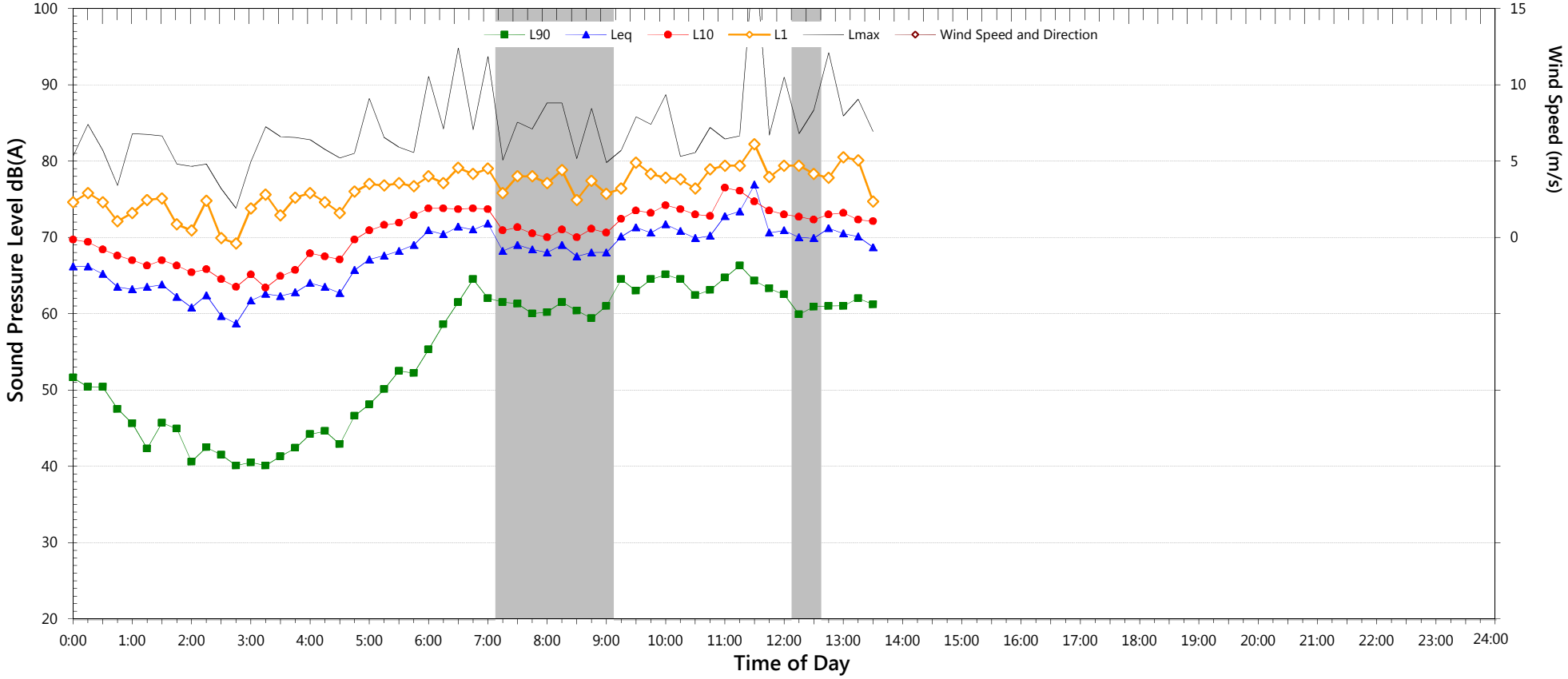
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	71.7	69.2
$L_{eq\ 1hr}$ upper 10 percentile	73.0	73.7
$L_{eq\ 1hr}$ lower 10 percentile	69.9	63.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	79.9	to	94.8
Lmax - Leq (Range)	18.9	to	23.6

Unattended Noise Monitoring Results

871-877 Pacific Highway Chatswood located at front facade

Friday, 27 February 2015



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured in free-field; tabulated results facade corrected
4. Night time Lmax values are shown only where Lmax >65dB(A) and where Lmax- Leq ≥15dB(A)

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	74.2	-
$L_{eq\ 1hr}$ upper 10 percentile	76.2	-
$L_{eq\ 1hr}$ lower 10 percentile	72.0	-

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-