1 Introduction

Renzo Tonin & Associates was engaged to conduct a noise assessment for the proposed residential rezoning at 92-96 Victoria Street, Werrington from existing road traffic along Victoria Street and rail noise and vibration associated with the T1 Western passenger rail line to support the proposed rezoning of the site from R3 to R4 Residential.

Noise surveys have been conducted by Renzo Tonin & Associates between Thursday 28th April and Thursday 5th May 2016 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 Victoria Street
- Rail Noise and vibration associated with the CityRail T1 Western 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 rezoning at 92-96 Victoria Street, Werrington is bounded to the south by the rail corridor and to the north by Victoria Street. To the West are residential properties and to the east of the site is a car park for Werrington Station and a small shopping centre.

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 Rail Noise and Vibration

An assessment of rail noise and vibration impacting the site has been undertaken to determine the feasibility of compliance with the relevant policies and codes.

3.1.1 Airborne Rail Noise

The existing rail line impacting on the proposed development is the T1 Western Line. This is a dedicated line passenger train with frequent freight rail. The site is located between St Marys Station and Werrington Station.

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
- Penrith City Council's Development Control Plan (DCP) 2014

Penrith City Council DCP presents the criteria for assessing rail noise and vibration:

12.2 Rail Traffic Noise and Vibration

C. Controls

1) Rail noise and vibration

a) The siting and design of developments on land sited on, or within, 80m of an operating rail corridor or land reserved for the construction of a railway line is to address the matters raised in the Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning, 2008) and, where appropriate, incorporate any recommendations into the design of the development.

b) Council will not grant consent to residential development, residential subdivision or other sensitive land uses on land in the vicinity of a rail corridor unless it complies with the relevant standards and criteria set by the EPA and Department of Planning, as well as any relevant Australian Standards.

c) Council will not grant consent to any development which potentially has sensitive occupancies (such as residential, office or laboratory premises) and is proposed to be constructed within 20m of the rail line unless an assessment of the vibration impacts from the rail line has been carried out. This is to be undertaken by a recognised acoustic consultant to demonstrate that the impact of vibration from the rail corridor will not significantly impact upon the future occupants of the development.

Noise Impact Statements - specific requirements

a) Where a site is likely to be affected by unacceptable levels of rail noise or vibration, the applicant is required to provide a Noise Impact Statement prepared by a qualified acoustic consultant in accordance with the requirements set out in Appendix F3 – Submission Requirements of this DCP.

b) The Noise Impact Statement should demonstrate acoustic protection measures necessary to achieve an indoor environment meeting residential standards, in accordance with EPA and Department of Planning criteria, as well as relevant Australian Standards and Clause 87 – Impact of Rail Noise or Vibration on Non-Rail Development of SEPP (Infrastructure) 2007.

As the proposed site lies 12m from the T1 Western Railway Line. This lies within the 80m requirement presented in 12.2.1a of the Penrith City Council DCP above. It states that the Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning, 2008) must be considered. Details of the guideline can be found in B.1 in APPENDIX B.

Figure 3.1 of the guideline provides a guide as to the assessment required when noise sensitive developments are located in the vicinity of existing rail lines.

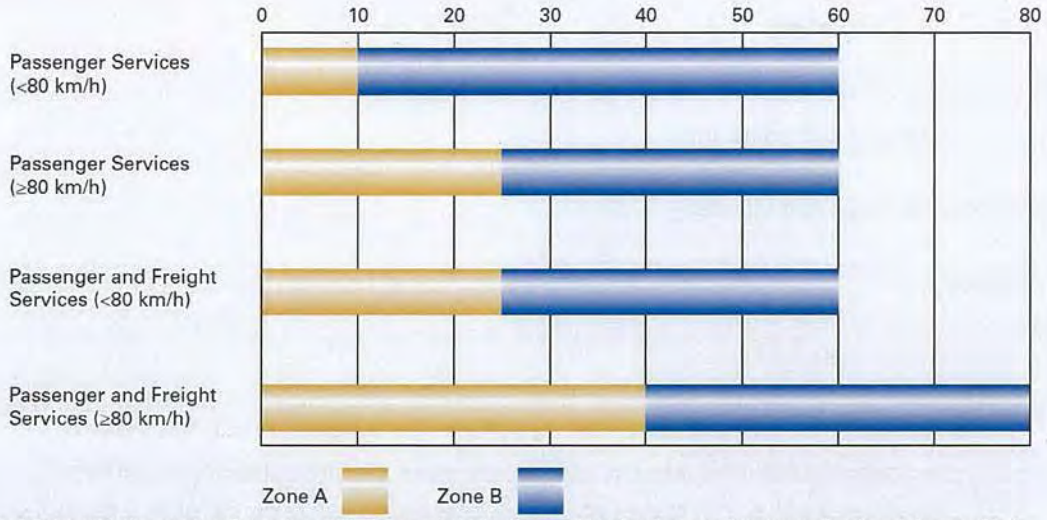


Figure 3.1: Acoustic Assessment Zones based on distance (m) of noise-sensitive development from operational track (not corridor)

The proposed site falls into the 'Passenger and Freight Services (<80km/h)' category, and is 12m from the rail line. This means the proposed site will be assessed to Zone A.

Zone A requires that a full noise assessment should be undertaken. The acoustic assessment will be in accordance with the criteria set out in Clause 87 of the ISEPP has been used when determining suitable internal rail noise limits for the proposed development.

Table 1 below summaries the airborne rail noise criteria determined suitable for this development.

Table 1: 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

3.1.2 Rail Vibration

The criteria above in Section 3.1.1, which presents the criteria for assessing rail noise and vibration by Penrith City Council DCP states that:

12.2 Rail Traffic Noise and Vibration

C. Controls

1) Rail noise and vibration

c) Council will not grant consent to any development which potentially has sensitive occupancies (such as residential, office or laboratory premises) and is proposed to be constructed within 20m of the rail line unless an assessment of the vibration impacts from the rail line has been carried out. This is to be undertaken by a recognised acoustic consultant to demonstrate that the impact of vibration from the rail corridor will not significantly impact upon the future occupants of the development.

Although the proposed site lies 12m from the rail line, which is inside the recommended assessment zone given by Penrith City Council. In addition, in Figure 3.2 of the Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline", the proposed site lies within the assessable zone. The guideline shows that other vibration sensitive buildings up to 60m from the rail line should be assessed. In order to ensure that rail vibration does not adversely impact on the proposed development, a vibration assessment will be undertaken.

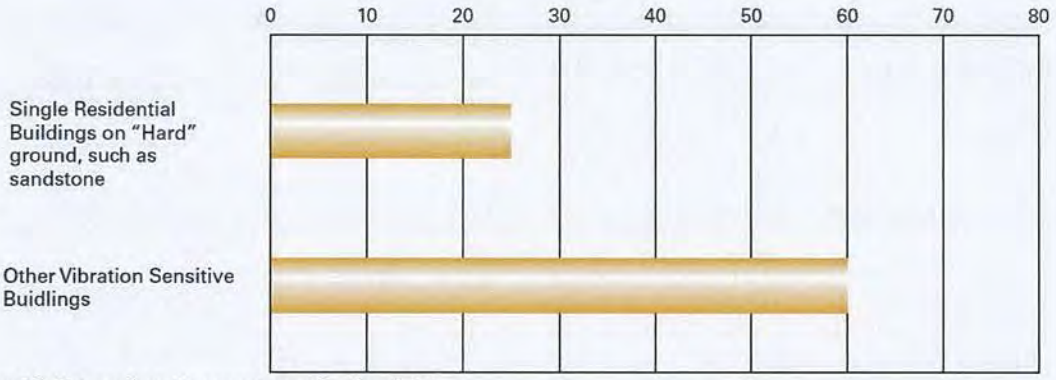


Figure 3.2: Distance from the nearest operational track (m)

The Department of Planning 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 2: 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

Note: *Noise levels are predicted to 1m from the facade

3.2 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
- Penrith City Council's Development Control Plan (DCP) 2014
- Australian Standard 2017:200 "Acoustics – Recommended design sound levels and reverberation times for building interiors" (AS2107)

Penrith City Council DCP presents the following criteria for assessing traffic noise:

12.1 Road Traffic Noise

C. Controls

Road traffic noise criteria including sensitive land uses

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

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

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

Noise Impact Statements - Specific Requirements

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

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

An assessment in accordance with The State Environment Planning Policy (Infrastructure) is mandatory for developments near roads having an Annual Average Daily Traffic (AADT) of more than 40,000 and recommended for roads having an AADT of between 20,000 and 40,000.

The Annual Average Daily Traffic (AADT) volume for Victoria Street, Werrington, according to RMS ISEPP Maps is less than AADT 20,000 vehicles per day, and therefore does not evoke the ISEPP.

However, as the criteria defined in the Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" is deemed to be the most appropriate criteria for assessing traffic noise at the site.

Table 3 below summaries the airborne traffic noise criteria recommended for the proposed development.

Table 3: 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

4 Existing Measured Noise Levels

4.1 Train Noise and Vibration Measurements

The T1 Western railway line is located approximately 12m from the southern boundary of the site. Train noise and vibration levels were recorded at location of the proposed northern boundary of the site at 94 Victoria Street, Werrington from 9:30am-11:15am. Operator-attended noise and vibration measurements were conducted on site on Thursday 5th May, 2016. The noise logger was also set up at the western boundary of the existing building, along the site boundary facing the West Lane.

Weather conditions were fine and 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.

4.1.1 Long-term Noise Survey

One RTA Technology Environmental Noise Logger was set up for the ambient noise survey from Thursday 28th April to Thursday 5th May 2016. The logger was installed at the rear boundary of the proposed development, facing the rail corridor. The logger was set up in free field, meaning that it was 3.5m from all buildings and other reflecting structures.

The noise logger records 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 noise levels were used to predict airborne rail noise levels at the rear façade of the development facing West Lane.

The design external train noise levels are presented below.

Table 4: Predicted External Train Noise Levels

Facade	Time Period, T	Design Train Noise Level LAeq,T
Southern Facade, facing rail corridor	Day time (7am to 10pm)	60
	Night time (10pm to 7am)	59

4.2 Rail Vibration Survey

Train vibration levels were measured using the Sinus SoundBook multi-channel analyser and Endevco accelerometers. An accelerometer was fixed to the concrete ground along the west boundary of the site. This location allowed for shortest distance from the rail corridor to be measured, the worst case scenario (Location 1) as shown in Appendix C.

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

Table 5: Calculated Vibration Dose Value (VDV)

Location	Assessment Period	Calculated VDV m/s1.75
At the corner of the Northern and Western site boundaries, near the rear carpark next to the rail corridor.	Day time (7am - 10pm)	0.00443524913637799
	Night time (10pm - 7am)	0.00355603091758053

The calculated VDV at the boundary of the site is below both the daytime and night time criteria as presented in Table 2.

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

4.3 Existing Traffic Noise Levels

4.3.1 Short-term Noise Survey

A short-term noise survey was undertaken on Thursday 5th May 2016 at 10:15am outside of 94 Victoria Street, Werrington to determine traffic noise along Victoria Street.

Table 6 below presents the results from the short term measurements.

Table 6: Measured Traffic Noise Levels on Queen Street

Location	Time of Day	Noise Descriptor	Measured Noise Level (dB) in Octave Band Centre Frequency Hz									Measured Overall Noise level in dB(A)
			31.5	63	125	250	500	1k	2k	4k	8k	
94 Victoria Street, Werrington	10:15am-10:30am 05/05/2016	L90	61.2	53.0	51.3	49.3	48.5	53.5	52.1	38.8	27.9	57.1
		Leq	61.0	54.7	55.6	52.4	50.5	55.6	54.6	41.7	32.0	59.4

The short term measurement results were correlated with the long term measurements in order to predict the external noise level 1m from the façade on Victoria due to traffic noise. Table 7 shows the predicted design external traffic noise levels 1m from the facade.

Table 7: Predicted External Traffic Noise Levels

Facade	Time Period, T	Design Traffic Noise Level LAeq,T
North Facade (Victoria Street)	Day time (7am to 10pm)	59
	Night time (10pm to 7am)	56

Note: Design levels are predicted to 1m from the facade

4.3.2 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.

5 Recommendations

5.1 Facade Design

Based on the measured noise levels at the site, a minimum noise reduction of 24dB would be required for residences facing the rail line.

The use of standard brick veneer construction, double brick or insulated lightweight walls along with laminated glazing would result in internal noise levels complying with the nominated internal acoustic criteria.

Further assessment of habitable spaces impacted on by road and rail noise is to be undertaken at the Design Development phase of the project.

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 10dB(A), 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.

It has long been industry standard to assume a 10dB loss of noise from external to internal through an opened window in a building facade. It is based on the average results of a number of test cases, experimental data and published papers. This assumption has been well documented in The Roads and Traffic Authority (RTA) publications, including the RTA's Environmental Noise Management Manual (ENMM), Table 4.2.

Recent studies on noise reduction through facades with open windows[1] have shown that noise transmission through an open window can vary greatly based on the construction of the facades and noise flanking paths, including exposed floors and roof constructions.

The study indicates that noise loss through an open window of a development consisting of masonry construction with no exposed flooring and a concrete roof will be in the range of 11-15dB.

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

[1] Ryan, Lanchester and Pugh, 2011

open) through careful design solutions. These may include wintergardens with operable facades, partially shielded and insulated balconies, building design and orientation, building setbacks and selection of acoustic materials for the building construction.

6 External noise emission from building services

6.1 EPA Requirements

The NSW Environmental Protection Authority (EPA) sets out noise criteria in its Industrial Noise Policy (INP) to control the noise emission from industrial sources.

The NSW Industrial Noise Policy (INP) sets criteria to protect noise amenity for residential receivers. The basis for its policy relies on two components:

- controlling intrusive noise impacts in the short term for residences, and
- maintaining noise level amenity for particular land uses for residences and other land uses.

Noise intrusiveness ensures that industrial noise does not exceed the existing background noise level by an excessive margin. This is commonly referred to as the 'background plus 5' criterion, that is, that the noise level from the new industrial development should not exceed the existing background noise level (measured in the absence of that development) by more than 5dB(A).

Noise amenity ensures that industrial noise levels do not increase without limit, for if a number of industrial noise sources are permitted to increase the background noise level by 5dB(A), in turn there would be a point where the ultimate noise level is unacceptable. A limit on the ultimate acceptable noise level is therefore included in the INP as a way of ensuring that cumulative noise impact from industrial growth is curtailed. This limit is referred to as the amenity goal. The appropriate limit in any circumstance relates to the land use category, for example, there are different limits for rural, suburban and urban areas. The table below presents the amenity criteria relevant to the receivers surrounding the proposed development site.

Table 8: INP Amenity Criteria - Recommended LAeq Noise Levels from Industrial Noise Sources [NSW INP Table 2.1]

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq(Period) Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface - for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note:

Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am

On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

The modification factors in Table 2.2 of the INP (summarised in the table below) are to be applied where the total existing LAeq noise level from *industrial* sources are within 6dB of the acceptable noise level (ANL) presented in the table above.

Table 9: Modification to Acceptable Noise Level (ANL)* to Account for Existing Level of Industrial Noise [NSW INP Table 2.2]

Total Existing LAeq noise level from Industrial Noise Sources	Maximum LAeq Noise Level for Noise from New Sources Alone, dB(A)
≥ Acceptable noise level plus 2	If existing noise level is likely to decrease in future: acceptable noise level minus 10 If existing noise level is unlikely to decrease in future: existing noise level minus 10
Acceptable noise level plus 1	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
< Acceptable noise level minus 6	Acceptable noise level

* ANL = recommended acceptable LAeq noise level for the specific receiver, area and time of day from Table 2.1 (INP)

From observations at the proposed development site, the current LAeq noise level measured at the proposed development site are dominated by a combination of existing industrial noise and traffic/rail noise, therefore the modifying factors in Table 2.2 above have been applied to the measured LAeq noise levels.

The following table presents the site specific noise production criteria from industrial noise sources, namely mechanical plant.

Table 10– LAeq Design Criterion for Noise Production (EPA INP)

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Time of Day	Rating Background Level (RBL) LA90	Intrusiveness Criterion (RBL+5)	Amenity Criterion - Acceptable	Measured LAeq Ambient Noise Levels	LAeq exceed amenity criterion?	Existing noise level likely to decrease in future?	Relevant modification to ANL?	Project Specific Design Criterion LAeq
Day (7am to 6pm)	36	41	60	57	No -3dB	No	Existing LAeq minus 3dB - 54 dB	41
Evening (6pm to 10pm)	39	44	50	57	Yes 7dB	No	Existing LAeq minus 10dB - 47dB	44
Night (10pm to 7am)	33	38	45	57	Yes 12dB	No	Existing LAeq minus 10dB - 47	38

Explanatory notes:

Column 3 – Recommended LAeq noise level based on 'Residence –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 - Measured in accordance with the INP

Column 7 - Determined from Table 2.2 of the INP

Column 8 – Project Specific Design Criterion based on EPA's INP. Lower of modified ANL and Intrusiveness Criteria

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

As a minimum requirement, walls and floors and separation of services shall comply with the National Construction Code - Building Code of Australia 2016 (BCA).

7.1.1 National Construction Code (NCC) Building Code of Australia 2016 - Class 2 & 3

The National Construction Code Series (NCC) 2016 - Volume 1, Building Code of sets out the following acoustic provisions for Class 2 and 3 buildings:

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 1276.1orISO717.1 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 (Ln,w) determined inaccordancewithASISO717.2usingresultsfromlaboratory 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; and

(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

(a) 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—

(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—

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

(ii) 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

(iii) comply with F5.3(b) if it separates—

(A) 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

(B) 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.

(e) Where a wall required to have sound insulation has a floor above, the wall must continue to—

(i) the underside of the floor above; or

(ii) a ceiling that provides the sound insulation required for the wall.

(f) Where a wall required to have sound insulation has a roof above, the wall must continue to—

(i) the underside of the roof above; or

(ii) a ceiling that provides the sound insulation required for the wall.

F5.6 Sound insulation rating of internal services

(a) 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—

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

(ii) 25 if the adjacent room is a kitchen or non-habitable room.

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

8 Conclusion

Renzo Tonin & Associates have completed an assessment of the potential traffic noise and rail noise impacts on the site at 92-96 Victoria Street, Werrington to support the rezoning application. In addition, relevant criteria for noise emission from the site has been determined.

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.

It has been determined that the internal criteria for the site is achievable thought standard acoustic treatments.

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 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 dB(A)	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.

B.2 SEPP (Infrastructure) 2007

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

4. 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.

5. 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.

6. 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:

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

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

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

APPENDIX C Noise Survey Results

C.1 Locations of short-term and long-term Noise Surveys

Figure 2: Site Location and Measurement Locations

- Long Term monitoring location
- Short Term monitoring location for rail vibration
- Short Term monitoring location for traffic noise

C.2 Results of the Short-term Noise Survey

Results of short-term train noise measurements along T1 Western Railway line are presented below.

Table 11 – Short-term Rail Noise Measurements - Train Pass-bys

Location	Date	Time	Train	Measured SEL
94 Victoria Road, Werrington	5th May 2016	9:59am	Passenger	76 dB(A)
		10:02am	Passenger	82 dB(A)
		10:02am	Passenger	75 dB(A)
		10:04am	Passenger	70 dB(A)
		10:06am	Passenger	78 dB(A)
		10:09am	Passenger	69 dB(A)
		10:19am	Passenger	75 dB(A)
		10:22am	Passenger	68 dB(A)
		10:23am	Passenger	75 dB(A)
		10:30am	Passenger	84 dB(A)
		10:34am	Passenger	81 dB(A)
		10:37am	Passenger	68 dB(A)
		10:38am	Passenger	77 dB(A)
		10:44am	Freight	86 dB(A)
		10:49am	Passenger	67 dB(A)
		10:52am	Passenger	79 dB(A)
		11:00am	Passenger	71 dB(A)
		11:04am	Passenger	69 dB(A)
		11:05am	Passenger	79 dB(A)
		11:10am	Passenger	69 dB(A)
		11:11am	Freight	88 dB(A)

C.3 Results of the Long-term Noise Surveys

Noise Monitoring Location 94 Victoria Street, Werrington

Survey Period: Thursday 28th April – Thursday 5th May 2016

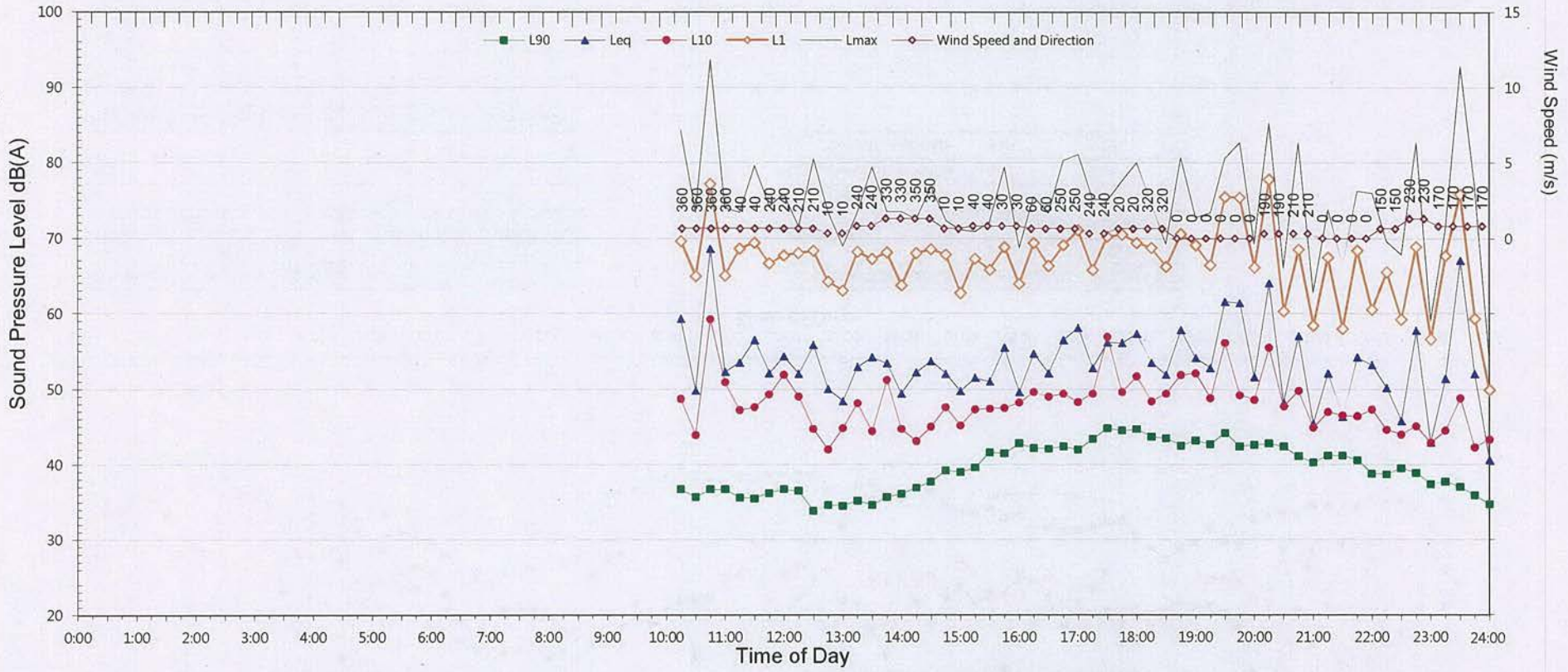
Positioned on the southern boundary, approximately 12m from the T1 Western Railway line.

Figure 3: Long Term Noise Survey Logger Setup

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Thursday, 28 April 2016



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	-	40.3	32.9
LAeq	-	57.1	56.7

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	73.4	to	92.8
L_{Max} - L_{eq} (Range)	22.1	to	31.6

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.4	59.2
$L_{eq\ 1hr}$ upper 10 percentile	65.1	63.7
$L_{eq\ 1hr}$ lower 10 percentile	54.7	39.1

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)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

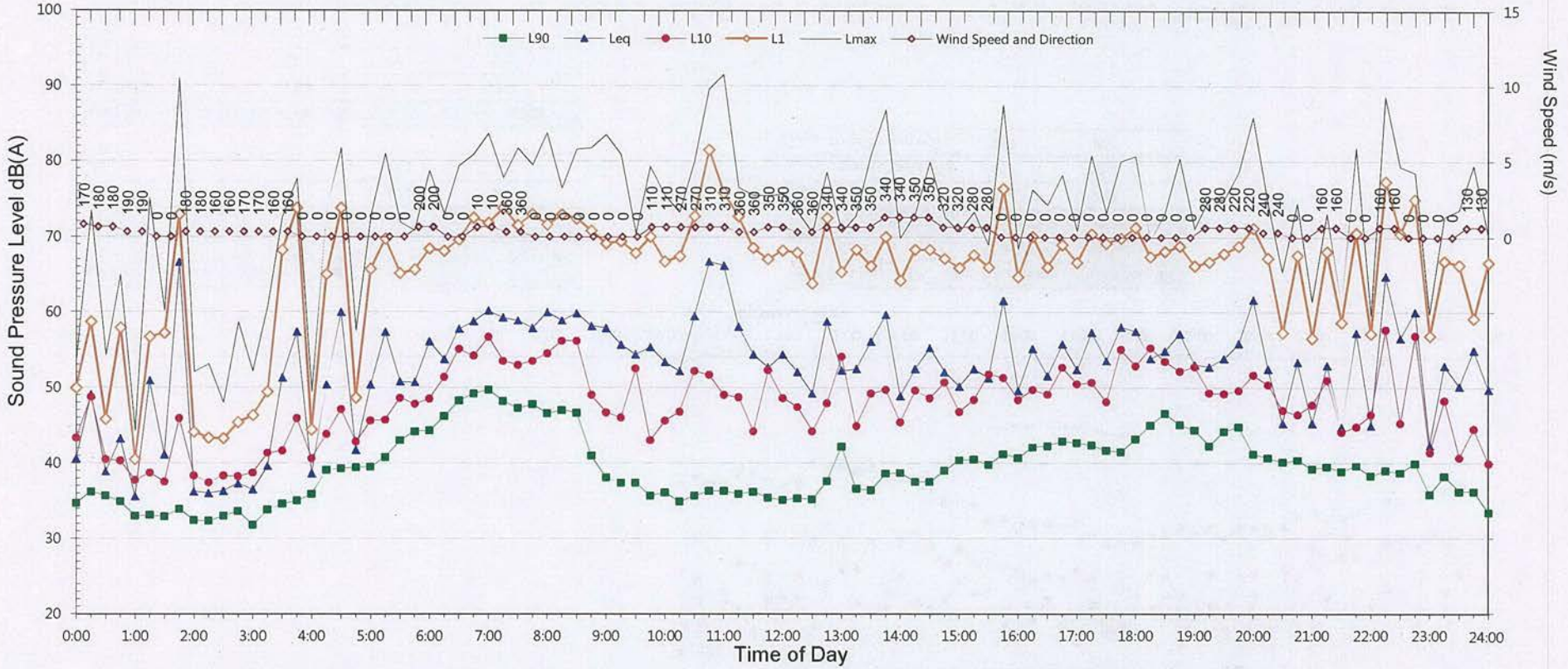
TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Friday, 29 April 2016



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4,5]
L_{90}	35.4	38.9	33.0
LAeq	57.9	54.8	57.1

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	75.2	to	96.7
L_{Max} - L_{eq} (Range)	24.0	to	33.7

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	59.6
$L_{eq\ 1hr}$ upper 10 percentile	64.7	65.5
$L_{eq\ 1hr}$ lower 10 percentile	54.4	50.0

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 $L_{A1,1hr}$ values are shown only where $L_{A1,1hr}$ >65dB(A) and where $L_{A1,1hr}$ - Leq ≥15dB(A)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

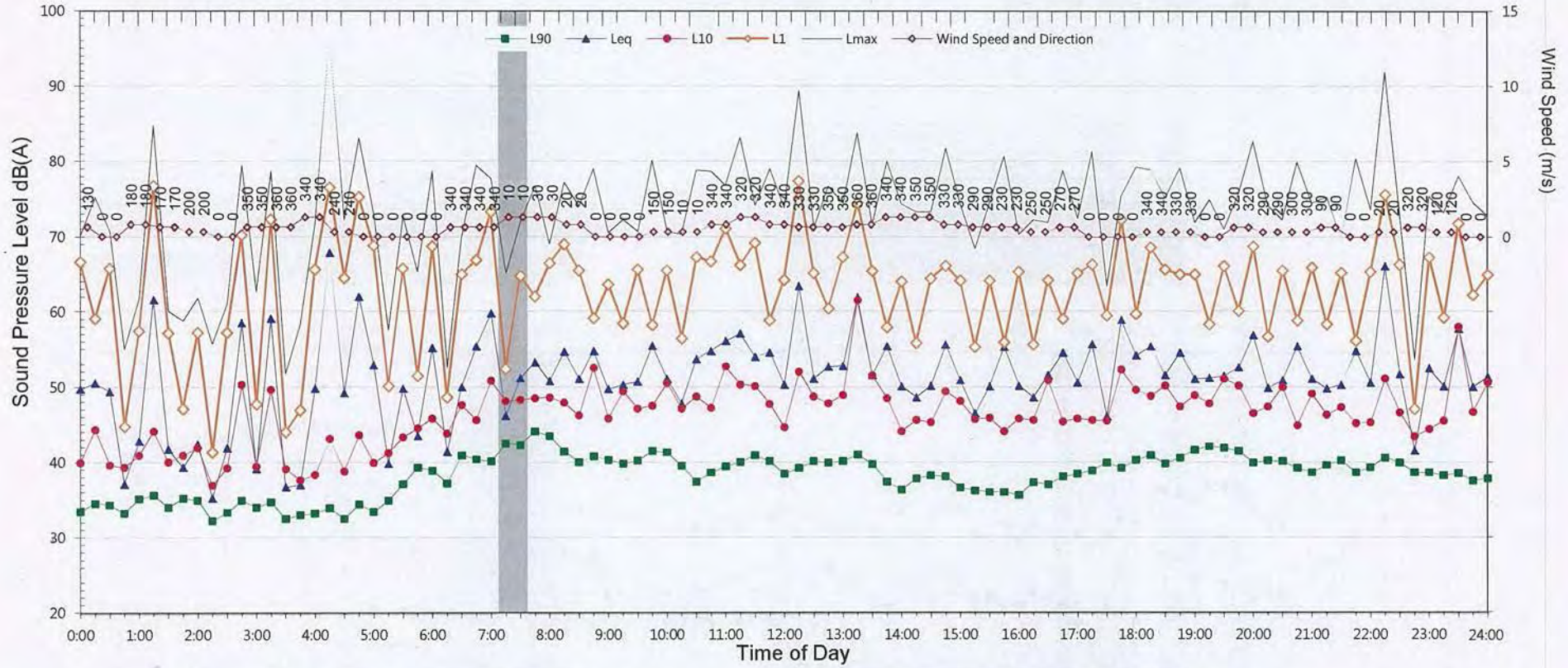
TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Saturday, 30 April 2016



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	36.3	38.6	29.7
LAeq	54.6	53.0	54.3

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	69.5	to	91.9
L_{Max} - L_{eq} (Range)	21.8	to	31.5

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	56.7	56.9
$L_{eq\ 1hr}$ upper 10 percentile	60.3	62.9
$L_{eq\ 1hr}$ lower 10 percentile	54.3	41.4

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 $L_{A1,Max}$ values are shown only where $L_{A1,Max}$ >65dB(A) and where $L_{A1,Max}$ - Leq ≥15dB(A)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

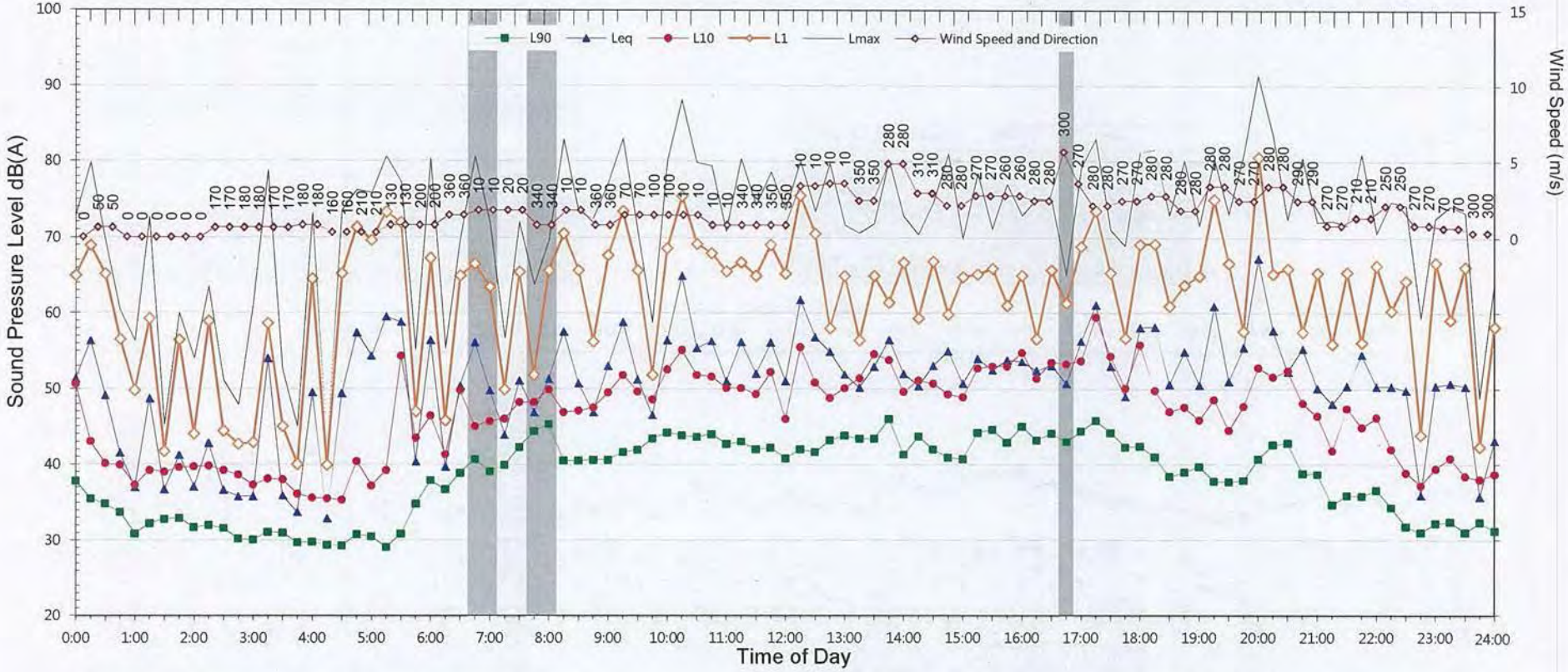
TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Sunday, 1 May 2016



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	40.6	35.8	30.2
LAeq	56.0	57.9	55.9

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	74.1	to	89.0
L_{Max} - L_{eq} (Range)	20.2	to	28.0

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.0	58.4
$L_{eq\ 1hr}$ upper 10 percentile	63.9	63.5
$L_{eq\ 1hr}$ lower 10 percentile	52.9	45.2

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)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

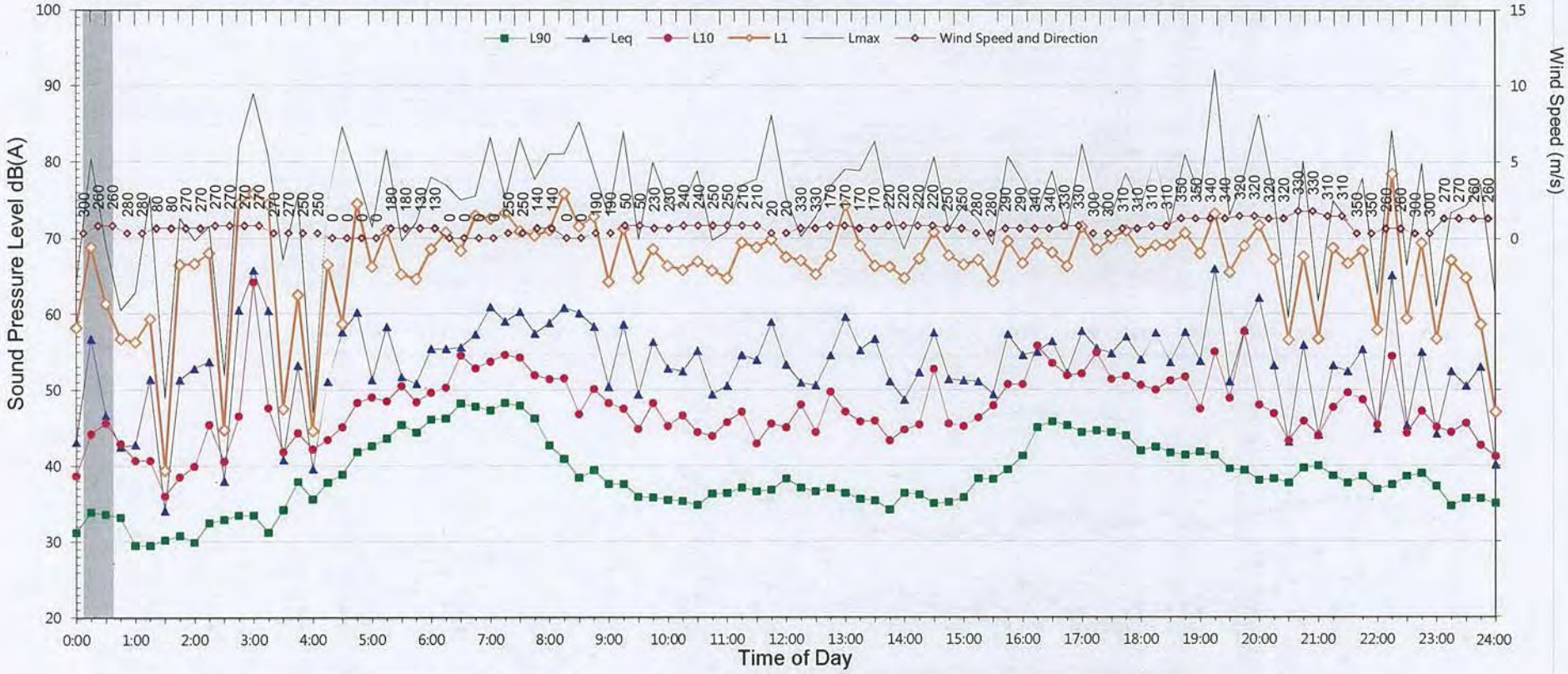
TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Monday, 2 May 2016



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	35.3	37.7	34.1
LAeq	55.9	57.7	56.1

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	75.9	to	87.9
L_{Max} - L_{eq} (Range)	24.3	to	28.2

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.0	58.6
$L_{eq\ 1hr}$ upper 10 percentile	63.3	62.7
$L_{eq\ 1hr}$ lower 10 percentile	54.7	50.2

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 $L_{A1,1hr}$ values are shown only where $L_{A1,1hr}$ >65dB(A) and where $L_{A1,1hr}$ - Leq ≥15dB(A)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

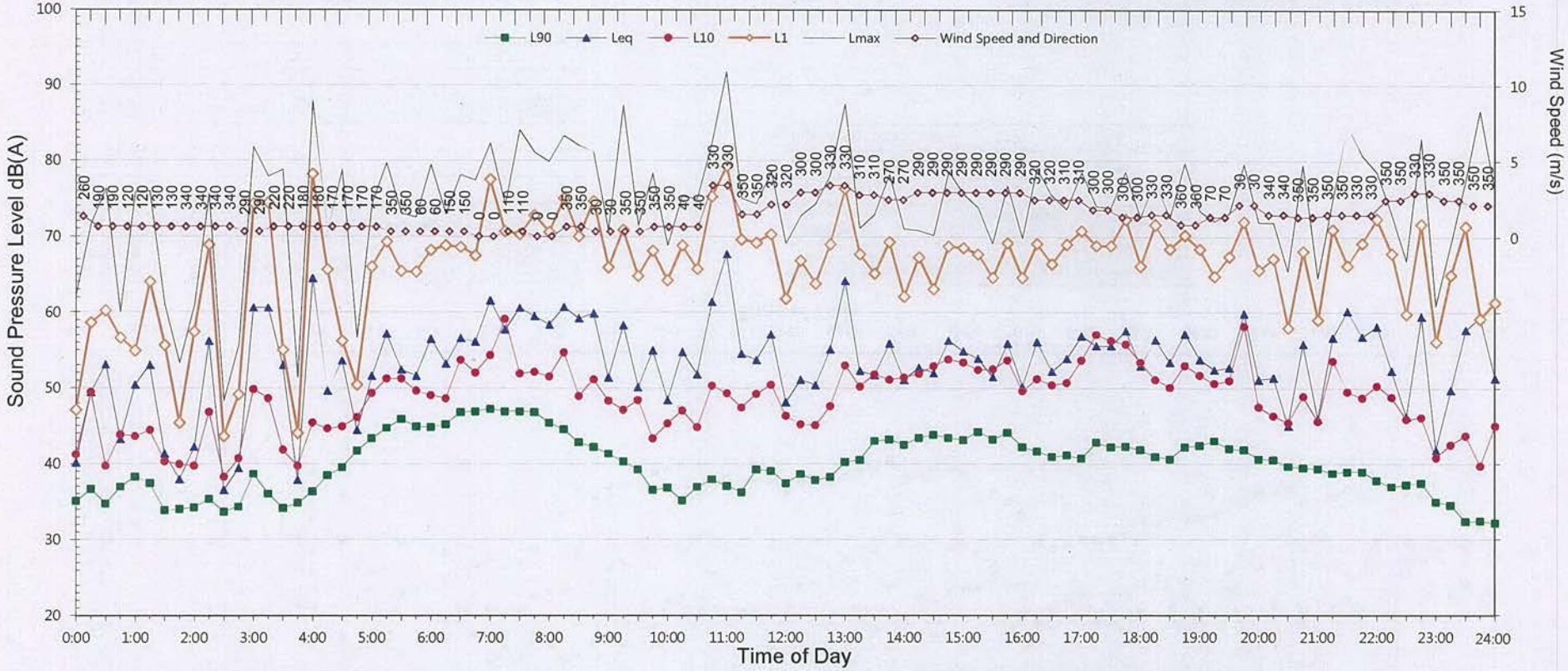
TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Tuesday, 3 May 2016



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	36.9	38.7	29.8
LAeq	57.6	55.8	57.2

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	72.1	to	92.4
L_{Max} - L_{eq} (Range)	24.2	to	31.5

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.7	59.7
$L_{eq\ 1hr}$ upper 10 percentile	63.9	64.1
$L_{eq\ 1hr}$ lower 10 percentile	55.0	47.5

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)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

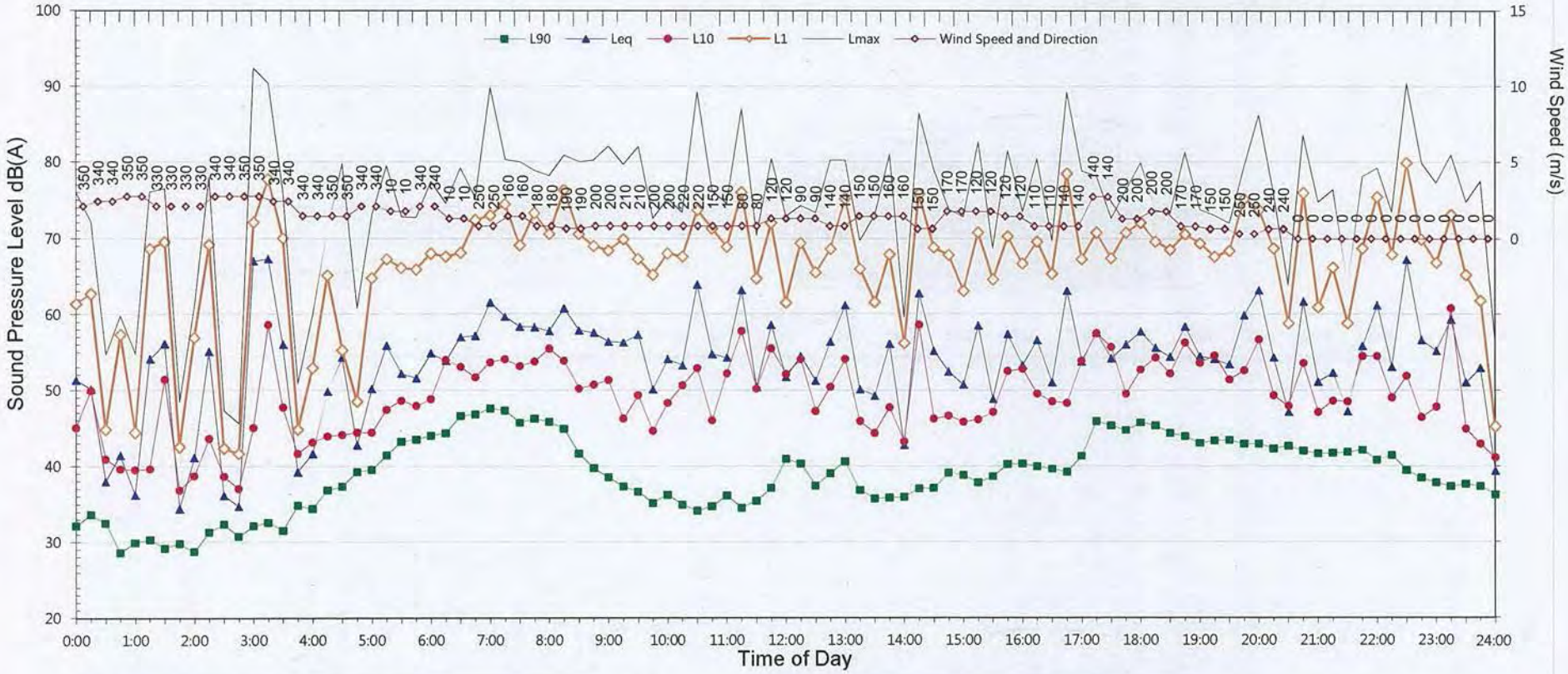
TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Wednesday, 4 May 2016



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{90}	35.1	41.6	33.2
LAeq	57.5	57.5	58.2

Night Time Maximum Noise Levels			(see note 7)
L_{Max} (Range)	75.3	to	93.8
L_{Max} - L_{eq} (Range)	18.1	to	30.9

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.0	60.7
$L_{eq\ 1hr}$ upper 10 percentile	61.8	65.4
$L_{eq\ 1hr}$ lower 10 percentile	56.3	40.3

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 $L_{A\,Max}$ values are shown only where $L_{A\,Max}$ >65dB(A) and where $L_{A\,Max}$ - Leq ≥15dB(A)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

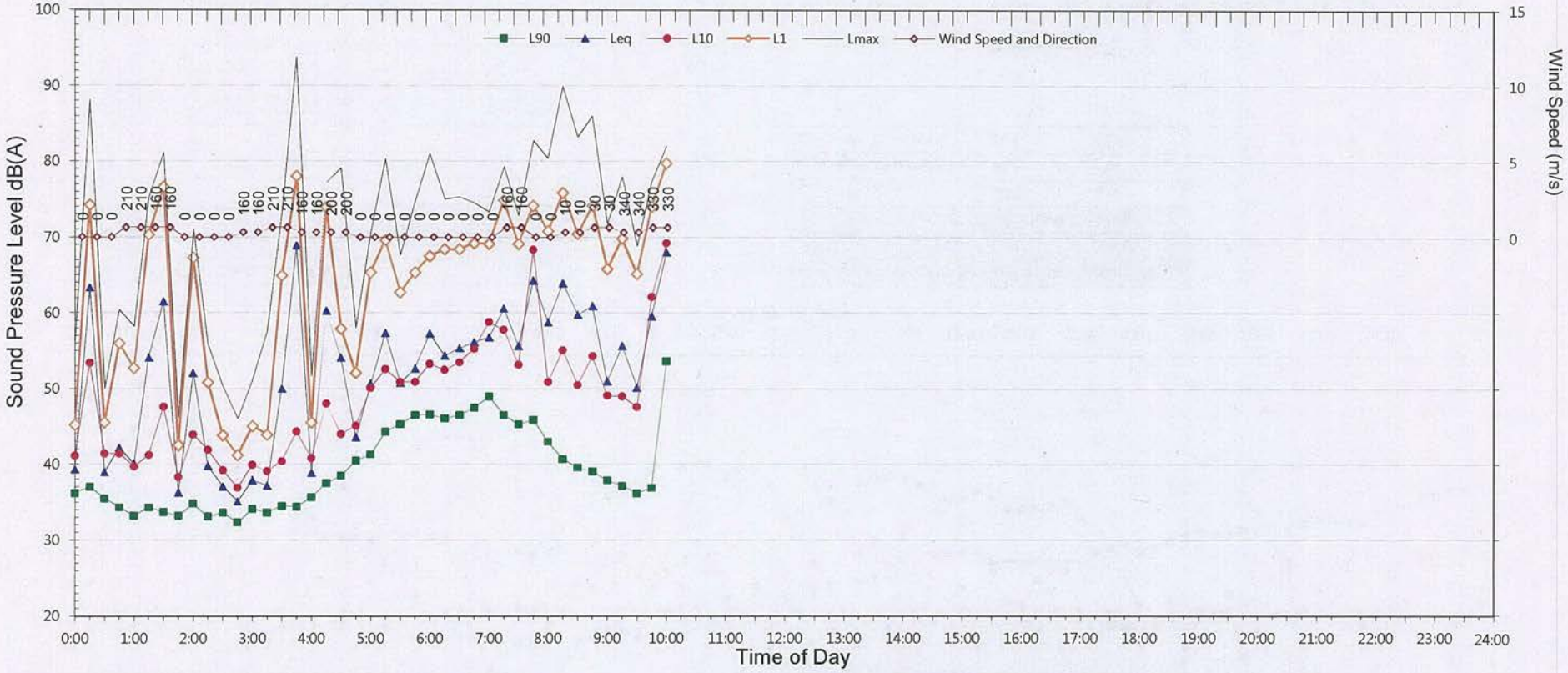
TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program

Unattended Noise Monitoring Results

92-94 Victoria Street, Werrington

Thursday, 5 May 2016



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 $L_{eq\ 9\ hr}$	64.1	-
$L_{eq\ 1hr}$ upper 10 percentile	65.3	-
$L_{eq\ 1hr}$ lower 10 percentile	63.3	-

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 $L_{A1,1hr}$ values are shown only where $L_{A1,1hr}$ >65dB(A) and where $L_{A1,1hr}$ - Leq ≥15dB(A)

Data File: 2016-04-28_SLM_000_123_Rpt_Report.txt

TJ065 Logger Graph

QTE-26 (rev 10) Logger Graphs Program