Transport Roads & Maritime Services

Showground Road upgrade: Carrington Road to Old Northern Road, Castle Hill

Review of Environmental Factors

Volume 2 - Appendices D to I

MARCH 2014

RMS xx .xxx ISBN xxxxxxxxxxx

Appendices

Appendices – Volume 2

Appendix D Noise and vibration assessment

Appendix E Drainage investigation

Appendix F Biodiversity assessment

Appendix G Aboriginal heritage

Appendix H Non-Aboriginal heritage assessment

Appendix I Urban design and visual impact assessment

Appendix D Noise and vibration assessment

Consultants in Acoustics, Vibration & Structural Dynamics
email: sydney@renzotonin.com.au
website: www.renzotonin.com.au

SHOWGROUND ROAD UPGRADE - CARRINGTON ROAD TO OLD NORTHERN ROAD

NOISE AND VIBRATION ASSESSMENT

TG356-01F03 (REV 4) NOISE AND VIBRATION ASSESSMENT

11 MARCH 2014

Prepared for:

Roads & Maritime Services - Infrastructure Development

Sydney (Head Office)
Renzo Tonin & Associates (NSW) Pty Ltd
ABN 29 117 462 861
1/418A Elizabeth St., SURRY HILLS, NSW 2010
PO Box 877 STRAWBERRY HILLS, NSW 2012
Ph (02) 8218 0500 Fax (02) 8218 0501

Melbourne
Brisbane
Gold Coast
Kuwait

DOCUMENT CONTROL

Date	Revision History	Non-Issued Revision	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
01.11.2013	Draft	0	1	RP	MG	PK
20.12.2013	Final draft		2	MG		MG
23.01.2014	Final		3	MG		MG
11.03.2014	Final #2		4	RP		PK

CONTENTS

1 INTRODUCTION 6

2 PROJECT DESCRIPTION 7

2.1 Background 7

2.2 Project Key Features 7

2.3 Land Uses 8

3 EXISTING NOISE ENVIRONMENT 10

3.1 Noise Catchment Areas 10

3.2 Existing Ambient Noise Conditions 11

3.2.1 Noise Monitoring Locations 11

3.2.2 Measured Noise Levels 12

4 NOISE CRITERIA 14

4.1 Operational Traffic Noise Criteria 14

4.1.1 Residential Land Uses 14

4.1.2 Sensitive Land Use Developments 14

4.2 Relative Increase Criteria 16

4.3 Maximum Noise Level Criteria 16

5 OPERATIONAL NOISE ASSESSMENT 17

5.1 Traffic Flow and Composition Summary 17

5.1.1 Existing Traffic Volumes 17

5.1.2 Opening and Design Year Traffic Volumes 17

5.2 Road Traffic Noise Prediction Modelling 18

5.3 Model Validation 19

5.4 Noise Model Prediction Results 19

5.5 Noise Contours 20

5.6 Road Traffic Noise Mitigation Options 20

5.6.1 Quieter Pavements 21

5.6.2 Noise Barriers 22

5.6.3 At-Property Treatment 22

5.7 Bus Stops 23

5.8 New Traffic Signals at Rowallan Ave & Kentwell Ave/Cheriton Ave. 23

6 MAXIMUM NOISE LEVEL ASSESSMENT 25

7 CONSTRUCTION NOISE ASSESSMENT 27

7.1 Construction Noise Objectives 27

7.1.1 Construction Noise Management Levels at Residences 27

7.1.2 Construction Noise Management Levels at Other Sensitive Land Uses 28

7.1.3 Sleep Disturbance 30

7.2 Construction Activities 30
7.3 Construction Noise Sources 31
7.4 Predicted Noise Levels 32
7.5 Construction Noise Mitigation Options 36
7.5.1 Standard Noise and Vibration Management Measures 36
7.5.2 Additional Airborne Noise Mitigation Measures 38
7.5.3 Noise Monitoring 39
7.5.4 Complaints Handling Procedure 39
8 CONSTRUCTION VIBRATION ASSESSMENT 40
8.1 Construction Vibration Objectives 40
8.1.1 Disturbance to Buildings Occupants 40
8.1.2 Structural Damage to Buildings 42
8.2 Vibration Sources 42
8.3 Potential Vibration Impacts to Residential and Commercial Uses 44
8.4 Potential Vibration Impacts to Heritage Listed Properties 44
8.5 Vibration Mitigation 45
8.5.1 Recommended Minimum Buffer Distances for Residential/Commercial Properties 45
8.5.2 Vibration Management Measures 45
9 CONCLUSION 47
10 REFERENCES 48
APPENDIX A - GLOSSARY OF ACOUSTIC TERMS 49
APPENDIX B - NOISE MONITORING METHODOLOGY 51
B.1 Noise Monitoring Equipment 51
B.2 Meteorology during Monitoring 51
B.3 Noise vs Time Graphs 51
APPENDIX C - OPERATIONAL NOISE PREDICTIONS (WITHOUT MITIGATION) 52
APPENDIX D - NOISE CONTOURS 59
APPENDIX E - ACUTE PROPERTIES 64
APPENDIX F - MEASURED NOISE DATA 67

List of Tables

Table 1 - Noise Catchment Areas 10

Table 2 – Noise Monitoring Locations 11

Table 3 – Results of Long Term Noise Monitoring 12

Table 4 – Road Traffic Noise Assessment Criteria for Residential Land Uses 14

Table 5 – Road Traffic Noise Assessment Criteria for Non-Residential Land Uses 15

Table 6 – Relative Increase Criteria 16

Table 7 – Existing 2013 Traffic Volumes and Compositions 17

Table 8 – Showground Road Future Traffic Volumes 17

Table 9 - Summary of Modelling Inputs 18

Table 10 - Noise Model Validation 19

Table 11 – Summary of Operational Noise Model Results 20

Table 12 - Residential At-Property Treatment Options 23

Table 13 - Maximum Noise Levels at Night 26

Table 14 - Noise Management Levels at Residential Receivers 27

Table 15 - Construction Noise Management Levels at Residential Receivers 28

Table 16 - Noise Management Levels at Other Noise Sensitive Land Uses 29

Table 17 – Other Sensitive Receivers 29

Table 18 - Construction Activity & Equipment List 30

Table 19 - Typical Construction Equipment & Sound Power Levels 31

Table 20 - Predicted L_{Aeq} Construction Noise Levels (Residential) 33

Table 21 - Predicted L_{Aeq} Construction Noise Levels (Other Sensitive Receivers) 34

Table 22 - Predicted L_{Amax} Construction Noise Levels for Night Works (Residential) 35

Table 23 – Standard Mitigation Measures to Reduce Construction Noise and Vibration 36

Table 24 - Additional Airborne Noise Mitigation Measures 38

Table 25 – Types of Vibration 40

Table 26 – Preferred and Maximum Levels for Human Comfort 41

Table 27 – DIN 4150-3 Structural Damage Criteria 42

Table 28 – Typical Ranges of Construction Plant Vibration Levels 43

Table 29 – Potential Vibration for Residential/Commercial Properties 44

Table 30 – Potential Vibration for Heritage Properties 44

Table 31 - Recommended Minimum Working Distances for Vibration Intensive Plant 45

1 INTRODUCTION

Showground Road runs between Old Northern Road and Windsor Road, at Castle Hill. It is generally a four-lane road between Old Northern Road and Pennant Street and between Carrington Road and Windsor Road. The section between Carrington Road and Pennant Street is generally only one lane in each direction and is congested in peak periods. The NSW Roads and Maritime Services (RMS) propose to widen approximately 1.5 kilometres of Showground Road, between Carrington Road and Pennant Street, Castle Hill.

Renzo Tonin & Associates were engaged to conduct an environmental noise and vibration assessment for the proposed Showground Road upgrade. Noise emissions from road traffic have been calculated and assessed at the potentially most affected residential receivers in accordance with the NSW Road Noise Policy (RNP) and the Roads and Maritime Services' Environmental Noise Management Manual (ENMM). Noise and vibration associated with the construction phase of the project has also been assessed in accordance with the NSW Interim Construction Noise Guideline (ICNG).

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.

2 PROJECT DESCRIPTION

2.1 Background

Showground Road provides a major road link between the Castle Hill shopping centre/commercial precinct (Castle Hill centre) and Sydney's North West Growth Centre. It provides a link between the Castle Hill centre to the east, and the Castle Hill Trading Zone (located around Victoria Avenue), Norwest, and the Bella Vista business park to the west. Once the North West Rail Link is constructed, Showground Road will also provide a key road traffic link to Showground and Castle Hill stations.

The NSW Roads and Maritime Services (RMS) propose to widen Showground Road between Carrington Road and Old Northern Road to relieve current congestion and meet the projected future traffic demand.

2.2 Project Key Features

The key features of the proposal are shown in Figure 1 and include:

- Widening and upgrading about 1.5 kilometres of Showground Road from a two lane partially divided carriageway to a four lane divided carriageway, to connect with the existing four lane section west of Carrington Road and east of Pennant Street.
- Upgrading the existing carriageway and associated drainage amplification and pavement strengthening work to create a four lane divided carriageway between Carrington Road and Rowallan Avenue.
- Widening the carriageway and associated works to the north to create a four lane divided carriageway between Rowallan Avenue and Kentwell Avenue.
- Widening the carriageway and associated works to the south to create a four lane divided carriageway between Kentwell Avenue and Pennant Street.
- Modifying the intersections of Showground Road with Britannia Road, Rowallan Avenue, Cecil Avenue, Kentwell Avenue/Cheriton Avenue and Pennant Street.
- Providing left-in / left-out restrictions at the intersection of Showground Road and Britannia Road.
- Providing new sets of traffic lights at the intersections of Showground Road with:
  - Rowallan Avenue.
  - Kentwell Avenue/Cheriton Avenue.
- Removing the existing pedestrian controlled traffic lights at the intersection of Showground Road and Cecil Avenue.

- Modifying the existing signals at the intersection of Showground Road and Pennant Street.
- Providing bus priority measures in the eastbound direction at the intersections of Showground Road with Rowallan Avenue, Kentwell Avenue and Pennant Street.
- Constructing a 2.5 metres wide shared footpath and cycleway along the northern side of Showground Road.
- Constructing a 1.5 metres wide footpath along the southern side of Showground Road.
- Adjusting property accesses to be compatible with the road widening proposal.
- Relocating and/or adjusting utility services that are in conflict with the road widening proposal.

2.3 Land Uses

The proposal is located within The Hills Shire local government area (LGA) and RMS Sydney region. The study area within which the proposal site is located includes a mix of residential, commercial, recreation, education and other institutional land uses. The proposal site is located mainly within the existing road corridor of Showground Road.

The proposal site is surrounded mainly by residential and commercial land uses. Adjoining land uses include:

- Detached residential dwellings and scattered commercial activities to the north.
- A mix of detached dwellings, residential apartment buildings and commercial activities to the south.
- Castle Towers shopping centre is located about 200 metres from the eastern extent of the proposal site.

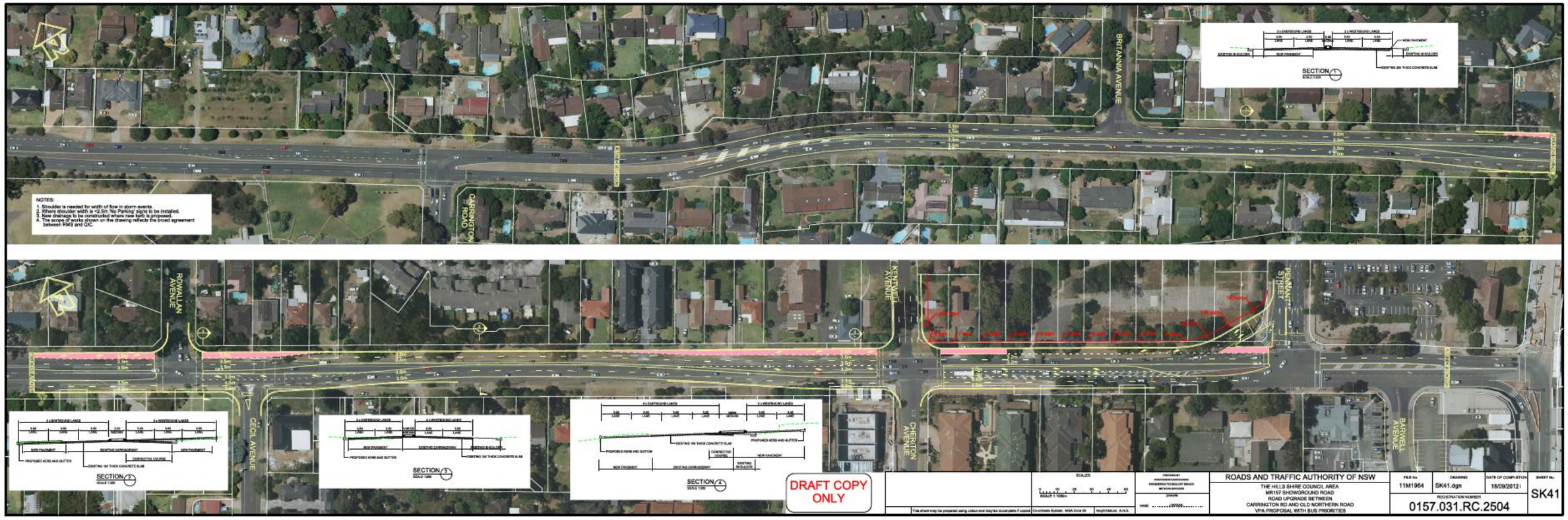


Figure 1 - Project Proposal

3 EXISTING NOISE ENVIRONMENT

3.1 Noise Catchment Areas

To facilitate the assessment of noise impacts from the proposed Showground Road Upgrade, noise sensitive receiver areas along the route have been divided into Noise Catchment Areas (NCAs).

NCAs are areas that are likely to have similar noise exposures, on the basis of factors such as topography, road design (cuttings, embankments, intersections etc), setbacks and types of residences or other noise receptors.

The NCAs identified for this project are described in Table 1 and shown on Figure 2.

Table 1 - Noise Catchment Areas

NCA	Location	Description
NCA 1	Carrington Rd – Britannia Rd (northern side of Showground Rd)	• Detached residential dwellings and commercial receivers • Typical setbacks of approximately 15m • Elevation of receiver floor level varies, above road level near Carrington Rd, lower than road level towards Britannia Rd
NCA 2	Carrington Rd – Britannia Rd (southern side of Showground Rd)	• Detached residential dwellings and commercial receivers • Typical setbacks of approximately 15m • Typically raised elevation above Showground Road
NCA 3	Britannia Rd – Rowallan Ave (northern side of Showground Rd)	• Detached residential dwellings and commercial receivers • Typical setbacks of approximately 15m • Elevation of receiver floor level typically lower than road level
NCA 4	Britannia Rd – Rowallan Ave (southern side of Showground Rd)	• Detached residential dwellings and commercial/childcare receivers • Typical setbacks of approximately 20m from Showground Rd • Elevation of receiver floor level typically higher than road level
NCA 5	Rowallan Ave – Kentwell Ave (northern side of Showground Rd)	• Detached residential dwellings and church receivers. • Typical setbacks of approximately 15-20m • Elevation of receiver floor level typically similar to road level
NCA 6	Rowallan Ave – Kentwell Ave (southern side of Showground Rd)	• Detached residential dwellings and commercial receivers • Typical setbacks of approximately 20-25m • Typically raised receiver elevation
NCA 7	Kentwell Ave – Old Northern Rd (northern side of Showground Rd)	• Detached residential dwellings • Typical setbacks of approximately 20m • Vacant lot 4-22 Showground Rd (previously public school) • Elevation of receiver floor level typically similar to road level
NCA 8	Kentwell Ave – Old Northern Rd (southern side of Showground Rd)	• Multi story residential apartments and church receivers • Typical setbacks of approximately 20m • Elevation of receiver floor level typically similar to road level

3.2 Existing Ambient Noise Conditions

The ambient noise environment in the study area is controlled by traffic noise from Showground Road. Long-term noise monitoring was conducted to quantify ambient noise levels. The purpose of the noise monitoring is to establish:

- existing traffic noise levels for benchmarking and validation of the operational noise model, and
- background noise levels for the setting of construction noise goals for the project.

3.2.1 Noise Monitoring Locations

Long-term noise monitoring was conducted from Friday 6th to Tuesday 17th September 2013. The following monitoring locations were selected as being representative of the various NCA's along the project route. The monitoring locations are shown in Figure 2.

Inspections of properties in NCA 4 and NCA 7 were conducted however none were suitable due to local construction works, front fences, verandas and conversion of residences to business uses. Nonetheless the six selected locations are sufficient for characterising the existing noise environment and allowing calibration of the noise model.

Table 2 – Noise Monitoring Locations

Location	NCA	Address	Description
M1	1	100 Showground Rd	Northern Side of Showground Road. Noise monitor installed in front yard in the free field near property boundary at road.
M2	2	115 Showground Rd	Southern Side of Showground Road. Noise monitor installed 1m from front facade facing Showground Road.
M3	3	86 Showground Rd	Northern Side of Showground Road. Noise monitor installed in front yard in the free field near property boundary at road.
M4	5	48 Showground Rd	Northern Side of Showground Road. Noise monitor installed in front yard in the free field near property boundary at road.
M5	6	49 Showground Rd	Southern Side of Showground Road. Noise monitor installed 1m from front facade facing Showground Road.
M6	8	23-25 Showground Rd	Southern Side of Showground Road. Noise monitor installed 1m from front facade facing Showground Road.

3.2.2 Measured Noise Levels

The noise monitoring methodology is described in Appendix B. A summary of the long-term noise monitoring results are in Table 3 below, and the graphical outputs from the noise monitors are presented in Appendix F.

Table 3 – Results of Long Term Noise Monitoring

Location	Address	L_{Aeq} Traffic Noise Levels		L_{A90} Background Noise Levels		
		Day, $L_{Aeq,15hr}$	Night, $L_{Aeq,9hr}$	Day	Evening	Night
M1	100 Showground Rd	71	66	62	57	31
M2	115 Showground Rd	68	63	60	52	28
M3	86 Showground Rd	72	67	62	55	31
M4	48 Showground Rd	72	67	62	54	30
M5	49 Showground Rd	68	63	60	51	31
M6	23-25 Showground Rd	66	61	58	50	34

Figure 2 - Project Noise Catchment Areas and Noise Monitoring Locations

4 NOISE CRITERIA

4.1 Operational Traffic Noise Criteria

This report assesses road traffic noise impact in accordance with the NSW 'Road Noise Policy' (RNP) and RMS' (ex RTA's) 'Environmental Noise Management Manual' (ENMM). Showground Road is currently classed as an arterial road in that it handles through traffic bound for another locality and has characteristically heavy and continuous traffic flows.

According to the ENMM, this project does not constitute a 'new road traffic noise source' because the road is not new and does not produce noise to receptors from a different direction. The project is within the existing road corridor and therefore the project is classed as a 'road redevelopment'.

4.1.1 Residential Land Uses

The RNP is used to assess the potential traffic noise impact from a redevelopment of road infrastructure. The 'redevelopment' criteria for residential type receivers, as set out in the RNP apply and are presented in the table below. These criteria are for assessment against noise levels when measured in front of a building facade, or facade corrected noise levels when measured in the free-field.

Table 4 – Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Development	Assessment Criteria, dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by noise from redevelopment of existing freeway / arterial / sub-arterial roads	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)

Where feasible and reasonable, noise levels from existing roads would be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulations of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

The criteria set out above are the target noise levels that the road redevelopment project would try to achieve. All feasible and reasonable noise mitigation measures would be considered in the design of the project.

4.1.2 Sensitive Land Use Developments

The RNP also sets guidelines for the assessment of traffic noise on sensitive land uses such as schools, hospitals, places of worship and recreation areas. The noise assessment criteria are presented in Table 5 below.

Table 5 – Road Traffic Noise Assessment Criteria for Non-Residential Land Uses

	Existing sensitive land use	Assessment Criteria, dB(A)		Additional considerations
		Day (7am-10pm)	Night (10pm-7am)	
1.	School classrooms	$L_{Aeq,1hour}$ 40 (internal) when in use	–	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
2.	Hospital wards	$L_{Aeq,1hour}$ 35 (internal)	$L_{Aeq,1\ hour}$ 35 (internal)	
3.	Places of worship	$L_{Aeq,1hour}$ 40 (internal)	$L_{Aeq,1\ hour}$ 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise. For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see point 5) may be applied.
4.	Open space (active use)	$L_{Aeq,15hour}$ 60 (external) when in use		Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. playing chess, reading. In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, e.g. school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
5.	Open space (passive use)	$L_{Aeq,15hour}$ 55 (external) when in use		
6.	Childcare facilities	Sleeping rooms $L_{Aeq,1hour}$ 35 (internal) Indoor play areas $L_{Aeq,1hour}$ 40 (internal) Outdoor play areas $L_{Aeq,1hour}$ 55 (external)	–	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
7.	Aged care facilities	–	–	Residential land use noise assessment criteria should be applied to these facilities

Notes: Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for sensitive developments near busy roads.

It is generally accepted that most buildings provide a noise reduction of at least 10dB(A) when windows are left 20% open, without providing additional treatment. Therefore where the noise goals are internal, a 10dB(A) reduction from external noise levels to internal noise levels has been adopted to allow an external assessment.

4.2 Relative Increase Criteria

The traffic noise impact from the proposed road 'redevelopment' would need to also comply with the 'Relative Increase Criteria' as discussed in Section 2.4 of the RNP. The relative increase criteria are to be applied to the external areas of existing residential and sensitive land uses impacted upon by the redeveloped road.

The relative increase criteria as set out in the RNP applicable to this project are reproduced below and apply for all NCAs.

Table 6 – Relative Increase Criteria

Type of Development	Total Traffic Noise Level Increase, dB(A)
Redevelopment of existing road	Existing Traffic $L_{Aeq(period)}$ + 12 dB (external)

Note: 'Existing traffic' refers to the traffic noise levels for the relevant 'no build' option

Receivers alongside Showground Road are already exposed to high levels of traffic noise. Since this project is an upgrade of an existing road and only minor changes to the road width and alignment are being proposed, noise modelling presented in Appendix C shows that the noise level change at any receiver between the build and no build scenarios is small, well below 12dB(A). There are no locations where the project will cause an increase of more than 12dB over the existing noise levels. The project therefore complies with the relative increase criteria.

4.3 Maximum Noise Level Criteria

The RNP does not specify a night-time L_{max} noise limit or noise goal. This is primarily because research conducted to date in this field has not been definitive and the relationship between maximum noise levels, sleep disturbance and subsequent health effects is not currently well defined.

According to the policy however, the likely maximum or peak noise levels are to be broadly assessed and reported for the night-time period, which is considered by the NSW Environment Protection Authority (EPA) as being 10pm to 7am.

5 OPERATIONAL NOISE ASSESSMENT

5.1 Traffic Flow and Composition Summary

5.1.1 Existing Traffic Volumes

Traffic counts of Showground Road within the project area were conducted concurrently with the long term noise monitoring in September 2013 to allow validation of the computer noise model. The results of the traffic survey are summarised in Table 7 below.

Table 7 – Existing 2013 Traffic Volumes and Compositions

ROAD	DAY (7:00 – 22:00)			NIGHT (22:00 – 7:00)		
	Volume	HV%	Speed km/h	Volume	HV%	Speed km/h
Showground Road (West Bound)	16,274	0.7	61	1,762	0.8	66
Showground Road (East Bound)	15,826	1.0	60	1,890	2.1	69

Notes:
HV% = percentage of heavy vehicles

5.1.2 Opening and Design Year Traffic Volumes

Traffic data for Showground Road has been provided by Roads and Maritime Services (RMS) for future years 2016 (Year of Opening) and 2026 (Design Year) as shown in Table 8. This data was utilised for the purpose of noise modelling predictions.

Table 8 – Showground Road Future Traffic Volumes

Showground Road Location	Direction	2016 (Year of Opening)					2026 (Design Year)				
		Day time 7:00 – 22:00		Night time 22:00 – 7:00		Speed km/h	Day time 7:00 – 22:00		Night time 22:00 – 7:00		Speed km/h
		Volume	HV%	Volume	HV%		Volume	HV%	Volume	HV%	
West of Carrington Road	EB	23363	1.0	2673	1.8	60	24640	1.0	2820	1.8	60
	WB	17599	1.0	2014	1.8	60	19411	1.0	2221	1.8	60
West of Britannia Road	EB	27676	1.0	3167	1.8	60	29508	1.0	3377	1.8	60
	WB	21664	1.0	2479	1.8	60	23931	1.0	2738	1.8	60
West of Rowallan Avenue	EB	26519	1.0	3035	1.8	60	28271	1.0	3235	1.8	60
	WB	21658	1.0	2478	1.8	60	23924	1.0	2738	1.8	60
West of Kentwell Avenue	EB	25656	1.0	2936	1.8	60	27294	1.0	3123	1.8	60
	WB	22614	1.0	2588	1.8	60	24667	1.0	2823	1.8	60
West of Pennant Street	EB	17057	1.0	1952	1.8	60	18555	1.0	2123	1.8	60
	WB	20060	1.0	2295	1.8	60	22567	1.0	2582	1.8	60
West of Old Northern Road	EB	12016	1.0	1375	1.8	60	13213	1.0	1512	1.8	60
	WB	12036	1.0	1377	1.8	60	16282	1.0	1863	1.8	60

The proposal is a road redevelopment essentially involving the addition of lanes within the existing road corridor. It is assumed that RMS has included traffic generation from known future developments into their volume forecasts and that the same volume of traffic will use the road whether or not the project is built. Therefore the noise models for both the 'build' and 'no build' options utilise the same traffic data.

5.2 Road Traffic Noise Prediction Modelling

Noise predictions are based on a method developed by the United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)" known as the CoRTN (1988) method. This method has been adapted to Australian conditions and extensively tested by the Australian Road Research Board and as a result it is recognised and accepted by the NSW Environment Protection Authority. The model predicts noise levels for steady flowing traffic and noise from high truck exhausts is also taken into account.

The CoRTN algorithms are contained within the 'CadnaA' noise modelling software which has been used to calculate traffic noise levels at receivers. The noise prediction model takes into account the following inputs.

Table 9 - Summary of Modelling Inputs

Input Parameters	Data Acquired From
Traffic volumes and mix	Based on forecast data from RMS and traffic counts
Vehicle speed	Validation model: Based on measured 85th percentile speeds during traffic counting Future Model: 60km/h
Gradient of roadway	Topographic data provided by RMS
Source height	0.5 metre for car exhaust, 1.5 metres for car and truck engines and 3.6 metres for truck exhaust and detailed within CORTN88
Ground topography at receiver and road	2m Ground Contours obtained from NSW Land & Property Information (LPI)
Angles of view from receiver	Contained within model
Reflections from existing barriers, structures and cuttings on opposite side of road	Calculated in CadnaA through CoRTN algorithm
Ground absorption	0.75 [can vary between 0 (hard surface) to 1 (soft ground)]
Receiver Heights	1.5 metre above ground level for ground floor and 4.5 metre above ground level for 1st floor
Facade correction	+2.5dB(A)
Correction for Australian conditions	LAeq,15h: -1.7 dB(A) for 'at facade' conditions from Australian Road Research Board (ARRB) Transport Research (Saunders et al 1983) LAeq,9h: No Australian Conditions correction applied
Acoustic properties of road surfaces	Dense graded asphalt – no corrections applied
Noise mitigation measures	Existing significant fences included in noise model

5.3 Model Validation

The noise model was validated using the long-term noise monitoring results. Table 10 below summarises the results of the validation, providing a comparison of the modelled traffic noise levels for existing conditions compared to the measured traffic noise levels.

Table 10 - Noise Model Validation

Location	$L_{Aeq,15hr}$ Daytime Noise Level			$L_{Aeq,9hr}$ Night time Noise Level		
	Measured	Modelled	Variation	Measured	Modelled	Variation
100 Showground Rd	71	71	-0.1	66	66	0.6
115 Showground Rd	68	68	0.0	63	63	-0.3
86 Showground Rd	72	71	0.6	67	66	1.3
48 Showground Rd	72	71	0.9	67	66	0.8
49 Showground Rd	68	68	0.0	63	63	-0.1
2/23-25 Showground Rd	66	67	-1.5	61	63	-1.6
Mean Variation			0.0			0.1

The noise model validation results show that the noise model outputs are in very good agreement with the noise monitoring and there is a high level of confidence that can be placed on the noise model for predicting future traffic noise levels. No model calibration corrections were considered necessary to apply to the noise model when generating the operational noise predictions for future traffic noise scenarios.

5.4 Noise Model Prediction Results

Operational noise modelling has been conducted based on the traffic volumes presented in Section 5.1. The scenarios predicted are:

- **'Opening Year',** where noise levels are the levels produced by the 2016 traffic volumes for both the 'build' and 'no build' options, for the day and night.
- **'Design Year',** where noise levels are the predicted noise levels for 2026 for both the 'build' and 'no-build' options, for the day and night periods.

The outcomes of noise modelling are:

- The increase in noise levels between the design year 'no build' and 'build' options is not more than 2dB(A) at any residence and therefore the impact associated with increased noise from the project is considered minor.
- Existing noise levels at receivers fronting Showground Road along the project route typically exceed the 'acute' criteria of 65dB(A) $L_{Aeq,15h}$ and/or 60dB(A) $L_{Aeq,9h}$,
- Design year noise levels were found to also be 'acute' at a number of residential receivers, particularly those fronting Showground Road. The 'acute' properties are identified in Appendix C.

Further noise mitigation would be considered where design year noise levels are acute, that is greater than or equal to $L_{Aeq,15hr}$ 65dB(A) or $L_{Aeq,9hr}$ 60dB(A), or where noise levels exceed the RNP criteria and have increased by more than 2dB(A) as a result of the project following consideration of feasible and reasonable measures.

The predicted noise levels produced by the noise model are shown in detail in Appendix C. A summary of the results is shown in Table 11. Specific properties where further noise mitigation would be considered are identified in Appendix C and a discussion of possible noise mitigation options is presented in Section 5.6. Appendix E displays the properties identified as being exposed to 'acute' noise levels in either the daytime or night-time periods.

Table 11 – Summary of Operational Noise Model Results

NCA	Does project increase noise levels by more than 2dB(A)?	Are the noise levels at any residential property 'acute'?	Number of properties where further noise mitigation would be considered
1	No	Yes	14
2	No	Yes	8
3	No	Yes	9
4	No	Yes	13
5	No	Yes	27
6	No	Yes	13
7	No	Yes	0 (properties are to be acquired by QIC)
8	No	Yes	1
		Total	**85**

5.5 Noise Contours

The $L_{Aeq,15hr}$ Day and $L_{Aeq,9hr}$ Night noise contours for the 2026 'Build' and 'No Build' scenarios are presented in Appendix D. The noise contours assume no noise mitigation measures have been incorporated into the road development. The noise contours are produced by interpolation from a series of calculations to specific points within a regularly spaced grid, 1.5 metres above ground level. It is noted that the noise contours are estimates of the predicted noise levels, and that contour values may differ slightly from equivalent spot calculations.

5.6 Road Traffic Noise Mitigation Options

Although the noise impact of the project is minor [not more than 2dB(A) increase], some residences within the project area are already exposed to 'acute' noise levels, and therefore an assessment of feasible and reasonable noise mitigation options is required.

This project is still at 'concept design phase' and final noise mitigation treatments will not be decided until the 'detailed design phase' to allow for all design changes to be considered in the noise assessment. Nonetheless, the following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. 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.

Section 3.4.1 of the RNP indicates the following priority order for noise mitigation:

> *"…identify feasible and reasonable mitigation measures in the following order of priority:*
>
> *i. Road design and traffic management*
>
> *ii. Quieter pavement surfaces*
>
> *iii. In-corridor noise barriers/mounds*
>
> *iv. At-property treatments or localised barriers/mounds"*

All reasonable and feasible traffic management and road design opportunities to reduce road traffic noise have been considered in the concept design. Therefore, the following sections assess the feasible and reasonableness of the remaining mitigation options in accordance with the order of priority stated above.

5.6.1 Quieter Pavements

The ENMM gives guidance on appropriate treatment of dwellings affected by traffic noise. 'Quiet' road pavement surfaces such as Stone Mastic Asphalt (SMA) and Open Graded Asphaltic Concrete (OGAC) could be laid along the proposed realignment as part of the road redevelopment. However this treatment is most effective for high speed roads such as freeways. The ENMM states that;

> *"…in areas with posted speeds of 70km/h or more, the reduction of road tyre noise can be a useful noise reduction treatment"*

Application of a quiet pavement is not recommended for this project for the following reasons:

- The posted speed limit for the upgraded road is to be 60 km/h, and the noise reductions achieved from this mitigation measure would be minimal.
- There are several intersections where traffic slows down and then accelerates, which is not ideal for quiet pavements and can cause increased wear and maintenance.
- While the application of a quiet pavement may reduce noise levels slightly, the pavement alone would not be sufficient to mitigate all the predicted noise impacts and other measures would still need to be applied.

5.6.2 Noise Barriers

Noise barriers are most feasible where residences are closely grouped, where the barriers do not cause access difficulties to properties, and where they are visually acceptable. Where driveway access is required it is preferred not to use noise barriers as the overall noise reduction provided by the barrier is compromised by the need to install an access gate.

As residences access their properties via driveways that connect to Showground Road for the entire length of the project on both the northern and southern side of Showground Road, noise barriers are not a feasible mitigation measure.

During the project Value and Risk Management Workshop, the Council representative advised that Council was not supportive of noise barriers along Showground Road.

5.6.3 At-Property Treatment

At-property treatment would only be considered for dwellings where other noise mitigation measures are either exhausted or are not feasible or cost effective.

The RNP's noise criteria are external noise goals, and building treatment only reduces noise levels inside a dwelling. Therefore, any building treatment would be designed to achieve the internal noise levels that would have been achieved had the project complied with the RNP criteria externally.

It is generally accepted that most buildings provide a noise reduction of at least 10dB(A) when windows are left 20% open, without providing additional treatment. This equates to an RNP internal criteria of $L_{Aeq(15\ hour)}$ 50dB(A) and $L_{Aeq(9\ hour)}$ 45dB(A) for residences along the road upgrade.

According to the ENMM, building treatments (in no particular order) may comprise:

- Fresh air ventilation systems that allow existing windows and doors to be kept shut;
- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only (these techniques are unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls);
- Upgrading window and door seals;
- Sealing wall vents; and
- External screen walls or property boundary fencing.

The following table provides guidance on the level of treatment required in relation to the exceedance above the RNP external assessment criteria.

Table 12 - Residential At-Property Treatment Options

There has been an amendment to treatment 1 in this table in line with the Environmental Noise Management Manual. To view the updated table, please visit www.rms.nsw.gov.au/documents/projects/sydney-north/castle-hill-showground-road-upgrade/showground-road-upgrade-submissions-report-2014-09.pdf

Treatment	Predicted exceedance of RNP external criteria, dB(A)	At-Property Acoustic Treatment
1	<5	Ducted air-conditioning with fresh air ventilation or split air-conditioning system with separate fresh air mechanical ventilation where ducted systems are not practical.
2	6-10	Treatment 1 + replace existing weather seals with acoustic seals on windows and doors.
3	11-15	Treatment 1 + Treatment 2 + replace existing glazing with thicker laminated glazing.
4	>15	Treatment 1 + Treatment 2 + install supplementary window, fitted with acoustic seals, to inner side of existing window.

5.7 Bus Stops

Where new bus stops are added during a road upgrade project, noise from buses arriving and departing the stop can sometimes change the level and characteristics of traffic noise to nearby residences.

There are a number of bus stops currently located within the project area on Showground Road. For this proposal all existing bus stops will be maintained and there is no proposal for any additional bus stops. Therefore operational noise levels will not change as a result of bus movements.

5.8 New Traffic Signals at Rowallan Ave & Kentwell Ave/Cheriton Ave.

Interrupted (or stop-and-go) traffic flow conditions on urban roads create different noise characteristics from free or uninterrupted traffic flow that is normally found on highways and motorways. Stop-and-go conditions resulting from changing traffic signals result in deceleration and acceleration noises as vehicles approach and depart road intersections. These deceleration and acceleration noises not only differ from each other, but also differ from the cruising traffic noise that occurs in the middle of a green light period. Different characteristics which are apparent throughout the noise measurement period of interrupted traffic flow conditions in urban areas make formulating a theoretical traffic noise model difficult and complex for this kind of condition.

Notwithstanding the above, the RLS-90 noise prediction method defines a correction for signalised intersections which is dependent on distance from the road. Assuming a reduced traffic speed as vehicles approach an intersection to stop, and adding the RLS-90 correction, we have conducted noise calculations with and without signalised intersections, and we expect the L_{eq} noise levels to change by less than 1dB(A) at the nearest residence due to the introduction of the signalised intersection compared to free-flowing traffic. This is consistent with our past experience where noise levels from vehicles were measured at an intersection for both free-flowing and stop-and-go conditions, and the measured levels were within 1dB(A) for each scenario.

This outcome can be explained by there being relatively quiet periods with very little to no traffic noise generated from stopped or slow moving vehicles at an intersection, while there is generally more noise generated from faster continuous moving vehicles found under free-flowing traffic conditions. Overall the introduction of traffic signals only causes minor changes in L_{eq} noise levels.

In terms of L_{max}, noise levels can be higher near intersections than along equivalent sections of road with continuous traffic flow. This is due to the acceleration of vehicles away from an intersection; however this only occurs for vehicles traveling with instantaneous speeds of less than 60km/h. At instantaneous speeds of approx. 60km/h or greater, a vehicle's passby noise level will tend to be the same whether the vehicle is travelling at a constant speed or accelerating at that instant in time. This is likely due to tyre-to-road noise dominating over engine noise at higher speeds. Also the passby noise level of a vehicle at 60km/h is greater than the noise of a vehicle accelerating at instantaneous speeds of less than 60km/h. This applies to light vehicles and could vary for heavy vehicles depending on gearing. [Reference: '*Prediction of noise changes due to traffic speed control'*, p2074-2081, JASA 122(4), October 2007].

In summary, while the introduction of intersections may alter the character of noise that the surrounding receivers are currently experiencing, the new intersections themselves will not significantly alter the level of noise at those receivers.

6 MAXIMUM NOISE LEVEL ASSESSMENT

The RNP does not specify a night-time L_{max} noise limit or noise goal. This is primarily because research conducted to date in this field has not been definitive and the relationship between maximum noise levels, sleep disturbance and subsequent health effects is not currently well defined.

According to the policy however, the likely maximum or peak noise levels are to be broadly assessed and reported for the night-time period, which is considered by the EPA as being 10pm to 7am.

Taking guidance from Practice Note iii of the ENMM, we have used the following methodology for assessing maximum noise levels;

- Collate external L_{Amax} and L_{Aeq} noise levels from the monitored existing noise levels between 10 pm and 7 am based on 1 second stored data at all available monitoring locations (4 in total).
- Calculate the $L_{Amax} - L_{Aeq}$ range from the monitored existing noise levels at each location.
- Analyse the L_{Amax} noise levels based on the 1 second stored data to determine the number of maximum noise events per hour during the night period.
- Predict the future L_{Amax} noise levels based on the proposed road design and distance corrections.
- Predict the future L_{Amax} events by factoring the measured events to the increase in traffic between existing (2013) and future (2026) traffic volumes data provided by RMS.
- Evaluate whether maximum noise impacts will reduce or increase for the design year.

Table 13 shows L_{max} traffic noise levels at night at locations where 1 second stored data was available from the noise monitor. Future maximum noise levels at night have been predicted using existing L_{max} noise level data and taking into consideration the proposed road design and the increase in traffic volumes. The assessment of maximum noise levels are only applicable to residential receivers.

Since the road upgrade involves widening of the road within the same road corridor, the change in distance from road to receiver as a result of the project will be minor and therefore L_{Amax} noise levels in the future will remain similar to current levels.

The number of maximum noise events occurring on any night would increase in proportion to the volume of trucks on the road, and an indication of the expected number of maximum noise events for the future year 2026 has been provided. The increase in the number of Lmax events

between 2013 and 2026 is in direct proportion to the increase in truck movements at night over the same period.

Table 13 - Maximum Noise Levels at Night

Receiver	Measured 2013									Predicted 2026						
	L_{Amax} Range		L_{Amax} - L_{Aeq} Range		L_{Amax} events Per hour		L_{Amax} Events per Night		Average No. of L_{Amax} Events per night	L_{Amax} Range		L_{Amax} Events per hour		L_{Amax} Events per Night		Average No. of L_{Amax} Events per night
	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max	
115 Showground Rd	73	93	15	29	0	22	35	79	65	73	93	0	34	54	122	100
86 Showground Rd	69	82	10	20	0	13	9	59	37	72	84	0	20	14	90	56
49 Showground Rd	73	96	16	29	0	20	13	59	37	75	98	0	30	20	89	56
23-25 Showground Rd	73	93	16	29	0	16	29	62	51	76	96	0	19	34	72	59

1. Night-time LAmax values are shown only where LAmax > 65dB(A) and where LAmax – LAeq ≥ 15dB(A)

7 CONSTRUCTION NOISE ASSESSMENT

For this construction noise assessment the quantitative assessment method has been applied in accordance with the NSW 'Interim Construction Noise Guideline' (ICNG, DECC 2009).

7.1 Construction Noise Objectives

7.1.1 Construction Noise Management Levels at Residences

Construction noise management levels are determined by the NSW 'Interim Construction Noise Guideline'. Table 14 below (reproduced from Table 2 of the ICNG) sets out the noise management levels (NMLs) for residences and how they are to be applied.

The guideline intends to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

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

Table 14 - Noise Management Levels at Residential Receivers

Time of Day	Management Level L_{Aeq} (15 min)	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of Day	Management Level L_{Aeq} (15 min)	How to Apply
Outside recommended standard hours	Noise affected RBL + 5dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

The NML represents the point above which there may be some community reaction to noise. Residential receivers are considered 'noise affected' where construction noise levels are greater than the NML.. Where predicted and/or measured construction noise levels exceed the NML, all feasible and reasonable work practices will be applied to meet the management levels.

During standard construction hours a highly affected noise objective of $L_{Aeq(15min)}$ 75 dB(A) applies at all receivers.

Table 15 identifies the adopted NMLs for receivers within the various NCA's along the route. The NMLs for each NCA are derived from the RBL results of the nearest long term noise monitoring location.

Table 15 - Construction Noise Management Levels at Residential Receivers

NCA	L_{A90} Background Noise Level (RBL)			Noise Management Level $L_{Aeq(15min)}$		
	Day	Evening	Night	Day	Evening	Night
NCA 1	62	57	31	72	62	36
NCA 2	60	52	28	70	57	33
NCA 3	62	55	31	72	60	36
NCA 4	62	55	31	72	60	36
NCA 5	62	54	30	72	59	35
NCA 6	60	51	31	70	56	36
NCA 7	58	50	34	68	55	39
NCA 8	58	50	34	68	55	39

Notes: *Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

7.1.2 Construction Noise Management Levels at Other Sensitive Land Uses

Table 16 sets out the noise management levels for various noise-sensitive land use developments adopted from the ICNG. The noise management levels are applicable where the premises are in use.

Table 16 - Noise Management Levels at Other Noise Sensitive Land Uses

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

A number of other sensitive receivers that have been identified along the project construction route are detailed in the following table.

Table 17 – Other Sensitive Receivers

ID	NCA	Address	Receiver	Receiver Type
S1	1	110 Showground Rd	Irrawaddy Dental Surgery	Commercial
S2	2	101-103 Showground Rd	Yellow Brick Rd	Commercial
S3	2	105 Showground Rd	Baulkham Hills Physio Centre	Commercial
S4	2	107 Showground Rd	Inner Harmony And Health	Commercial
S5	2	111 Showground Rd	Smilegroup Dentist	Commercial
S6	2	123 Showground Rd	123 Dental Surgery	Commercial
S7	2	125 Showground Rd	Sydney Central Cleaning Services	Commercial
S8	2	4 Carrington Rd	Carrington Dental	Commercial
S9	3	74 Showground Rd	Rowlandson & Co Solicitors	Commercial
S10	3	76 Showground Rd	Custom Smiles Dental Surgery	Commercial
S11	4	77 Showground Rd	Inala Education	Classroom
S12	4	79 Showground Rd	Angels Castle Child Care	Classroom
S13	4	81 Showground Rd	Castle Hill Chiropractor	Commercial
S14	5	30 Showground Rd	Wesley Castle Hill Church	Place of worship
S15	5	38 Showground Rd	Dr Surgery	Commercial
S16	6	43 Showground Rd	Jasmines Hair & Beauty	Commercial
S17	6	47 Showground Rd	SkinSense Clinic	Commercial
S18	8	7-17 Showground Rd	Castle Hill Baptist Church	Place of worship

For schools, hospitals and places of worship where an internal management level of 45dB(A) is specified, an equivalent external management level is 55dB(A) assuming 10dB(A) noise reduction through an open window.

As identified for residential receivers, at all other noise sensitive receivers a highly affected noise objective of $L_{Aeq(15min)}$ 75dB(A) shall apply. Construction activity noise above this level would be handled as described in Table 14.

7.1.3 Sleep Disturbance

The ICNG recommends that where construction works are planned to extend over two or more consecutive nights, the assessment should consider maximum noise levels and the extent and frequency of maximum noise level events exceeding the RBL. The ICNG (p15) refers to the discussion on sleep disturbance provided in the NSW Environmental Criteria for Road Traffic Noise (ECRTN, Environment Protection Authority 1999, pp 25-30). The ECRTN presents a summary of the findings from all the research conducted world-wide on sleep disturbance, and after consideration of all the information presented it concludes the following:

- Maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions.
- One or two events per night with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing. (ECRTN p29)

Based on the above, an upper external noise limit of L_{Amax} 65 dB(A) is set as a NML for the purposes of this construction noise assessment.

7.2 Construction Activities

Construction is anticipated to begin in late 2014. Whilst construction work would be carried out during daytime hours whenever practicable, due to high traffic volumes on Showground Road during the day, it is likely that much of the construction work will need to be carried out during the evening and night.

The following table lists the general construction activities and the associated major plant and equipment likely to be used by the contractor to carry out the necessary construction work for this project.

Table 18 - Construction Activity & Equipment List

Activity	Plant/ Equipment
Site clearance	Chain Saw Tracked Excavator Dump Truck Bull Dozer
Utility, property, service adjustment	Tracked Excavator Dump Truck Mobile Crane

Activity	Plant/ Equipment
Pavement and Kerb demolition	Milling Machine Tracked Excavator Tracked Excavator (with Rock Breaker) Front end loader Backhoe Dump Truck
Installation of drainage pits & lines	Tracked Excavator Drilling Rig Dump Truck Front end loader Backhoe
Supply, lay and compact road fill, sub base and surface Supply, lay and compact footpath, kerb and gutter	Mobile Crane Concrete Truck Concrete pump Grader Pavement Laying Machine Roller Generator
Traffic Signals	Mobile Crane
Signposting and line marking	Mobile Crane Truck

7.3 Construction Noise Sources

The following table lists the sound power levels of the plant and equipment likely to be used by the contractor to carry out the necessary construction work for this project.

Table 19 - Typical Construction Equipment & Sound Power Levels

Plant Description	Sound Power Levels, dB(A)	
	L_{Aeq}	L_{Amax}
Rock Breaker	117	125
Concrete Saw	115	118
Mobile Crane	110	116
Compactor	110	116
Front End Loader	110	112
Pavement Laying Machine	109	118
Bulldozer	109	115
Tracked Excavator	107	115
Grader	107	115
Road Milling Machine	108	111
Concrete Truck	106	110
Dump Trucks	105	110
Rollers	104	110
Truck (>20tonne)	103	106

Plant Description	Sound Power Levels, dB(A)	
	L_{Aeq}	L_{Amax}
Concrete Pump	102	104
Backhoe	101	108
Power Generator	100	106

Note: LAmax levels only noted for equipment potentially used during the night period

The sound power levels for the majority of activities presented in the above table are based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 "Guide to Noise Control on Construction, Demolition and Maintenance Sites", ICNG, information from past projects and information held in the Renzo Tonin & Associates library files.

7.4 Predicted Noise Levels

Noise emissions were determined by modelling the noise sources, receiver locations, and operating activities as outlined above. Predicted noise levels assume all listed equipment for individual tasks are operating concurrently. This approach is conservative and has been adopted to ensure the full extent of possible noise impacts are assessed (what might occur in the worst-case). Therefore, the noise generated during construction works will generally be below the predictions presented below.

All construction activities are assessed against all time periods to give an indication of the potential noise impacts should construction occur out of hours.

Table 20 presents a summary of the predicted L_{Aeq} noise levels at residential receivers for each activity associated with the construction phase for residential receivers. The assessment point is at the residential boundary.

Table 21 presents a summary of the predicted L_{Aeq} noise levels for each activity associated with the construction phase for other sensitive receivers. The assessment point is at the most affected occupied point of the premises, typically at the front facade.

Table 22 presents a summary of the predicted L_{Amax} noise levels during potential night time works for residential receivers. The assessment point is at the building facade assuming a bedroom window.

The predictions show that construction phase noise levels at residences are expected to exceed the NMLs at residences, and furthermore that residences may also be "highly noise affected". Other sensitive receivers are expected to be slightly less affected than residences as they generally only operate during the day (with the exception of places of worship) and are often set back further from the road. Nonetheless many of the sensitive receivers are also predicted to be "highly noise affected".

The predictions for L_{Amax} noise levels at night are above the goals for residences which highlights the potential for sleep disturbance during night works. Noise mitigation measures are discussed in Section 7.5.

Table 20 - Predicted L_{Aeq} Construction Noise Levels (Residential)

Activity			NCA 1	NCA 2	NCA 3	NCA 4	NCA 5	NCA 6	NCA 7	NCA 8
	NML	*Day*	*72*	*70*	*72*	*72*	*72*	*70*	*68*	*68*
		Evening	*62*	*57*	*60*	*60*	*59*	*56*	*55*	*55*
		Night	*36*	*33*	*36*	*36*	*35*	*36*	*39*	*39*
Site clearance			**87**	**88**	**85**	**88**	**91**	**90**	**89**	**83**
Site Clearance (without chainsaw)			82	**83**	80	**83**	**86**	**85**	**84**	78
Utility & service adjustment			82	**83**	80	**84**	**86**	**86**	**84**	**79**
Pavement & kerb demolition			**89**	**90**	**87**	**90**	**93**	**93**	**91**	**86**
Pavement & kerb demolition (without rock breaker)			**85**	**86**	**83**	**86**	**89**	**89**	**87**	**82**
Drainage pits & lines			**85**	**86**	**83**	**86**	**89**	**88**	**87**	**82**
Supply, lay & compact road & footpath			**85**	**86**	**83**	**86**	**89**	**88**	**87**	**81**
Traffic signals			79	80	78	81	**83**	**83**	**81**	76
Line Marking			80	**81**	78	82	**84**	**84**	**82**	77

Notes:

1. ***Bold*** *font represents exceedance of greater than 10dB(A) above the daytime NML (20dB(A) above daytime RBL).*
2. ***Red*** *font represents exceedance of the 75dB(A)* ***highly affected*** *noise objective.*

Table 21 - Predicted L_{Aeq} Construction Noise Levels (Other Sensitive Receivers)

Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
Criteria	*70*	*70*	*70*	*70*	*70*	*70*	*70*	*70*	*70*	*70*	*55*	*55*	*70*	*55*	*70*	*70*	*70*	*55*
Site clearance	**78**	**76**	73	**77**	**77**	**80**	**79**	64	**81**	**82**	**79**	**74**	**78**	**83**	**77**	**76**	**77**	**82**
Utility & service adjustment	74	72	68	72	72	**76**	**75**	59	**77**	**77**	**74**	**70**	73	**79**	72	71	72	**77**
Pavement & kerb demolition	**80**	**79**	**75**	**79**	**79**	**83**	**82**	66	**84**	**84**	**81**	**77**	**80**	**86**	**79**	**78**	**79**	**84**
drainage pits & lines	**76**	74	71	**75**	**75**	**79**	**78**	62	**79**	**80**	**77**	**72**	**76**	**82**	**75**	74	**75**	**80**
Supply, lay & compact road & footpath	**76**	74	71	**75**	**75**	**78**	**77**	62	**79**	**80**	**77**	**72**	**76**	**82**	**75**	74	**75**	**80**
Traffic signals	71	69	66	69	70	73	72	57	74	74	**71**	**67**	71	**76**	70	69	70	**75**
Line Marking	72	70	66	70	71	74	73	57	**75**	**75**	**72**	**68**	72	**77**	71	69	70	**75**

Notes:

1. ***Bold*** *font represents exceedance of greater than 10dB(A) above the daytime NML.*
2. ***Red*** *font represents exceedance of the 75dB(A)* ***highly affected*** *noise objective.*

Table 22 - Predicted L_{Amax} Construction Noise Levels for Night Works (Residential)

Activity		NCA 1	NCA 2	NCA 3	NCA 4	NCA 5	NCA 6	NCA 7	NCA 8
Sleep Disturbance Upper Limit	*Night*	*65*	*65*	*65*	*65*	*65*	*65*	*65*	*65*
Site clearance		**81**	**80**	**82**	**80**	**78**	**79**	**80**	**83**
Utility & service adjustment		**78**	**77**	**79**	**77**	**75**	**76**	**77**	**80**
Pavement & kerb demolition (without rock breaker)		**86**	**85**	**88**	**85**	**83**	**84**	**85**	**88**
Drainage pits & lines		**87**	**86**	**88**	**86**	**84**	**85**	**86**	**89**
Supply, lay & compact road & footpath		**78**	**77**	**79**	**77**	**75**	**76**	**77**	**80**
Traffic signals		**78**	**77**	**79**	**77**	**75**	**76**	**77**	**80**
Line Marking		**78**	**77**	**79**	**77**	**75**	**76**	**77**	**80**

Notes:

1. ***Bold*** *font represents exceedance of night time sleep disturbance upper limit.*
2. *Noise level predictions for L_{Amx} sleep disturbance have been made at the building facade*

7.5 Construction Noise Mitigation Options

The following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. Where actual construction activities differ from those assessed in this report, more detailed design of noise control measures may be required once specific items of plant and construction methods have been chosen and assessed on site.

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.

7.5.1 Standard Noise and Vibration Management Measures

Table 23 sets out standard noise and vibration mitigation, as outlined in the ENMM (Section 5), to be implemented on the Project as required.

Table 23 – Standard Mitigation Measures to Reduce Construction Noise and Vibration

Action Required	Applies to	Details
Management Measures		
Implement community consultation measures – inform community of construction activity and potential impacts	Airborne noise Ground-borne vibration	Incorporate into Community Liaison Plan
Site inductions	Airborne noise Ground-borne vibration	All employees, contractors and subcontractors are to receive a Project induction. The environmental component may be covered in toolboxes and should include: • all relevant project specific and standard noise and vibration mitigation measures; • relevant licence and approval conditions; • permissible hours of work; • any limitations on high noise generating activities; • location of nearest sensitive receivers; • construction employee parking areas; • designated loading/unloading areas and procedures; • site opening/closing times (including deliveries); and • environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height where practicable, throwing of metal items and slamming of doors.
Monitoring	Airborne noise Ground-borne vibration	See Section 7.5.3
Site specific attended vibration measurements	Ground-borne Vibration	As required
Source Controls		
Construction hours and scheduling	Airborne noise Ground-borne vibration	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods if practicable.

Action Required	Applies to	Details
Construction respite period	Airborne noise Ground-borne vibration	Noise and vibration generating activities with impulsive, tonal or low frequency characteristics (such as jack hammering, rock breaking, rock hammering, vibratory rolling) would only be carried out: • in continuous blocks, up to but not exceeding 3 hours each; and • with a minimum respite period of one hour between each block.
Equipment selection	Airborne noise Ground-borne vibration	Use quieter and less noise/ vibration emitting construction methods where feasible and reasonable. Where vibration intensive equipment is used within the minimum working distances identified, determine whether alternative construction methodology or less vibration intensive equipment can be used, e.g. when piling is required, use bored piles rather than impact-driven piles.
Maximum noise levels	Airborne noise	All plant and equipment to be appropriately maintained to ensure optimum running conditions, with periodic monitoring.
Use and siting of plant	Airborne noise Ground-borne vibration	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be limited/ avoided where possible. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised where practicable. Plant used intermittently to be throttled down or shut down when not in use where practicable. Noise-emitting plant to be directed away from sensitive receivers where possible.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) should be fitted and used on all construction vehicles and mobile plant regularly used on site for periods of over two months where practicable.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Ensure all deliveries occur during standard construction hours.
Path Controls		
Shield sensitive receivers from noisy activities	Airborne noise	Where reasonable and feasible, use structures to shield residential receivers from noise such as: • site shed placement; • earth bunds; • temporary noise screens (where practicable) • enclosures to shield fixed noise sources such as pumps, compressors, fans etc screens (where practicable); and • consideration of site topography when situating plant.

7.5.2 Additional Airborne Noise Mitigation Measures

Additional mitigation measures to be considered in preparing CNVMs include:

- **Phone calls:** phone calls detailing relevant information would be made to identified/ affected stakeholders;
- **Letter box drops:** used to disseminate Project information to interested stakeholders and/or to provide advanced warning of high noise impact activities during the day or potentially audible OOHW activities (can also be emailed);
- **Individual briefings:** used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented;
- **Project specific respite offer:** residents subjected to lengthy periods of noise or vibration may be eligible for a Project specific respite offer (e.g. pre-purchased movie tickets);
- **Specific notifications:** letterbox dropped, emailed or hand delivered to advise stakeholders that construction activities are likely to exceed the noise objectives;
- **Monitoring:** noise or vibration monitoring offered to stakeholders likely to incur noise and/ or vibration levels above the applicable levels; and
- **Alternative accommodation:** offered to residents living in close proximity to Project construction works that are likely to incur noise levels at night that are significantly above the applicable levels in Section 0.

Table 24 below should be used to advise the appropriate additional noise mitigation.

Table 24 - Additional Airborne Noise Mitigation Measures

Time Period		Mitigation Measures/Predicted LAeq(15min) Noise Level above RBL			
		0 to 10 dB(A) Noticeable	**10 to 20 dB(A) Clearly audible**	**20 to 30 dB(A) Moderately intrusive**	**>30 dB(A) Highly intrusive**
Standard	Mon-Fri (7am-6pm) Sat (8am-1pm) Sun/ Public Hol (Nil)	-	-	Letterbox drop, Monitoring	Letterbox drop, Monitoring
OOHW Period 1	Mon-Fri (6pm-10pm) Sat (7am to 8am & 1pm-10pm) Sun/ Public Hol (8am -6pm)	-	Letterbox Drop	Monitoring, Letterbox Drop	Monitoring, Individual Briefing, Letterbox Drop Project Specific Respite Offer, Phone Calls, Specific Notification
OOHW Period 2	Mon-Fri (10pm-7am) Sat (10pm-7am) Sun/ Public Hol (6pm-8am)	Letterbox Drop	Monitoring, Letterbox Drop	Monitoring, Individual Briefing, Letterbox drop, Phone Calls, Specific Notification	Alternate Accommodation, Monitoring, Individual Briefing, Letterbox Drop, Phone Calls, Specific Notification

Source: TCA Construction Noise Strategy, October 2010

7.5.3 Noise Monitoring

The following approach would be adopted with regard to noise monitoring procedures during the construction works.

- Where potential noise impacts are predicted to be within 10 to 15dB(A) of the noise management level, the potential construction noise nuisance is considered to be moderate. Noise monitoring would be carried out to confirm predicted noise impacts within two weeks of commencement of construction. Reasonable and feasible noise reduction measures would be investigated, where necessary.

- Where potential noise impacts are predicted to be more than 15dB(A) above the noise management levels, the potential construction noise nuisance is considered to be high. All reasonable and feasible noise control measures would be implemented prior to the commencement of construction works. Noise compliance monitoring for all major equipment and activities on the sites would be undertaken prior to their commencement of work on site. Finally, noise levels during construction would be monitored and where exceeded, further noise reduction measures (where reasonable and feasible) would be implemented eg. restrict working hours, use silencing equipment.

7.5.4 Complaints Handling Procedure

In addition to the noise mitigation measures outlined above, it is recommended that a management procedure be put in place to deal with noise complaints that may arise from the construction works. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.

8 CONSTRUCTION VIBRATION ASSESSMENT

8.1 Construction Vibration Objectives

8.1.1 Disturbance to Buildings Occupants

For disturbance to human occupants of buildings, we refer to the NSW EPA's (ex DECC) 'Assessing Vibration; a technical guideline', published by DECC in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)'.

Vibration sources are defined as Continuous, Impulsive or Intermittent. Table 25 below provides a definition and examples of each type of vibration.

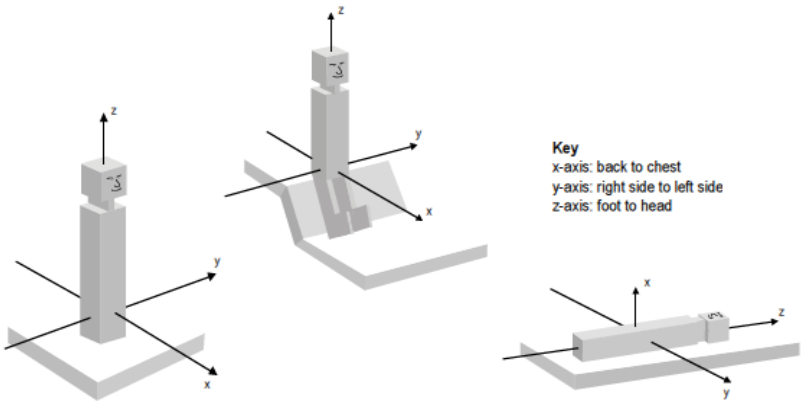
Table 25 – Types of Vibration

Type of Vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Source: Assessing Vibration; a technical guideline, Dept Environment & Climate Change 2006

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states: 'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

When applying the criteria, it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.



Source: Assessing Vibration; a technical guideline, Dept Environment & Climate Change 2006 p4

Figure 3 – Orthogonal Axes for Human Exposure to Vibration

Preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced below.

Table 26 – Preferred and Maximum Levels for Human Comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration[3] *(Weighted RMS Acceleration, m/s^2, 1-80Hz)*					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration[3] *(Weighted RMS Acceleration, m/s^2, 1-80Hz)*					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92
Intermittent vibration[4] *(Vibration Dose Values, VDV, m/s$^{1.75}$, 1-80Hz)*					
Critical areas[2]	Day- or night-time	0.10		0.20	
Residences	Daytime	0.20		0.40	
	Night-time	0.13		0.26	
Offices, schools, educational institutions and places of worship	Day- or night-time	0.40		0.80	
Workshops	Day- or night-time	0.80		1.60	

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis

Notes:
1. *Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am*
2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992*
3. *For continuous and impulsive vibration the preferred and maximum values are weighted acceleration rms values (m/s^2)*
4. *For intermittent vibration the preferred and maximum values are vibration dose values (VDVs), based on the weighted acceleration values ($m/s^{1.75}$)*

8.1.2 Structural Damage to Buildings

Safe limits for construction generated vibration have been determined using the vibration limits set out in the German Standard *DIN 4150 Part 3-1999 Structural Vibration in Buildings – Effects on Structures*.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (eg historical with preservation orders etc), it is 3mm/s. These limits increase as the frequency content of the vibration increases. These values are presented in Table 27 below and are generally recognised to be conservative.

Table 27 – DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation at Frequency of			Plane of Floor Uppermost Storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

8.2 Vibration Sources

The vibration generated from construction works will vary depending on the level and type of activity carried out at each site during each activity.

Table 28 below identifies the dominant vibration generating plant and their typical vibration levels based on library data and measurements from past projects. Potential vibration generated to receivers for this project will be dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver structure.

Table 28 – Typical Ranges of Construction Plant Vibration Levels

Plant Noise Source	PPV Vibration (mm/s) at distance from plant							
	5m	10m	15m	20m	30m	40m	50m	100m
Bobcat (Mustang 2054)	<1	-	-	-	-	-	-	-
Compactor (852G)	5.3	2.0	2.2	1.4	<1	-		
Dozer (D810) (with ripper)	<2	-	-	-	-	-		
Drilling machine – Pneumatic (Atlas Copco (ROC 812HC 20T)	3.2	1	-	-	<0.1	-	<0.1	-
Drilling Rig – Air Trac Rotary (Ingersoll/Rand CM350)	4.4	1.4	-	-	0.6	-	<0.1	-
Drilling Rig – Tracked (Samsung SE 240 LC3 18T)	<2	-	-	-	-	-	-	-
Excavator ≤30T (travelling)	8.0	3.4	1.6	-	-	-		
Excavator ≤30T (digging)	5.8	4.0	0.0	-	-	-		
Excavator & Rock Hammer (20T)	4.5	1.3	-	0.4	0.2	0.15		
Excavator & Rock Hammer (27T)	10.5	2.5	-	-	-	-		
Excavator & Heavy Rock Hammer (eg 1500 kg)	4.5	1.3	-	0.4	0.2	0.15	0.02	-
Grader (20 tonne)	2.0	-	0.2	-	-	-		
Jack hammers	2.0	1.0	0.2	0.1	0.0	0.1		
Piling Rig – Bored (Soilmec 60T) *	2.4	0.2	0.2	-	-	-		
Piling Rig – Sheet (blow energy 60,000 joules)	>90	40	25	20	12	11	7.5	3.5
Piling Rig – Sheet (blow energy 20,000 joules)	>50	20	14	10	7	6	4	2
Piling Rig – Vibratory (Mertz M26)	29-36	16-40	7-17	19-22	2-13	1-15	1-7	1-3.5
Ripper (D10 D375A-2)	1-2	-	-	-	-	-	-	-
Rocksaw (Komatsu AVANCE PC300)	1.5	-	-	-	-	-	-	-
Timber Pole Drill	3.2	1	-	-	-	<0.2		
Truck & Trailer (45T net)	14.5	10.3	3.4	-	-	-		
Vibratory Roller ≤ 3T (Smooth Drum)#	8.7	5.4	-	-	-	-	-	-
Vibratory Roller ≤ 8T (Pad Footed)#	9-12	3.1						
Vibratory Roller ≤ 17T (Smooth Drum)	24.5	8.9	4.2	-	-	-		
Vibratory Roller ≤ 17T (Pad Footed)	15.1	10.3	3.2	-	-	-		

Notes: *Source – Renzo Tonin & Associates database*
** data based on sand/clay soil conditions*
 # Monitor mounted on plate in sands

Site specific buffer distances for vibration significant plant items (e.g. vibratory rollers, compactors, pile boring, pole drilling) must be measured on site. Unlike noise, vibration can't be 'predicted'. There are many variables from site to site, for example soil type and conditions; sub surface rock; building types and foundations; and actual plant on site. The data relied upon in this assessment (tabulated above) is taken from a database of vibration levels measured at various sites or obtained from other sources (e.g. BS5228-2:2009). They are not specific to this project.

8.3 Potential Vibration Impacts to Residential and Commercial Uses

Based on the vibration data presented in Section 8.2 above, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 29 below. The assessment is relevant to all residential and commercial use buildings, and other similar type structures in the project area.

Table 29 – Potential Vibration for Residential/Commercial Properties

NCA	Approximate distance from works	Assessment on Potential Vibration Impacts		
		Structural Damage Risk	Human Disturbance	Vibration Monitoring
All	10 - 15m	Medium risk of structural damage from vibratory rolling. Low risk of structural damage from other activities.	High risk of adverse comment as a result of vibratory rolling. Medium risk of adverse comment for other activities.	Vibration monitoring shall be conducted during the construction phase

Recommendations for reducing potential vibration impacts, including minimum working distances for construction plant are provided in Section 8.5 below.

8.4 Potential Vibration Impacts to Heritage Listed Properties

There are four properties in the project area that are heritage listed and these are identified in Table 30. Vibration generated by construction plant associated with the road works was estimated at various distances and expected vibration impacts have been determined.

Table 30 – Potential Vibration for Heritage Properties

Property	Approximate distance from works	Assessment on Potential Vibration Impacts
107 Showground Road	18m	Medium risk of structural damage from vibratory rolling. Low risk of structural damage from other activities.
74 Showground Road (Dogwoods House)	13m	Medium risk of structural damage from vibratory rolling. Low risk of structural damage from other activities.
30 Showground Road	8m	Structural damage from vibratory rolling or excavation is possible.
Cnr Showground Road and Old Northern Road (former Police Station)	125m	Structural damage very unlikley

There is potential for structural damage at three of the four heritage buildings. Further comment on vibration management is provided in Section 8.5.2.

8.5 Vibration Mitigation

8.5.1 Recommended Minimum Buffer Distances for Residential/Commercial Properties

The pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific. Accordingly, based on our database containing vibration measurements from past projects and library information, Table 31 below presents the recommended minimum working distances for high vibration generating plant.

Table 31 - Recommended Minimum Working Distances for Vibration Intensive Plant

Plant Item	Rating / Description	Minimum Working Distance	
		Cosmetic Damage	Human Response
Vibratory Roller[1]	< 50 kN (Typically 1-2 tonnes)	5 m	15m – 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (Typically > 18 tonnes)	25 m	100 m
Compactors[2]	-	15 m	100 m
Dozer[1]	(D810) with ripper	2 m (nominal)	10 m
Excavators[2]	≤ 30 Tonne (travelling/ digging)	10 m	15 m
Grader[1]	<= 20 tonne	2 m (nominal)	10 m
Loaders[2]	-	-	5 m
Small Hydraulic Hammer[2]	300kg (5-12 tonne excavator)	2 m	7 m
Medium Hydraulic Hammer[2]	900kg (12-18 tonne excavator)	7 m	23 m
Large Hydraulic Hammer[2]	1600kg (18-34 tonne excavator)	22 m	73 m
Jackhammer[2]	Hand held	1 m (nominal)	Avoid contact with structure
Truck Movements[2]	-	-	10 m

Notes: *1. TCA Construction Noise Strategy (Rail Projects) November 2011*
2. Renzo Tonin & Associates project files, databases & library

Site specific buffer distances would be determined once vibration emission levels are measured from each plant item prior to the commencement of their regular use on site. Where construction activity occurs in close proximity to sensitive receivers, minimum buffer distances for structural damage would be determined by site measurements and maintained..

8.5.2 Vibration Management Measures

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers and to meet the relevant human comfort and structural damage vibration limits:

1. A management procedure would be implemented to deal with vibration complaints. Each complaint would be investigated and where vibration levels are established as exceeding

the set limits, appropriate amelioration measures would be put in place to mitigate future occurrences.

2. Where vibration is found to be excessive, management measures would be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones as mentioned above, and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

3. Where construction activity occurs in close proximity to sensitive receivers, vibration testing of actual equipment on site would be carried out prior to their commencement of site operation to determine acceptable buffer distances to the nearest affected receiver locations.

4. Dilapidation surveys would be conducted at all residential and other sensitive receivers within 50 metres of the construction site. Notification by letterbox drop would be carried out for all occupied buildings within 100m of the construction site. These measures are to address potential community concerns that perceived vibration may cause damage to property.

5. The following Heritage listed properties would also be surveyed, and vibration monitoring would be conducted prior to commencement of any work in close proximity to these properties to determine specific buffer distances.

    - 107 Showground Road
    - 74 Showground Road
    - 30 Showground Road

9 CONCLUSION

Renzo Tonin & Associates have completed a noise and vibration assessment of the proposed upgrade of Showground Road, between Carrington Road and Pennant Street, Castle Hill. Noise from the operation of the upgraded road has been assessed, along with noise and vibration associated with the project construction activities.

The findings of this study are:

Traffic Noise Assessment

- Traffic noise levels at the design year for the 'build' option are predicted to be within 2dB(A) of the 'no build' option and therefore the noise impact of the project is considered acceptable with regard to operational noise.
- Existing and future traffic noise levels are 'acute' at a number of residential receivers along the project route and therefore according to RMS assessment procedures, these properties must be considered for noise mitigation. The properties to be considered for noise treatment have been identified and possible noise mitigation options have been discussed. Since the project is still in concept phase, final noise mitigation treatments will not be decided until the 'detailed design phase' to allow for all design changes to be considered.

Construction Noise and Vibration Assessment

- Construction noise is likely to exceed the construction noise goals during all periods for the majority of receivers along with the construction route. Impacts will be greatest during any night time work, especially for those residences that front Showground Road with minimal shielding and distance to the road. All reasonable and feasible noise mitigation would be applied during the construction phase. Possible noise mitigation measures and their effectiveness have been discussed.
- The risk of structural damage during construction is generally assessed as being low risk, although there is medium risk for the nearest receivers. There is generally a medium risk of adverse comment from the nearest receivers for felt vibration. Vibration mitigation measures and indicative buffer distances have been provided.
- Dilapidation surveys are recommended prior to the commencement of construction at properties that do not comply with the nominated indicative buffer distances.
- Vibration monitoring is recommended during the construction phase to address community concerns and to determine more site specific buffer distances.

10 REFERENCES

1. *NSW Road Noise Policy* (NSW DECCW, March 2011)
2. *RTA Environmental Noise Management Manual* (RTA, December 2001)
3. *NSW Interim Construction Noise Guideline* (DECC, 2009)
4. *Assessing Vibration: A Technical Guideline* (DECC, 2006)
5. British Standard 6472-1992, *Evaluation of human exposure to vibration in buildings (1-80Hz)*
6. German Standard DIN 4150 – Part 3, *Structural vibration in buildings - Effects on Structures*

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

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 1.000dB The sound of a rock band 1.01.05dB Limit of sound permitted in industry 1.020dB 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.
Lmax	The maximum sound pressure level measured over a given period.
Lmin	The minimum sound pressure level measured over a given period.
L1.0	The sound pressure level that is exceeded for 1.0% of the time for which the given sound is measured.
L1.00	The sound pressure level that is exceeded for 1.00% of the time for which the given sound is measured.

L90	The level of noise exceeded for 90% of the time. The bottom 1.00% of the sample is the L90 noise level expressed in units of dB(A).
Leq	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 1.0 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 1.00 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B - NOISE MONITORING METHODOLOGY

B.1 Noise Monitoring Equipment

A noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave Band Data
RTA05 (NTi Audio XL2)	Type 1	1/1 octaves
RTA06 (NTi Audio XL2, with low noise microphone)	Type 1	1/1 octaves
RTA03 (Cesva SC30)	Type 1	Broadband Only

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 or 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology during Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the INP. The Bureau of Meteorology (BOM) provided meteorological data, which is considered representative of the site, for the duration of the noise monitoring period. The data was modified to allow for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data was taken from *Australian Standard AS1170.2 1989 Section 4.2.5.1*.

B.3 Noise vs Time Graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the $\mathbf{L_{10}}$, $\mathbf{L_{90}}$, and $\mathbf{L_{eq}}$ levels. The statistical descriptors $\mathbf{L_{10}}$ and $\mathbf{L_{90}}$ measure the noise level exceeded for 10% and 90% of the sample measurement time. The $\mathbf{L_{eq}}$ level is the equivalent continuous noise level or the level averaged on an equal energy basis. The measurement sample periods are were fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband results.

APPENDIX C - OPERATIONAL NOISE PREDICTIONS (WITHOUT MITIGATION)

NCA	NCA ID	Receiver Address	Floor	2016 No Build DAY dB(A)	2016 No Build NIGHT dB(A)	2016 Build DAY dB(A)	2016 Build NIGHT dB(A)	2026 No Build DAY dB(A)	2026 No Build NIGHT dB(A)	2026 Build DAY dB(A)	2026 Build NIGHT dB(A)	RNP Noise Criteria DAY dB(A)	RNP Noise Criteria NIGHT dB(A)	Are the RNP Criteria exceeded? DAY	Are the RNP Criteria exceeded? NIGHT	Change in Noise Level dB(A) Design Year DAY	Change in Noise Level dB(A) Design Year NIGHT	Change in Noise Level dB(A) Opening Year DAY	Change in Noise Level dB(A) Opening Year NIGHT	Exposed to Acute Noise Levels DAY 65	Exposed to Acute Noise Levels NIGHT 60	Consider further treatment	Comment
NCA 1 - Carrington Rd to Britannia Rd (Northern side of Showground Rd)																							
1	1_001	96 Showground Rd	G	69	64	70	64	70	65	70	65	60	55	YES	YES	0.1	0.1	0.1	-0.4	YES	YES	YES	
1	1_002	98 Showground Rd	G	69	64	69	64	69	64	69	64	60	55	YES	YES	0.3	0.3	0.3	-0.2	YES	YES	YES	
1	1_003	100 Showground Rd	G	69	64	69	64	69	64	69	64	60	55	YES	YES	0.1	0.1	0.1	-0.4	YES	YES	YES	
1	1_004	102 Showground Rd	G	69	64	69	64	69	64	70	64	60	55	YES	YES	0.5	0.5	0.5	0	YES	YES	YES	
1	1_005	104 Showground Rd	1	71	66	71	65	71	66	71	66	60	55	YES	YES	-0.1	-0.1	0	-0.5	YES	YES	YES	
1	1_005	104 Showground Rd	G	69	64	69	63	69	65	69	64	60	55	YES	YES	-0.5	-0.5	-0.5	-1	YES	YES	YES	
1	1_006	106 Showground Rd	G	63	57	63	58	63	58	63	58	60	55	YES	YES	0.1	0.2	0.2	-0.3	NO	NO	NO	
1	1_007	108 Showground Rd	G	63	58	63	58	63	59	63	58	60	55	YES	YES	0.2	0.3	0.2	-0.3	NO	NO	NO	
1	1_008	110 Showground Rd	1	69	64	69	64	70	65	70	64	n/a	n/a									NO	Irrawaddy Dental Surgery
1	1_008	110 Showground Rd	G	66	61	66	61	67	62	67	61	n/a	n/a									NO	Irrawaddy Dental Surgery
1	1_009	112 Showground Rd	1	71	66	71	66	71	67	71	66	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
1	1_009	112 Showground Rd	G	69	64	69	64	69	65	69	64	60	55	YES	YES	-0.1	-0.2	-0.2	-0.6	YES	YES	YES	
1	1_010	114 Showground Rd	1	71	66	71	66	71	67	71	66	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
1	1_010	114 Showground Rd	G	69	64	69	64	70	65	69	64	60	55	YES	YES	-0.2	-0.3	-0.3	-0.8	YES	YES	YES	
1	1_011	116 Showground Rd	1	71	65	70	65	71	66	71	66	60	55	YES	YES	-0.1	-0.1	-0.2	-0.6	YES	YES	YES	
1	1_011	116 Showground Rd	G	67	62	67	61	67	62	67	62	60	55	YES	YES	-0.1	-0.2	-0.2	-0.6	YES	YES	YES	
1	1_012	118 Showground Rd	1	71	66	71	65	71	67	71	66	60	55	YES	YES	-0.3	-0.3	-0.3	-0.8	YES	YES	YES	
1	1_012	118 Showground Rd	G	69	64	68	63	69	64	69	63	60	55	YES	YES	-0.3	-0.4	-0.4	-0.9	YES	YES	YES	
1	1_013	120 Showground Rd	1	70	65	70	65	70	66	70	65	60	55	YES	YES	0	0	-0.1	-0.5	YES	YES	YES	
1	1_013	120 Showground Rd	G	68	63	68	63	68	63	68	63	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
1	1_014	122 Showground Rd	1	70	65	70	65	70	65	70	65	60	55	YES	YES	-0.1	-0.1	-0.1	-0.6	YES	YES	YES	
1	1_014	122 Showground Rd	G	68	63	68	63	68	63	68	63	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
1	1_015	124 Showground Rd	1	70	65	70	65	70	65	70	65	60	55	YES	YES	0.1	0.1	0.1	-0.4	YES	YES	YES	
1	1_015	124 Showground Rd	G	68	63	68	63	68	64	68	63	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
1	1_016	126 Showground Rd	G	68	63	68	63	68	63	68	63	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
1	1_017	8 Belvedere Ave	1	56	51	56	51	57	52	56	51	60	55	NO	NO	-0.1	-0.1	-0.1	-0.6	NO	NO	NO	
1	1_017	8 Belvedere Ave	G	53	48	53	48	53	49	53	48	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
1	1_018	10 Belvedere Ave	G	56	51	56	51	56	51	56	51	60	55	NO	NO	0.1	0	0	-0.4	NO	NO	NO	
1	1_019	12 Belvedere Ave	1	62	57	62	57	62	58	62	57	60	55	YES	YES	0	-0.1	-0.1	-0.5	NO	NO	NO	
1	1_019	12 Belvedere Ave	G	57	52	57	52	57	53	57	52	60	55	NO	NO	0	0.1	0.1	-0.4	NO	NO	NO	
1	1_020	14 Belvedere Ave	G	56	51	56	51	56	52	56	51	60	55	NO	NO	0	0.1	0.1	-0.5	NO	NO	NO	
1	1_021	16 Belvedere Ave	1	60	55	60	55	61	56	61	56	60	55	YES	YES	-0.1	-0.1	-0.1	-0.6	NO	NO	NO	
1	1_021	16 Belvedere Ave	G	56	51	56	51	57	52	57	51	60	55	NO	NO	0	0	0	-0.6	NO	NO	NO	
1	1_022	18 Belvedere Ave	1	59	53	59	53	59	54	59	54	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
1	1_022	18 Belvedere Ave	G	55	50	55	50	55	50	55	50	60	55	NO	NO	0.1	0	0.1	-0.4	NO	NO	NO	
1	1_023	20 Belvedere Ave	G	56	51	56	51	57	52	56	51	60	55	NO	NO	0	-0.1	-0.1	-0.6	NO	NO	NO	
1	1_024	22 Belvedere Ave	1	59	54	59	54	59	55	59	54	60	55	NO	NO	-0.2	-0.2	-0.2	-0.8	NO	NO	NO	
1	1_024	22 Belvedere Ave	G	56	51	56	51	56	52	56	51	60	55	NO	NO	-0.1	0	0	-0.6	NO	NO	NO	
1	1_025	24 Belvedere Ave	1	58	53	58	53	59	54	59	53	60	55	NO	NO	-0.2	-0.1	-0.1	-0.6	NO	NO	NO	
1	1_025	24 Belvedere Ave	G	55	50	55	50	55	51	55	50	60	55	NO	NO	0	-0.1	-0.1	-0.5	NO	NO	NO	
1	1_026	26 Belvedere Ave	1	58	53	58	53	58	54	58	53	60	55	NO	NO	-0.1	-0.1	-0.1	-0.7	NO	NO	NO	
1	1_026	26 Belvedere Ave	G	55	49	55	49	55	50	55	50	60	55	NO	NO	-0.1	-0.1	-0.1	-0.5	NO	NO	NO	
1	1_027	28 Belvedere Ave	1	57	51	56	51	57	52	57	52	60	55	NO	NO	-0.2	-0.2	-0.2	-0.7	NO	NO	NO	
1	1_027	28 Belvedere Ave	G	54	49	54	48	54	49	54	49	60	55	NO	NO	-0.1	-0.1	-0.1	-0.6	NO	NO	NO	
1	1_028	30 Belvedere Ave	1	60	55	60	55	61	56	61	55	60	55	YES	NO	0	0.1	0.1	-0.4	NO	NO	NO	

NCA	NCA ID	Receiver Address	Floor	2016 No Build DAY dB(A)	2016 No Build NIGHT dB(A)	2016 Build DAY dB(A)	2016 Build NIGHT dB(A)	2026 No Build DAY dB(A)	2026 No Build NIGHT dB(A)	2026 Build DAY dB(A)	2026 Build NIGHT dB(A)	RNP Noise Criteria DAY dB(A)	RNP Noise Criteria NIGHT dB(A)	Are the RNP Criteria exceeded? DAY	Are the RNP Criteria exceeded? NIGHT	Change in Noise Level dB(A) Design Year DAY	Change in Noise Level dB(A) Design Year NIGHT	Change in Noise Level dB(A) Opening Year DAY	Change in Noise Level dB(A) Opening Year NIGHT	Exposed to Acute Noise Levels DAY 65	Exposed to Acute Noise Levels NIGHT 60	Consider further treatment	Comment
1	1_028	30 Belvedere Ave	G	57	52	57	52	57	52	57	52	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
1	1_029	32 Belvedere Ave	G	57	52	57	52	57	53	57	52	60	55	NO	NO	0	-0.1	0	-0.5	NO	NO	NO	
1	1_030	34 Belvedere Ave	G	58	52	58	53	58	53	58	53	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
1	1_031	36 Belvedere Ave	G	56	51	56	51	57	52	57	52	60	55	NO	NO	0.2	0.1	0.2	-0.4	NO	NO	NO	
1	1_032	30 Kathleen Ave	G	57	51	57	51	57	52	57	52	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
1	1_033	32 Kathleen Ave	G	56	51	56	51	56	52	56	51	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
1	1_034	83 Britannia Rd	1	59	53	59	53	59	54	59	54	60	55	NO	NO	0	0.1	0	-0.5	NO	NO	NO	
1	1_034	83 Britannia Rd	G	54	49	54	49	55	50	55	49	60	55	NO	NO	0.2	0.2	0.1	-0.4	NO	NO	NO	
1	1_035	85 Britannia Rd	G	58	53	58	53	59	54	59	54	60	55	NO	NO	0.1	0.1	0.1	-0.3	NO	NO	NO	
1	1_036	87 Britannia Rd	G	68	63	68	63	69	64	69	63	60	55	YES	YES	0	0	0	-0.6	YES	YES	YES	
																						Total Receivers to be considered for additional treatment	14
NCA 2 - Carrington Rd to Britannia Rd (Southern side of Showground Rd)																							
2	2_001	101-103 Showground Rd	G	70	65	70	64	70	66	70	65	n/a	n/a									NO	Yellow Brick Rd
2	2_002	105 Showground Rd	G	68	63	68	62	68	64	68	63	na/	n/a									NO	Baulkham Hills Physio Centre
2	2_003	107 Showground Rd	G	69	64	69	64	70	65	69	64	n/a	n/a										Inner Harmony And Health
2	2_004	109 Showground Rd	G	69	64	69	64	69	65	69	64	60	55	YES	YES	-0.2	-0.2	-0.2	-0.8	YES	YES	YES	
2	2_005	111 Showground Rd	1	71	66	71	65	71	67	71	66	n/a	n/a									NO	Smilegroup Dentist
2	2_005	111 Showground Rd	G	69	64	69	64	69	65	69	64	n/a	n/a									NO	Smilegroup Dentist
2	2_006	115 Showground Rd	G	71	66	71	66	71	67	71	66	60	55	YES	YES	0	-0.1	-0.1	-0.5	YES	YES	YES	
2	2_007	117 Showground Rd	G	71	66	71	66	72	67	71	66	60	55	YES	YES	-0.2	-0.2	-0.2	-0.7	YES	YES	YES	
2	2_008	119 Showground Rd	G	73	68	72	67	73	68	72	67	60	55	YES	YES	-1	-1	-0.9	-1.4	YES	YES	YES	
2	2_009	121 Showground Rd	1	71	66	70	65	71	67	71	66	60	55	YES	YES	-0.4	-0.4	-0.5	-1	YES	YES	YES	
2	2_009	121 Showground Rd	G	69	63	68	63	69	64	69	63	60	55	YES	YES	-0.3	-0.3	-0.3	-0.9	YES	YES	YES	
2	2_010	123 Showground Rd	1	72	67	72	67	72	68	72	67	60	55	YES	YES	-0.2	-0.3	-0.3	-0.7	YES	YES	YES	123 Dental Surgery & Residence
2	2_010	123 Showground Rd	G	71	66	71	65	71	67	71	66	60	55	YES	YES	-0.3	-0.3	-0.3	-0.7	YES	YES	YES	123 Dental Surgery & Residence
2	2_011	125 Showground Rd	G	71	66	71	66	72	67	72	67	60	55	YES	YES	-0.1	-0.1	-0.1	-0.6	YES	YES	YES	Alawadi Spiritual Therapist & Residence
2	2_012	2 Carrington Rd	G	73	68	73	68	73	69	73	68	60	55	YES	YES	0.1	0	0	-0.4	YES	YES	YES	
2	2_013	4 Carrington Rd	G	61	56	61	56	62	57	62	56	n/a	n/a									NO	Carrington Dental
2	2_014	1 Sexton Ave	G	54	49	54	49	54	50	55	50	60	55	NO	NO	0.4	0.4	0.4	-0.1	NO	NO	NO	
2	2_015	3 Sexton Ave	G	57	52	57	52	57	52	57	52	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
2	2_016	5 Sexton Ave	G	55	50	55	50	55	51	56	50	60	55	NO	NO	0.2	0.2	0.2	-0.3	NO	NO	NO	
2	2_017	7 Sexton Ave	G	57	52	57	52	57	52	57	52	60	55	NO	NO	0.4	0.4	0.4	-0.2	NO	NO	NO	
2	2_018	9 Sexton Ave	G	58	53	58	53	58	53	59	53	60	55	NO	NO	0.4	0.4	0.5	-0.1	NO	NO	NO	
2	2_019	11 Sexton Ave	G	56	51	56	51	56	51	56	51	60	55	NO	NO	0.3	0.3	0.3	-0.2	NO	NO	NO	
2	2_020	13 Sexton Ave	G	57	52	58	53	58	53	58	53	60	55	NO	NO	0.3	0.3	0.3	-0.1	NO	NO	NO	
2	2_021	15-1 Sexton Ave	G	56	51	57	52	57	52	57	52	60	55	NO	NO	0.3	0.3	0.3	-0.3	NO	NO	NO	
2	2_022	15-2 Sexton Ave	G	57	52	57	52	57	53	57	52	60	55	NO	NO	0.2	0.2	0.1	-0.4	NO	NO	NO	
2	2_023	15 Sexton Ave	1	61	56	61	56	61	56	61	56	60	55	YES	YES	0.3	0.2	0.2	-0.3	NO	NO	NO	
2	2_023	15 Sexton Ave	G	57	52	57	52	57	53	58	52	60	55	NO	NO	0.2	0.1	0.2	-0.4	NO	NO	NO	
2	2_024	40 Fishburn Cres	1	57	52	57	52	57	53	58	53	60	55	NO	NO	0.3	0.2	0.3	-0.3	NO	NO	NO	
2	2_024	40 Fishburn Cres	G	54	49	54	49	55	50	55	50	60	55	NO	NO	0.3	0.2	0.2	-0.3	NO	NO	NO	
2	2_025	42 Fishburn Cres	1	59	54	59	54	59	55	60	55	60	55	NO	NO	0.4	0.3	0.4	-0.2	NO	NO	NO	
2	2_025	42 Fishburn Cres	G	56	51	56	51	56	51	56	51	60	55	NO	NO	0.3	0.3	0.3	-0.3	NO	NO	NO	
2	2_026	44 Fishburn Cres	G	60	55	60	55	60	55	60	55	60	55	NO	NO	0.3	0.3	0.2	-0.3	NO	NO	NO	
2	2_027	46-48 Fishburn Cres	G	55	50	55	50	56	51	56	51	60	55	NO	NO	0.2	0.2	0.1	-0.4	NO	NO	NO	
2	2_028	50 Fishburn Cres	1	60	55	60	55	60	55	60	55	60	55	NO	NO	0.1	0.1	0.1	-0.5	NO	NO	NO	
2	2_028	50 Fishburn Cres	G	56	51	56	51	57	52	57	51	60	55	NO	NO	0.2	0.2	0.1	-0.4	NO	NO	NO	

NCA	NCA ID	Receiver Address		2016 No Build		2016 Build		2026 No Build		2026 Build		RNP Noise Criteria		Are the RNP Criteria exceeded?		Change in Noise Level dB(A)				Exposed to Acute Noise Levels		Consider further treatment	Comment
																Design Year		Opening Year					
				DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT							DAY	NIGHT		
			Floor	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	65	60		
2	2_029	52 Fishburn Cres	1	60	54	60	55	60	55	60	55	60	55	NO	NO	0.1	0.1	0.1	-0.5	NO	NO	NO	
2	2_029	52 Fishburn Cres	G	56	51	56	51	57	52	57	51	60	55	NO	NO	0.2	0.2	0.1	-0.4	NO	NO	NO	
																						Total Receivers to be considered for additional treatment	8
NCA 3 - Britannia Rd to Rowallan Ave (Northern side of Showground Rd)																							
3	3_001	72 Britannia Rd	1	61	56	62	56	62	57	62	57	60	55	YES	YES	0.2	0.2	0.2	-0.4	NO	NO	NO	
3	3_001	72 Britannia Rd	G	59	53	59	53	59	54	59	54	60	55	NO	NO	0	0	0	-0.4	NO	NO	NO	
3	3_002	74 Britannia Rd	1	72	66	72	67	72	67	72	67	60	55	YES	YES	0.3	0.4	0.3	-0.2	YES	YES	YES	
3	3_002	74 Britannia Rd	G	70	65	70	65	70	66	70	65	60	55	YES	YES	0.1	0	0	-0.5	YES	YES	YES	
3	3_003	74 Showground Rd	G	70	65	70	65	71	66	70	n/a	n/a										NO	Rowlandson & Co Solicitors
3	3_004	76 Showground Rd	G	70	65	70	65	71	66	70	n/a	n/a										NO	Custom Smiles Dental Sugery
3	3_005	78 Showground Rd	G	68	63	68	62	69	64	68	63	60	55	YES	YES	-0.6	-0.6	-0.6	-1	YES	YES	YES	
3	3_006	80 Showground Rd	G	69	64	69	64	70	65	69	64	60	55	YES	YES	-0.4	-0.3	-0.4	-0.9	YES	YES	YES	
3	3_007	82 Showground Rd	1	70	65	70	65	70	66	71	65	60	55	YES	YES	0.2	0.2	0.1	-0.3	YES	YES	YES	
3	3_007	82 Showground Rd	G	69	63	68	63	69	64	69	63	60	55	YES	YES	-0.4	-0.3	-0.4	-0.9	YES	YES	YES	
3	3_008	84 Showground Rd	1	70	65	70	65	71	66	71	65	60	55	YES	YES	0.2	0.2	0.1	-0.4	YES	YES	YES	
3	3_008	84 Showground Rd	G	69	63	68	63	69	64	69	63	60	55	YES	YES	-0.3	-0.3	-0.3	-0.8	YES	YES	YES	
3	3_009	86 Showground Rd	G	70	64	69	64	70	65	70	65	60	55	YES	YES	-0.1	-0.1	-0.2	-0.7	YES	YES	YES	
3	3_010	88 Showground Rd	G	69	63	68	63	69	64	69	63	60	55	YES	YES	-0.3	-0.3	-0.4	-0.9	YES	YES	YES	
3	3_011	90 Showground Rd	G	69	64	69	64	69	65	69	64	60	55	YES	YES	-0.2	-0.3	-0.3	-0.8	YES	YES	YES	
3	3_012	4 Patrick Ave	1	59	54	59	54	60	55	60	55	60	55	NO	NO	-0.1	-0.1	-0.1	-0.6	NO	NO	NO	
3	3_012	4 Patrick Ave	G	57	52	57	51	57	52	57	52	60	55	NO	NO	0	-0.1	-0.1	-0.5	NO	NO	NO	
3	3_013	6 Patrick Ave	G	55	50	55	50	56	51	56	51	60	55	NO	NO	0	-0.1	-0.1	-0.5	NO	NO	NO	
3	3_014	10 Patrick Ave	G	53	47	53	48	53	48	53	48	60	55	NO	NO	0.1	0.1	0	-0.5	NO	NO	NO	
3	3_015	12 Patrick Ave	G	53	48	53	48	54	49	54	48	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
3	3_016	14 Patrick Ave	1	55	50	55	50	55	51	55	50	60	55	NO	NO	-0.1	-0.1	0	-0.5	NO	NO	NO	
3	3_016	14 Patrick Ave	G	52	47	52	47	53	48	53	48	60	55	NO	NO	-0.1	0	0	-0.5	NO	NO	NO	
3	3_017	18 Patrick Ave	G	54	49	54	49	54	50	54	49	60	55	NO	NO	0	0.1	0.1	-0.4	NO	NO	NO	
3	3_018	20 Patrick Ave	G	56	50	56	50	56	51	56	51	60	55	NO	NO	0	0	0.1	-0.4	NO	NO	NO	
3	3_019	12 Rowallan Ave	G	61	56	61	56	61	56	61	56	60	55	YES	YES	0	0.1	0.1	-0.4	NO	NO	NO	
3	3_020	14 Rowallan Ave	1	70	65	71	66	71	66	71	66	60	55	YES	YES	0.4	0.4	0.3	-0.2	YES	YES	YES	
3	3_020	14 Rowallan Ave	G	69	63	69	64	69	64	69	64	60	55	YES	YES	0.1	0.1	0.1	-0.4	YES	YES	YES	
3	3_021	1 White Pl	G	52	47	53	47	53	48	53	48	60	55	NO	NO	0.1	0.1	0	-0.5	NO	NO	NO	
3	3_022	2 White Pl	G	55	50	55	50	55	50	55	50	60	55	NO	NO	0	0	0.1	-0.4	NO	NO	NO	
3	3_023	3 White Pl	1	61	55	61	55	61	56	61	56	60	55	YES	YES	0	0.1	0.1	-0.4	NO	NO	NO	
3	3_023	3 White Pl	G	56	51	57	51	57	52	57	52	60	55	NO	NO	0.1	0.2	0.2	-0.4	NO	NO	NO	
3	3_024	4 White Pl	1	59	54	59	54	59	55	59	54	60	55	NO	NO	0	0	-0.1	-0.6	NO	NO	NO	
3	3_024	4 White Pl	G	55	50	55	50	55	51	55	50	60	55	NO	NO	0.1	0.1	0	-0.5	NO	NO	NO	
3	3_025	2 Nobel Pl	G	56	50	56	51	56	51	56	51	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
3	3_026	3 Nobel Pl	G	60	55	60	55	60	56	60	55	60	55	NO	NO	-0.2	-0.2	-0.2	-0.6	NO	NO	NO	
3	3_027	4 Nobel Pl	G	58	53	58	53	58	54	58	53	60	55	NO	NO	0.1	0	0	-0.4	NO	NO	NO	
3	3_028	5 Nobel Pl	G	55	50	55	50	55	51	55	50	60	55	NO	NO	0	0	-0.1	-0.5	NO	NO	NO	
3	3_029	10 Rowallan Ave	G	56	51	56	51	57	52	57	51	60	55	NO	NO	-0.1	0	0	-0.5	NO	NO	NO	
3	3_030	10A Rowallan Ave	G	57	52	57	52	57	53	57	52	60	55	NO	NO	-0.1	-0.1	-0.1	-0.6	NO	NO	NO	
																						Total Receivers to be considered for additional treatment	9
NCA 4 - Britannia Rd to Rowallan Ave (Southern side of Showground Rd)																							
4	4_001	71 Showground Rd	G	71	65	70	65	71	66	71	65	60	55	YES	YES	-0.3	-0.3	-0.3	-0.8	YES	YES	YES	
4	4_002	73 Showground Rd	G	71	65	70	65	71	66	71	65	60	55	YES	YES	-0.3	-0.3	-0.3	-0.9	YES	YES	YES	

NCA	NCA ID	Receiver Address		2016 No Build		2016 Build		2026 No Build		2026 Build		RNP Noise Criteria		Are the RNP Criteria exceeded?		Change in Noise Level dB(A)				Exposed to Acute Noise Levels		Consider further treatment	Comment
																Design Year		Opening Year					
				DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT							DAY	NIGHT		
			Floor	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	65	60		
4	4_003	75 Showground Rd	G	69	64	69	64	70	65	69	64	60	55	YES	YES	-0.3	-0.3	-0.3	-0.7	YES	YES	YES	
4	4_004	77 Showground Rd	G	70	65	70	65	71	66	70	65	n/a	n/a									NO	Inala Education
4	4_005	79 Showground Rd	G	66	61	66	61	67	62	67	62	50	n/a	YES	n/a	-0.1	n/a	0	n/a	YES	n/a	YES	Angels Castle Child Care
4	4_006	81 Showground Rd	G	70	65	70	65	70	66	70	65	n/a	n/a									NO	Castle Hill Chiropractor
4	4_007	83 Showground Rd	G	65	60	65	60	65	61	65	60	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
4	4_008	85 Showground Rd	G	69	64	69	64	69	65	69	64	60	55	YES	YES	0.1	0.1	0.1	-0.4	YES	YES	YES	
4	4_009	87 Showground Rd	G	69	64	69	64	69	64	69	64	60	55	YES	YES	0.1	0.1	0.1	-0.4	YES	YES	YES	
4	4_010	89 Showground Rd	1	71	66	71	66	71	66	71	66	60	55	YES	YES	0.2	0.3	0.3	-0.3	YES	YES	YES	
4	4_010	89 Showground Rd	G	70	64	70	65	70	65	70	65	60	55	YES	YES	0.2	0.2	0.2	-0.3	YES	YES	YES	
4	4_011	91 Showground Rd	G	70	65	70	65	70	66	70	65	60	55	YES	YES	0.2	0.2	0.2	-0.3	YES	YES	YES	
4	4_012	93 Showground Rd	G	70	64	70	64	70	65	70	65	60	55	YES	YES	0.1	0.2	0.2	-0.3	YES	YES	YES	
4	4_013	95 Showground Rd	G	67	62	68	62	68	63	68	63	60	55	YES	YES	0.2	0.2	0.2	-0.4	YES	YES	YES	
4	4_014	97 Showground Rd	G	68	63	68	63	68	63	68	63	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
4	4_015	99 Showground Rd	1	69	64	69	64	70	65	70	65	60	55	YES	YES	0	-0.1	-0.1	-0.5	YES	YES	YES	
4	4_015	99 Showground Rd	G	68	63	68	63	69	64	69	63	60	55	YES	YES	-0.1	-0.1	-0.1	-0.5	YES	YES	YES	
4	4_016	54 Fishburn Cres	G	58	53	58	53	59	54	59	54	60	55	NO	NO	0.2	0.2	0.1	-0.4	NO	NO	NO	
4	4_017	56 Fishburn Cres	G	61	55	61	55	61	56	61	56	60	55	YES	YES	0.1	0.1	0.1	-0.4	NO	NO	NO	
4	4_018	58 Fishburn Cres	1	62	56	62	56	62	57	62	57	60	55	YES	YES	0.1	0.1	0.1	-0.4	NO	NO	NO	
4	4_018	58 Fishburn Cres	G	59	54	59	54	59	55	59	54	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
4	4_019	60 Fishburn Cres	G	60	54	60	55	60	55	60	55	60	55	NO	NO	0.1	0.1	0.2	-0.3	NO	NO	NO	
4	4_020	62 Fishburn Cres	G	60	55	60	55	61	56	61	56	60	55	YES	YES	0.1	0.2	0.1	-0.4	NO	NO	NO	
4	4_021	64 Fishburn Cres	G	61	56	61	56	61	57	61	56	60	55	YES	YES	0.1	0.1	0.2	-0.3	NO	NO	NO	
4	4_022	66 Fishburn Cres	G	59	54	59	54	59	55	60	55	60	55	NO	NO	0.2	0.2	0.2	-0.3	NO	NO	NO	
4	4_023	68 Fishburn Cres	G	58	53	59	54	59	54	59	54	60	55	NO	NO	0.3	0.2	0.2	-0.3	NO	NO	NO	
4	4_024	1 Cecil Ave	1	61	56	61	56	61	57	61	56	60	55	YES	YES	0.1	0.1	0.1	-0.5	NO	NO	NO	
4	4_024	1 Cecil Ave	G	58	53	58	53	58	53	58	53	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
4	4_025	1A Cecil Ave	G	59	53	59	53	59	54	59	54	60	55	NO	NO	0	0	0	-0.4	NO	NO	NO	
																						Total Receivers to be considered for additional treatment	13
NCA 5 - Rowallan Ave to Kentwell Ave (Northern side of Showground Rd)																							
5	5_001	28 Showground Rd	G	67	62	68	62	68	63	68	63	50	n/a	YES	n/a	0.3	n/a	0.3	n/a	YES	n/a	n/a	To be aquired by QIC
5	5_002	30 Showground Rd	G	71	66	72	67	72	67	73	67	50	n/a	YES	n/a	0.9	n/a	0.9	n/a	YES	n/a	YES	Wesley Castle Hill Church
5	5_003	32-34 Showground Rd	G	70	65	71	66	70	66	71	66	50	n/a	YES	n/a	0.6	n/a	0.6	n/a	YES	n/a	YES	Wesley Castle Hill Church
5	5_004	36 Showground Rd	G	69	64	69	64	69	64	70	64	60	55	YES	YES	0.4	0.4	0.4	-0.1	YES	YES	YES	
5	5_005	38 Showground Rd	G	70	65	70	65	70	65	71	65	n/a	n/a									NO	Dr Surgery
5	5_006	40 Showground Rd	1	71	66	72	67	72	67	72	67	60	55	YES	YES	0.6	0.6	0.6	0.1	YES	YES	YES	
5	5_006	40 Showground Rd	G	70	64	70	65	70	65	70	65	60	55	YES	YES	0.6	0.5	0.6	0	YES	YES	YES	
5	5_007	42-44 Showground Rd	1	71	66	72	67	72	67	72	67	60	55	YES	YES	0.6	0.6	0.6	0.1	YES	YES	YES	
5	5_007	42-44 Showground Rd	G	70	65	70	65	70	65	71	65	60	55	YES	YES	0.6	0.6	0.6	0	YES	YES	YES	
5	5_008	42-44 Showground Rd	1	65	59	65	59	65	60	65	60	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
5	5_008	42-44 Showground Rd	G	60	55	60	55	60	56	61	55	60	55	YES	NO	0.1	0.1	0.2	-0.4	NO	NO	NO	
5	5_009	42-44 Showground Rd	1	61	56	61	56	62	57	62	56	60	55	YES	YES	0	0	0	-0.5	NO	NO	NO	
5	5_009	42-44 Showground Rd	G	58	52	58	52	58	53	58	53	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
5	5_010	42-44 Showground Rd	1	59	54	59	54	59	55	59	54	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
5	5_010	42-44 Showground Rd	G	56	51	56	51	56	51	56	51	60	55	NO	NO	0	0.1	0.1	-0.4	NO	NO	NO	
5	5_011	42-44 Showground Rd	1	71	66	72	67	72	67	72	67	60	55	YES	YES	0.7	0.7	0.6	0.2	YES	YES	YES	
5	5_011	42-44 Showground Rd	G	70	65	70	65	70	65	71	65	60	55	YES	YES	0.5	0.5	0.5	0	YES	YES	YES	
5	5_012	42-44 Showground Rd	1	61	56	62	56	62	57	62	57	60	55	YES	YES	0.3	0.2	0.3	-0.2	NO	NO	NO	

NCA	NCA ID	Receiver Address		2016 No Build		2016 Build		2026 No Build		2026 Build		RNP Noise Criteria		Are the RNP Criteria exceeded?		Change in Noise Level dB(A)				Exposed to Acute Noise Levels		Consider further treatment	Comment
																Design Year		Opening Year					
				DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT							DAY	NIGHT		
			Floor	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	65	60		
5	5_012	42-44 Showground Rd	G	59	54	59	54	59	55	59	54	60	55	NO	NO	0.2	0.2	0.2	-0.3	NO	NO	NO	
5	5_013	42-44 Showground Rd	1	58	53	59	53	59	54	59	54	60	55	NO	NO	0.2	0.3	0.2	-0.3	NO	NO	NO	
5	5_013	42-44 Showground Rd	G	56	50	56	51	56	51	56	51	60	55	NO	NO	0.1	0.2	0.1	-0.3	NO	NO	NO	
5	5_014	46 Showground Rd	G	67	62	67	62	67	63	68	63	60	55	YES	YES	0.3	0.3	0.3	-0.2	YES	YES	YES	
5	5_015	48 Showground Rd	G	69	63	69	64	69	64	69	64	60	55	YES	YES	0.5	0.5	0.5	0	YES	YES	YES	
5	5_016	60 Showground Rd	G	68	62	68	63	68	63	68	63	60	55	YES	YES	0.5	0.5	0.5	0	YES	YES	YES	
5	5_017	62 Showground Rd	G	68	63	68	63	68	63	69	64	60	55	YES	YES	0.5	0.6	0.6	0.1	YES	YES	YES	
5	5_018	64 Showground Rd	G	68	63	69	63	68	64	69	64	60	55	YES	YES	0.6	0.6	0.6	0	YES	YES	YES	
5	5_019	66 Showground Rd	G	70	64	70	65	70	65	71	66	60	55	YES	YES	0.7	0.8	0.7	0.2	YES	YES	YES	
5	5_020	68-1 Showground Rd	G	70	65	71	66	70	66	71	66	60	55	YES	YES	0.8	0.8	0.8	0.2	YES	YES	YES	
5	5_021	68-2 Showground Rd	G	57	52	57	52	57	52	57	52	60	55	NO	NO	0	0	0	-0.5	NO	NO	NO	
5	5_022	70 Showground Rd	G	68	62	68	63	68	63	68	63	60	55	YES	YES	0.3	0.3	0.3	-0.1	YES	YES	YES	
5	5_023	13 Rowallan Ave	1	61	56	61	56	62	57	62	57	60	55	YES	YES	0	-0.1	-0.1	-0.5	NO	NO	NO	
5	5_023	13 Rowallan Ave	G	58	53	58	53	59	54	59	53	60	55	NO	NO	0.2	0.2	0.1	-0.4	NO	NO	NO	
5	5_024	59A Castle St	1	63	58	63	58	63	59	63	58	60	55	YES	YES	0.1	0.1	0.1	-0.4	NO	NO	NO	2 Dwellings
5	5_024	59A Castle St	G	58	53	58	53	59	54	59	54	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	2 Dwellings
5	5_025	59A Castle St	1	65	60	65	60	65	61	66	61	60	55	YES	YES	0.2	0.2	0.3	-0.2	YES	YES	YES	2 Dwellings
5	5_025	59A Castle St	G	61	56	61	56	61	57	62	56	60	55	YES	YES	0.1	0.2	0.2	-0.3	NO	NO	NO	2 Dwellings
5	5_026	59A Castle St	1	68	63	68	63	68	63	68	63	60	55	YES	YES	0.3	0.3	0.3	-0.2	YES	YES	YES	2 Dwellings
5	5_026	59A Castle St	G	62	57	62	57	63	58	63	58	60	55	YES	YES	0.1	0.1	0.1	-0.4	NO	NO	NO	2 Dwellings
5	5_027	59A Castle St	1	68	63	68	63	68	63	68	63	60	55	YES	YES	0.1	0.1	0.1	-0.3	YES	YES	YES	2 Dwellings
5	5_027	59A Castle St	G	61	56	62	56	62	57	62	57	60	55	YES	YES	0.1	0.2	0.1	-0.3	NO	NO	NO	2 Dwellings
5	5_028	59A Castle St	1	68	63	68	63	68	64	69	63	60	55	YES	YES	0.1	0.1	0.1	-0.5	YES	YES	YES	2 Dwellings
5	5_028	59A Castle St	G	62	57	62	57	62	57	62	57	60	55	YES	YES	0.1	0.2	0.1	-0.3	NO	NO	NO	2 Dwellings
5	5_029	59A Castle St	1	68	63	68	63	68	63	68	63	60	55	YES	YES	0	0.1	0	-0.4	YES	YES	YES	2 Dwellings
5	5_029	59A Castle St	G	62	57	62	57	62	58	63	57	60	55	YES	YES	0.1	0.1	0.2	-0.4	NO	NO	NO	2 Dwellings
5	5_030	59A Castle St	1	68	62	68	62	68	63	68	63	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	2 Dwellings
5	5_030	59A Castle St	G	62	57	62	57	62	58	62	57	60	55	YES	YES	0.1	0.1	0.1	-0.4	NO	NO	NO	2 Dwellings
																		Total Receivers to be considered for additional treatment				27	
NCA 6 - Rowallan Ave to Kentwell Ave (Southern side of Showground Rd)																							
6	6_002	39 Showground Rd	G	68	63	68	63	68	64	69	63	60	55	YES	YES	0.2	0.2	0.2	-0.3	YES	YES	YES	
6	6_003	41 Showground Rd	G	70	64	70	65	70	65	70	65	60	55	YES	YES	0.2	0.2	0.2	-0.3	YES	YES	YES	
6	6_004	43 Showground Rd	G	69	64	69	64	69	65	70	64	n/a	n/a									NO	Jasmines Hair & Beauty
6	6_005	45 Showground Rd	G	71	66	71	66	71	67	72	66	60	55	YES	YES	0.1	0.1	0.1	-0.4	YES	YES	YES	
6	6_006	47 Showground Rd	G	71	66	71	66	71	66	71	66	n/a	n/a									NO	SkinSense Clinic
6	6_007	49 Showground Rd	G	70	65	70	64	70	65	70	65	60	55	YES	YES	0	-0.1	-0.1	-0.5	YES	YES	YES	
6	6_008	51 Showground Rd	G	71	66	71	66	71	67	71	66	60	55	YES	YES	-0.1	-0.1	0	-0.6	YES	YES	YES	
6	6_009	53 Showground Rd	G	69	63	69	63	69	64	69	64	60	55	YES	YES	-0.1	-0.1	-0.1	-0.6	YES	YES	YES	
6	6_010	55 Showground Rd	G	69	64	69	64	69	65	69	64	60	55	YES	YES	-0.1	-0.1	-0.1	-0.6	YES	YES	YES	
6	6_011	57 Showground Rd	1	71	66	71	66	72	67	71	66	60	55	YES	YES	-0.1	-0.1	-0.1	-0.6	YES	YES	YES	
6	6_011	57 Showground Rd	G	70	64	69	64	70	65	70	64	60	55	YES	YES	-0.2	-0.2	-0.3	-0.8	YES	YES	YES	
6	6_012	59A Showground Rd	G	71	65	71	65	71	66	71	66	60	55	YES	YES	0	0	0	-0.5	YES	YES	YES	
6	6_013	59B Showground Rd	G	57	52	57	52	58	53	58	52	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
6	6_014	61A Showground Rd	G	71	66	71	66	71	66	71	66	60	55	YES	YES	0	0.1	0	-0.5	YES	YES	YES	
6	6_015	61B Showground Rd	G	56	51	57	51	57	52	57	52	60	55	NO	NO	0.1	0.1	0.1	-0.4	NO	NO	NO	
6	6_016	63 Showground Rd	G	69	64	69	64	70	65	70	64	60	55	YES	YES	0	0.1	0	-0.5	YES	YES	YES	
6	6_017	65 Showground Rd	G	70	65	70	65	70	66	70	65	60	55	YES	YES	0	0	0	-0.6	YES	YES	YES	

NCA	NCA ID	Receiver Address		2016 No Build		2016 Build		2026 No Build		2026 Build		RNP Noise Criteria		Are the RNP Criteria exceeded?		Change in Noise Level dB(A)				Exposed to Acute Noise Levels		Consider further treatment	Comment
																Design Year		Opening Year					
				DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT							DAY	NIGHT		
			Floor	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	65	60		
6	6_018	65A Showground Rd	G	58	53	58	53	58	54	59	53	60	55	NO	NO	0.1	0.1	0.1	-0.5	NO	NO	NO	
6	6_019	67 Showground Rd	G	71	65	70	65	71	66	71	66	60	55	YES	YES	-0.2	-0.2	-0.2	-0.7	YES	YES	YES	
6	6_020	67A Showground Rd	G	58	53	58	53	59	54	59	54	60	55	NO	NO	0	-0.1	-0.1	-0.6	NO	NO	NO	
6	6_021	69 Showground Rd	G	70	65	70	65	71	66	70	65	n/a	n/a									NO	Hills Colorectal Surgery
																						Total Receivers to be considered for additional treatment	13
NCA 7 - Kentwell Ave to Old Northern Rd (Northern side of Showground Rd)																							
7	7_001	24 Showground Rd	G	67	62	68	62	68	63	68	63	60	55	YES	YES	0.1	0.1	0.1	-0.5	YES	YES	n/a	To be aquired by QIC
7	7_002	26 Showground Rd	G	67	62	67	62	68	63	68	63	60	55	YES	YES	0.1	0	0	-0.4	YES	YES	n/a	To be aquired by QIC
7	7_003	1 Kentwell Ave	G	58	53	58	53	59	54	58	53	60	55	NO	NO	-0.2	-0.2	-0.2	-0.7	NO	NO	n/a	To be aquired by QIC
																						Total Receivers to be considered for additional treatment	0
NCA 8 - Kentwell Ave to Old Northern Rd (Southern side of Showground Rd)																							
8	8_001	7-17 Showground Rd	1	70	65	70	65	71	66	71	65	50	n/a	YES	n/a	-0.1	n/a	0	n/a	YES	n/a	YES	Castle Hill Baptist Church
8	8_001	7-17 Showground Rd	G	69	63	68	63	69	65	69	64	50	n/a	YES	n/a	-0.1	n/a	-0.2	n/a	YES	n/a	YES	Castle Hill Baptist Church
8	8_002	19-21 Showground Rd	1	70	65	70	65	70	66	70	65	60	55	YES	YES	0.2	0.2	0.2	-0.3	YES	YES	NO	Multi level apartment
8	8_002	19-21 Showground Rd	G	67	62	68	62	68	63	68	63	60	55	YES	YES	0.2	0.2	0.2	-0.3	YES	YES	NO	Multi level apartment
8	8_003	23-25 Showground Rd	1	71	65	71	66	71	66	72	66	60	55	YES	YES	0.5	0.5	0.5	0	YES	YES	NO	Multi level apartment
8	8_003	23-25 Showground Rd	G	66	60	66	61	66	61	67	62	60	55	YES	YES	0.6	0.6	0.6	0.1	YES	YES	NO	Multi level apartment
8	8_004	1/27-33 Showground Rd	1	70	65	71	65	70	66	71	66	60	55	YES	YES	0.7	0.7	0.7	0.1	YES	YES	NO	Multi level apartment
8	8_004	1/27-33 Showground Rd	G	68	63	69	64	68	64	69	64	60	55	YES	YES	0.7	0.7	0.7	0.2	YES	YES	NO	Multi level apartment
8	8_005	2/27-33 Showground Rd	1	70	65	71	65	70	66	71	66	60	55	YES	YES	0.7	0.7	0.8	0.3	YES	YES	NO	Multi level apartment
8	8_005	2/27-33 Showground Rd	G	68	63	69	64	69	64	70	64	60	55	YES	YES	0.7	0.7	0.8	0.3	YES	YES	NO	Multi level apartment
																						Total Receivers to be considered for additional treatment	1
																							Note: receivers in this NCA genrally comprise of multiple apartments
																						Grand total of receivers to be considered for additional treatment	85

APPENDIX D - NOISE CONTOURS

Noise Level - dB(A)

= 55
= 60
= 65

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve
Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait

1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:

NSW GOVERNMENT
Transport Roads & Maritime Services

Project:

SHOWGROUND ROAD UPGRADE
CARRINGTON ROAD TO OLD NORTHERN ROAD

Description:

DESIGN YEAR (2026)
'NO BUILD SCENARIO'
LAeq,15h DAY TIME
1.5M NOISE CONTOUR

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TG356-01	Created by:	RP
Fig Ref:	TG356-01.5.2.1.5.P02 (rev 0)	Grid:	01_C1
Date:	2013.10.29	Scale:	1: 4000 A3

Noise Level - dB(A)

= 50
= 55
= 60

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve
Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait

1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:

NSW GOVERNMENT
Transport Roads & Maritime Services

Project:

SHOWGROUND ROAD UPGRADE
CARRINGTON ROAD TO OLD NORTHERN ROAD

Description:

DESIGN YEAR (2026)
'NO BUILD SCENARIO'
LAeq,9h NIGHT TIME
1.5M NOISE CONTOUR

Project No.:	TG356-01	Created by:	RP
Fig Ref:	TG356-01.5.2.1.5.P03 (rev 0)	Grid:	02_C1
Date:	2013.10.29	Scale:	1: 4000 A3

Noise Level - dB(A)

= 55
= 60
= 65

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve
Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:

NSW GOVERNMENT Transport Roads & Maritime Services

Project:

SHOWGROUND ROAD UPGRADE
CARRINGTON ROAD TO OLD NORTHERN ROAD

Description:

DESIGN YEAR (2026)
'BUILD SCENARIO'
LAeq,15h DAY TIME
1.5M NOISE CONTOUR

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TG356-01	Created by:	RP
Fig Ref:	TG356-01.5.2.1.5.P04 (rev 0)	Grid:	03_C1
Date:	2013.10.29	Scale:	1: 4000 A3

Noise Level - dB(A)

= 50
= 55
= 60

Consultant:

RENZO TONIN & ASSOCIATES
inspired to achieve
Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:

NSW GOVERNMENT Transport Roads & Maritime Services

Project:

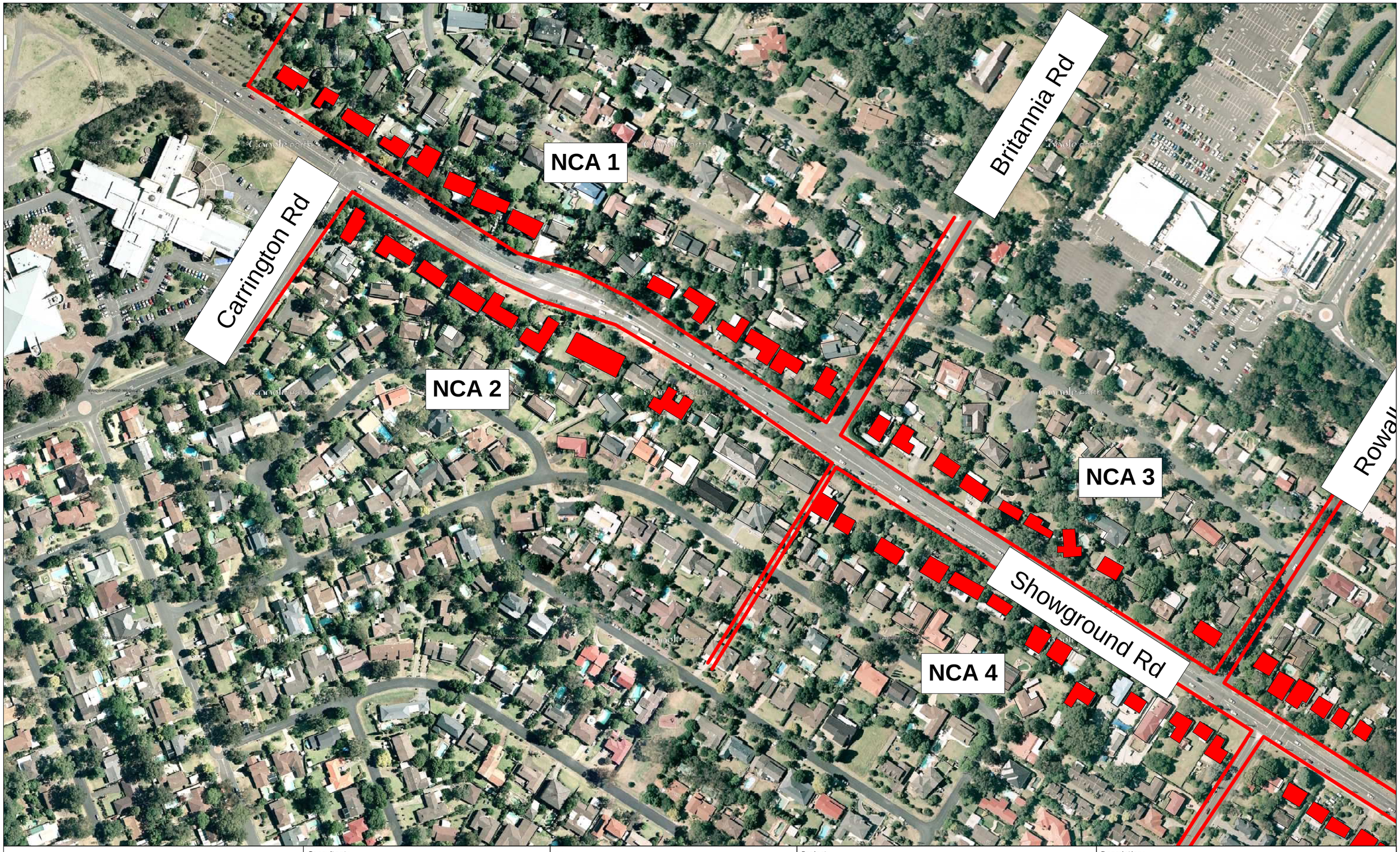
SHOWGROUND ROAD UPGRADE
CARRINGTON ROAD TO OLD NORTHERN ROAD

Description:

DESIGN YEAR (2026)
'BUILD SCENARIO'
LAeq,9h NIGHT TIME
1.5M NOISE CONTOUR

Project No.:	TG356-01	Created by:	RP
Fig Ref:	TG356-01.5.2.1.5.P05 (rev 0)	Grid:	04_C1
Date:	2013.10.29	Scale:	1: 4000 A3

APPENDIX E - ACUTE PROPERTIES



Properties Exposed to 'Acute' Noise Levels

ACUTE

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:
NSW GOVERNMENT
Transport Roads & Maritime Services

Project:
SHOWGROUND ROAD UPGRADE
CARRINGTON ROAD TO OLD NORTHERN ROAD

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Description:
DESIGN YEAR (2026)
'BUILD SCENARIO'
Properties Exposed to 'Acute' Noise Levels
NCA 1 - NCA 4

Project No.:	TG356-01	Created by:	RP
Fig Ref:	TG356-01.5.2.2.4.P01 (rev 0)	Grid:	
Date:	2014.03.11	Scale:	1: 2500 A3

Properties Exposed to 'Acute' Noise Levels

ACUTE

Consultant:
RENZO TONIN & ASSOCIATES
inspired to achieve
Acoustics, Vibration & Structural Dynamics
Sydney Melbourne Brisbane Gold Coast Kuwait
1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client:
NSW GOVERNMENT Transport Roads & Maritime Services

Project:
SHOWGROUND ROAD UPGRADE
CARRINGTON ROAD TO OLD NORTHERN ROAD

Description:
DESIGN YEAR (2026)
'BUILD SCENARIO'
Properties Exposed to 'Acute' Noise Levels
NCA 5 - NCA 8

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

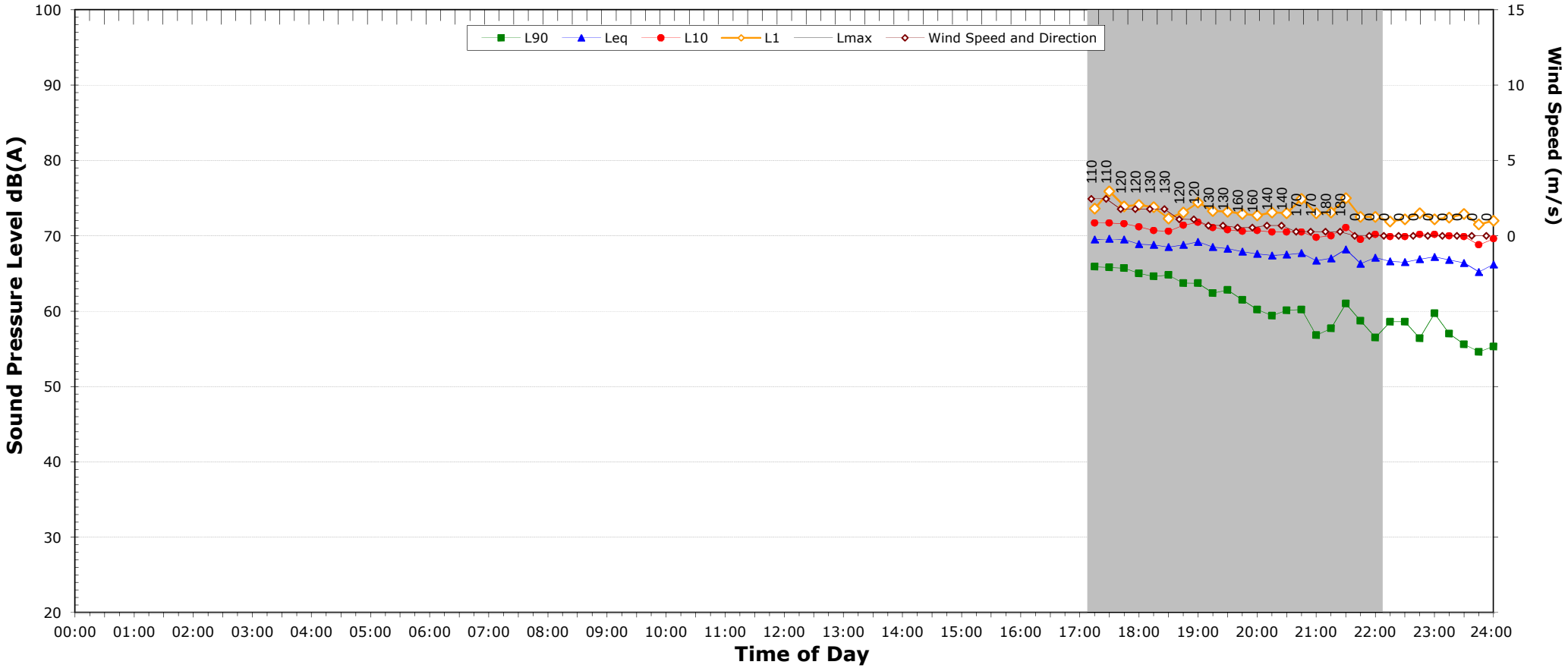
Project No.:	TG356-01	Created by:	RP
Fig Ref:	TG356-01.5.2.2.4.P02 (rev 0)	Grid:	
Date:	2014.03.11	Scale:	1: 2500 A3

APPENDIX F - MEASURED NOISE DATA

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Friday, 6 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	32.7
Leq	-	-	63.9

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 $L_{eq\ 9\ hr}$	-	66.4
$L_{eq\ 1hr}$ upper 10 percentile	-	69.3
$L_{eq\ 1hr}$ lower 10 percentile	-	62.3

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

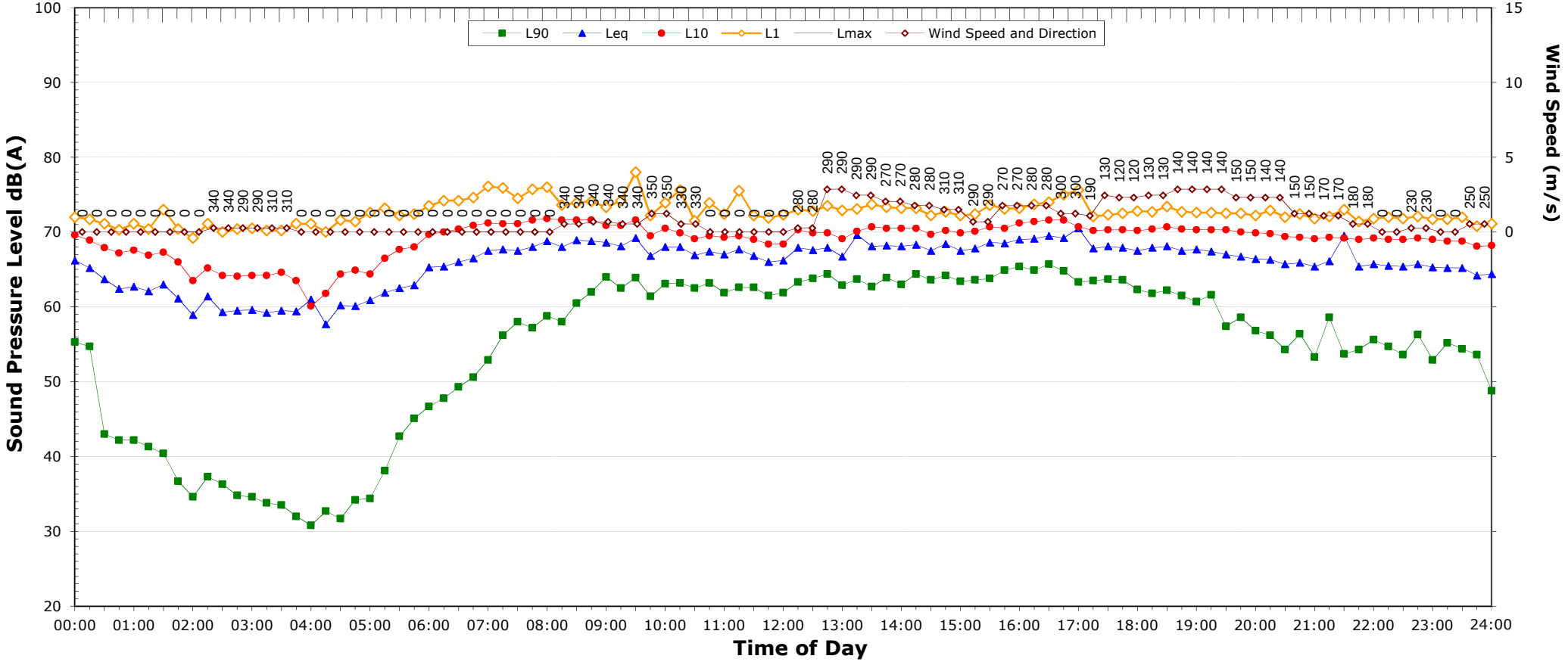
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Saturday, 7 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	58.8	53.7	31.3
Leq	68.1	66.9	62.3

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 $L_{eq\ 9\ hr}$	70.3	64.8
$L_{eq\ 1hr}$ upper 10 percentile	71.6	68.0
$L_{eq\ 1hr}$ lower 10 percentile	68.8	59.7

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

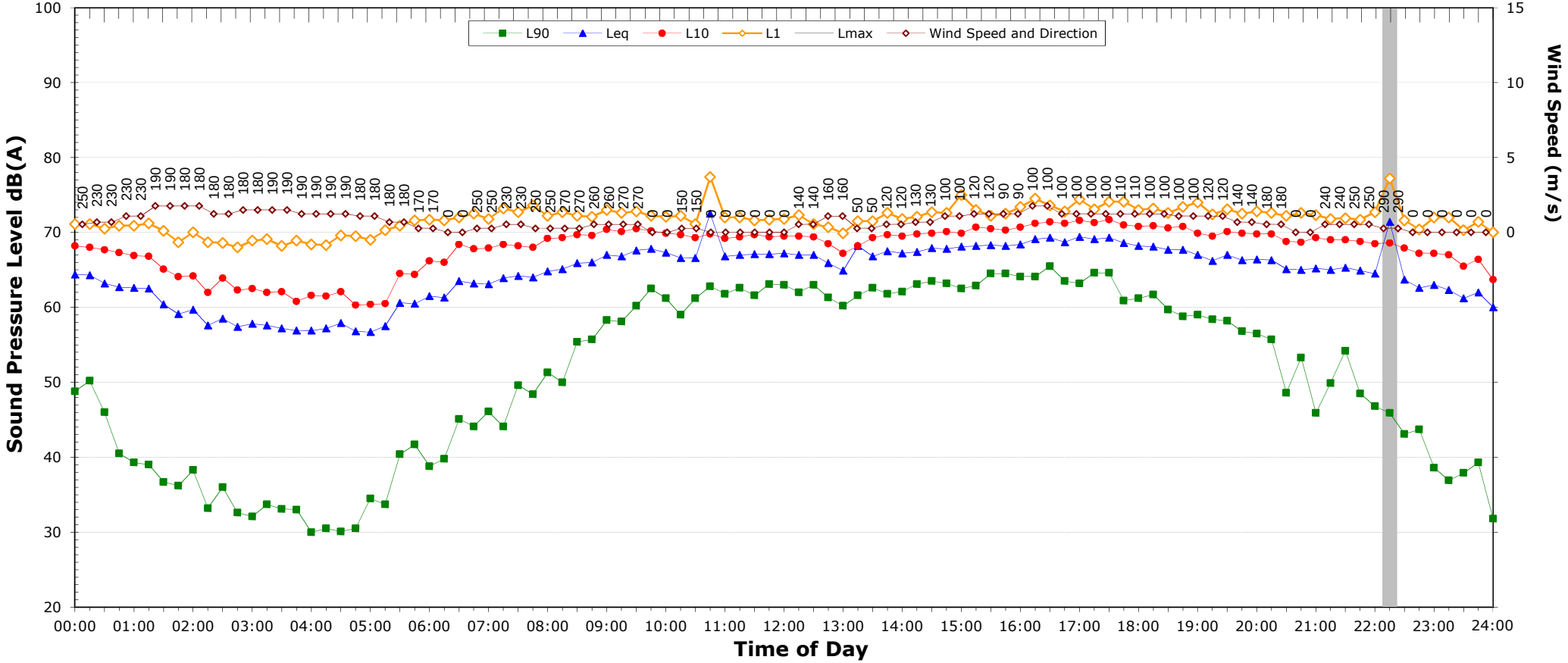
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Sunday, 8 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	58.2	46.8	26.7
Leq	67.9	66.3	63.7

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 $L_{eq\ 9\ hr}$	69.8	66.2
$L_{eq\ 1hr}$ upper 10 percentile	71.6	71.7
$L_{eq\ 1hr}$ lower 10 percentile	67.1	58.8

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

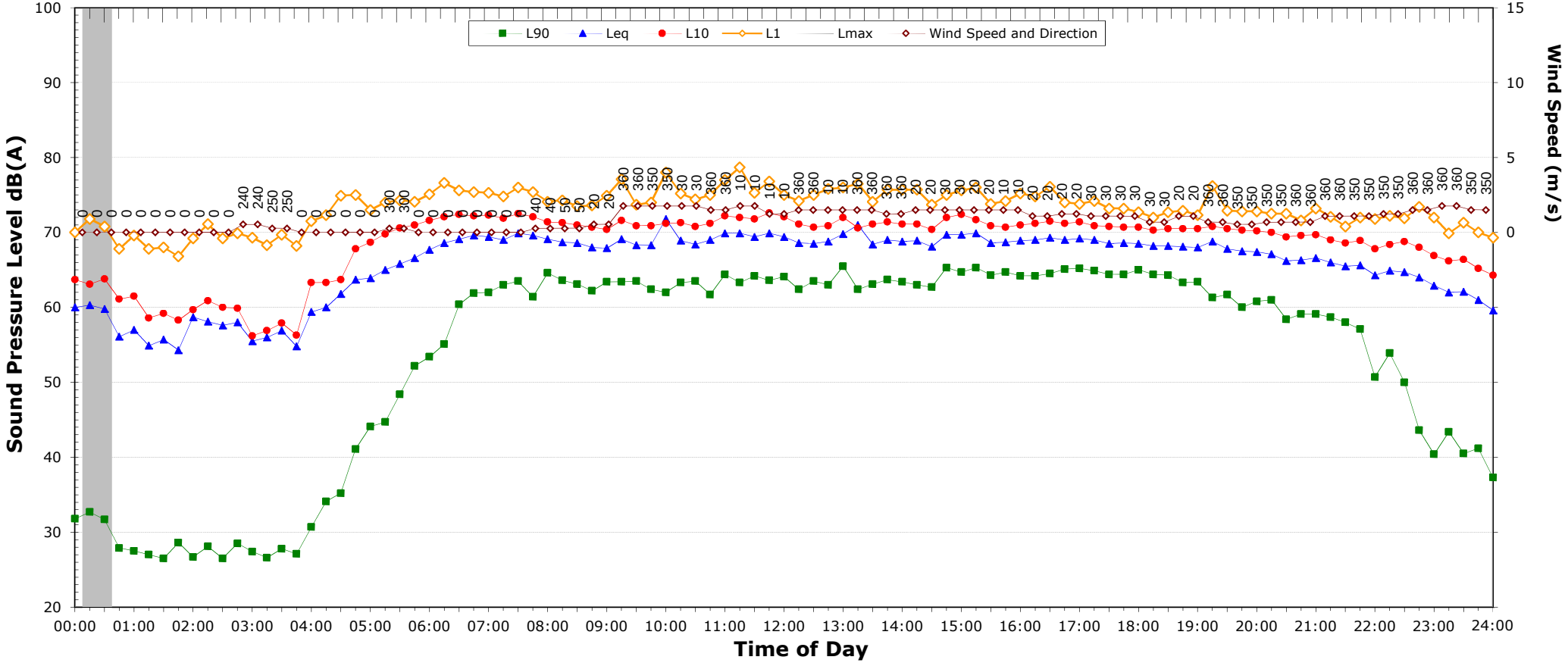
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Monday, 9 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	62.4	57.1	32.2
Leq	69.2	67.1	63.6

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 $L_{eq\ 9\ hr}$	71.2	66.1
$L_{eq\ 1hr}$ upper 10 percentile	72.1	71.7
$L_{eq\ 1hr}$ lower 10 percentile	68.5	57.6

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

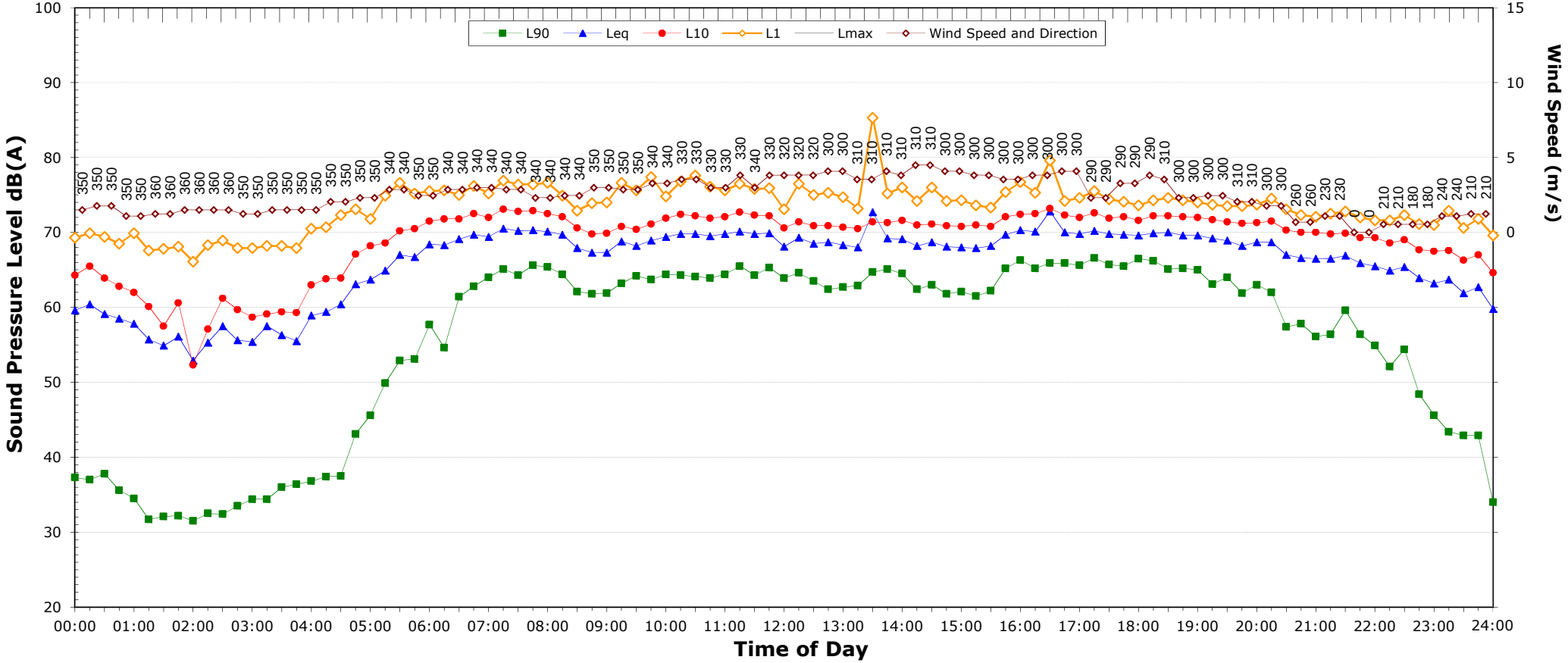
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Tuesday, 10 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	62.1	56.1	31.4
Leq	69.5	68.2	64.3

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	66.8
$L_{eq\ 1hr}$ upper 10 percentile	73.1	72.5
$L_{eq\ 1hr}$ lower 10 percentile	69.3	58.8

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

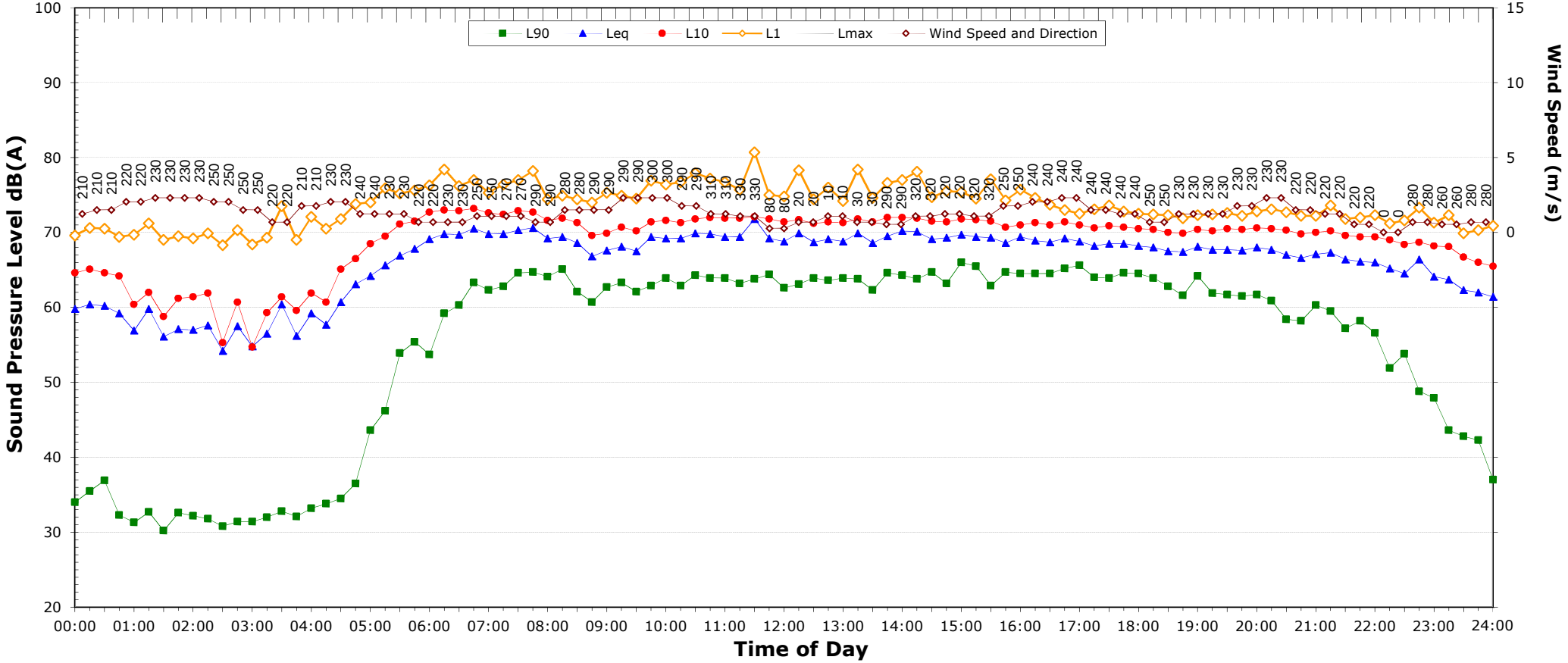
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Wednesday, 11 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	62.6	57.2	32.3
Leq	69.2	67.3	64.1

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 $L_{eq\ 9\ hr}$	71.3	66.6
$L_{eq\ 1hr}$ upper 10 percentile	72.5	72.1
$L_{eq\ 1hr}$ lower 10 percentile	69.3	59.2

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

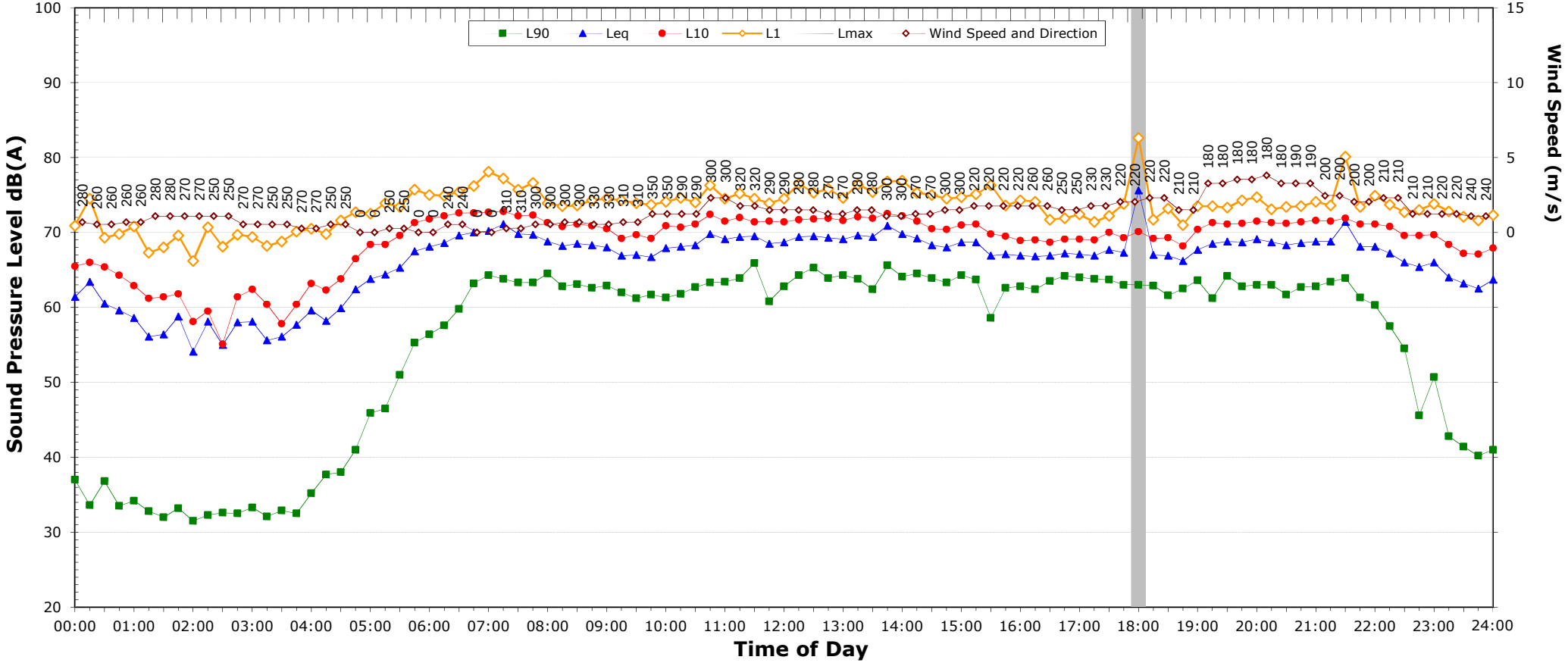
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Thursday, 12 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	61.7	61.2	31.2
Leq	68.6	68.5	64.8

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 $L_{eq\ 9\ hr}$	71.1	67.3
$L_{eq\ 1hr}$ upper 10 percentile	72.4	72.7
$L_{eq\ 1hr}$ lower 10 percentile	69.5	60.2

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

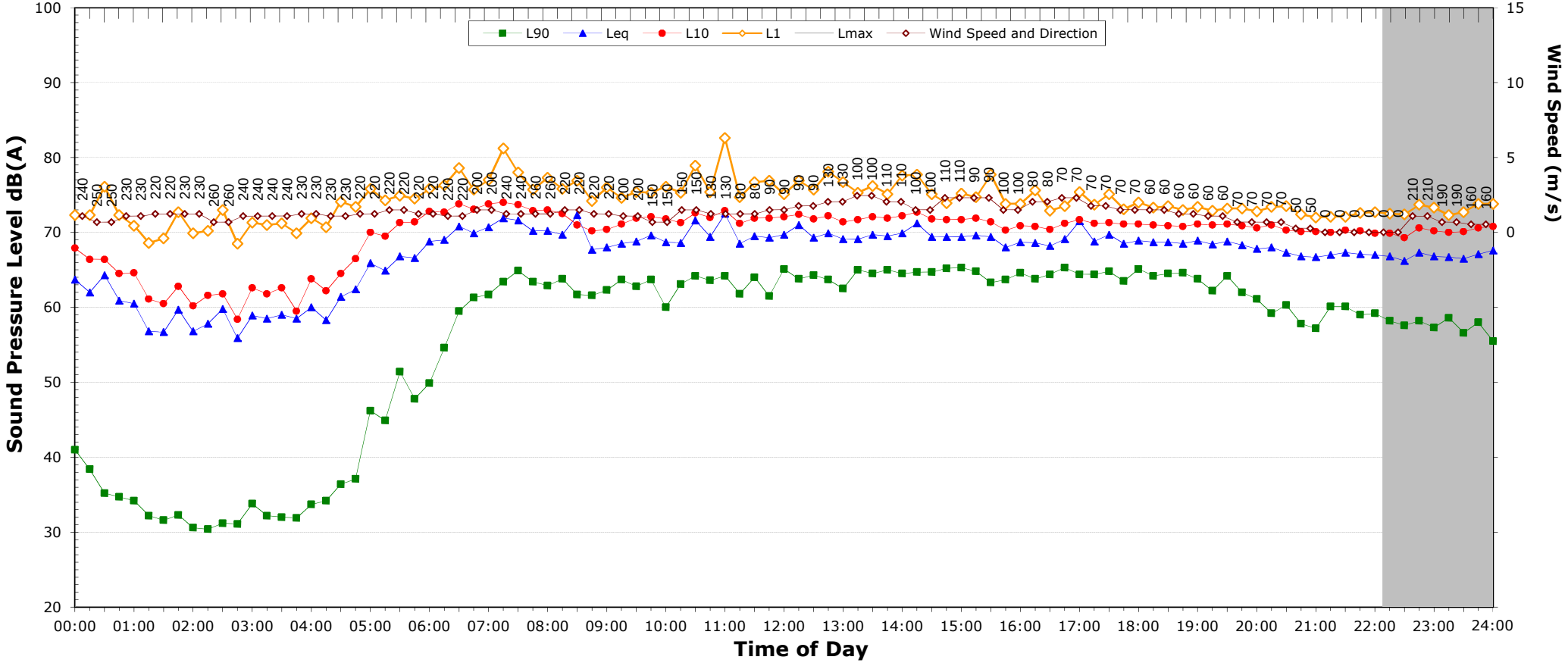
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

100 Showground Rd

Friday, 13 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	61.8	57.8	-
Leq	69.8	67.9	-

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 $L_{eq\ 9\ hr}$	71.8	-
$L_{eq\ 1hr}$ upper 10 percentile	73.4	-
$L_{eq\ 1hr}$ lower 10 percentile	69.7	-

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

Data File: T225418_2013-09-06_16-44-37_004_SLM.

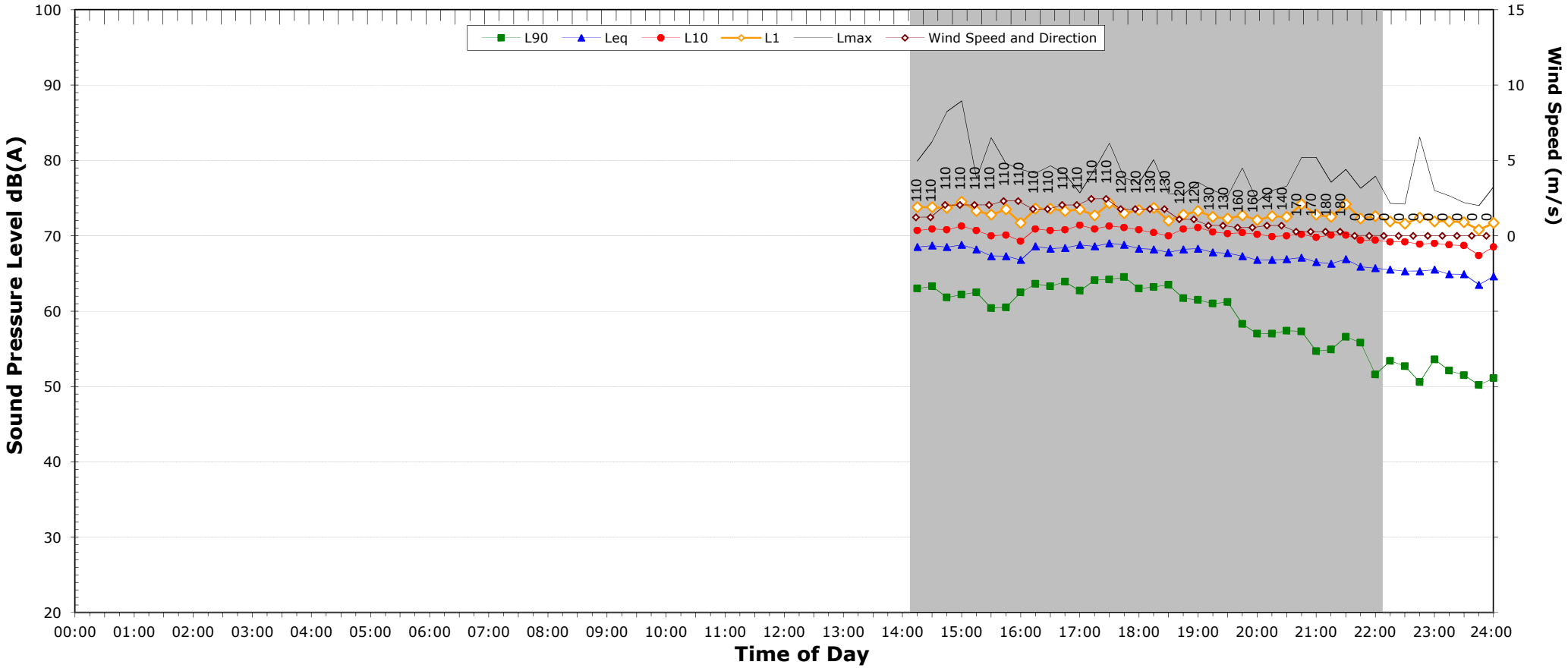
TG356-01.4.3.S05 (rev 2) 100 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

115 Showground Rd

Friday, 6 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	31.5
Leq (see note 3)	-	-	60.2

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 1m from facade; tabulated results free-field 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)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	-	62.7
$L_{eq\ 1hr}$ upper 10 percentile	-	65.7
$L_{eq\ 1hr}$ lower 10 percentile	-	58.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	77.4	to	85.9
Lmax - Leq (Range)	15.1	to	25.3

Data File: 2013-09-06_SLM_000_123_Rpt_Report.txt

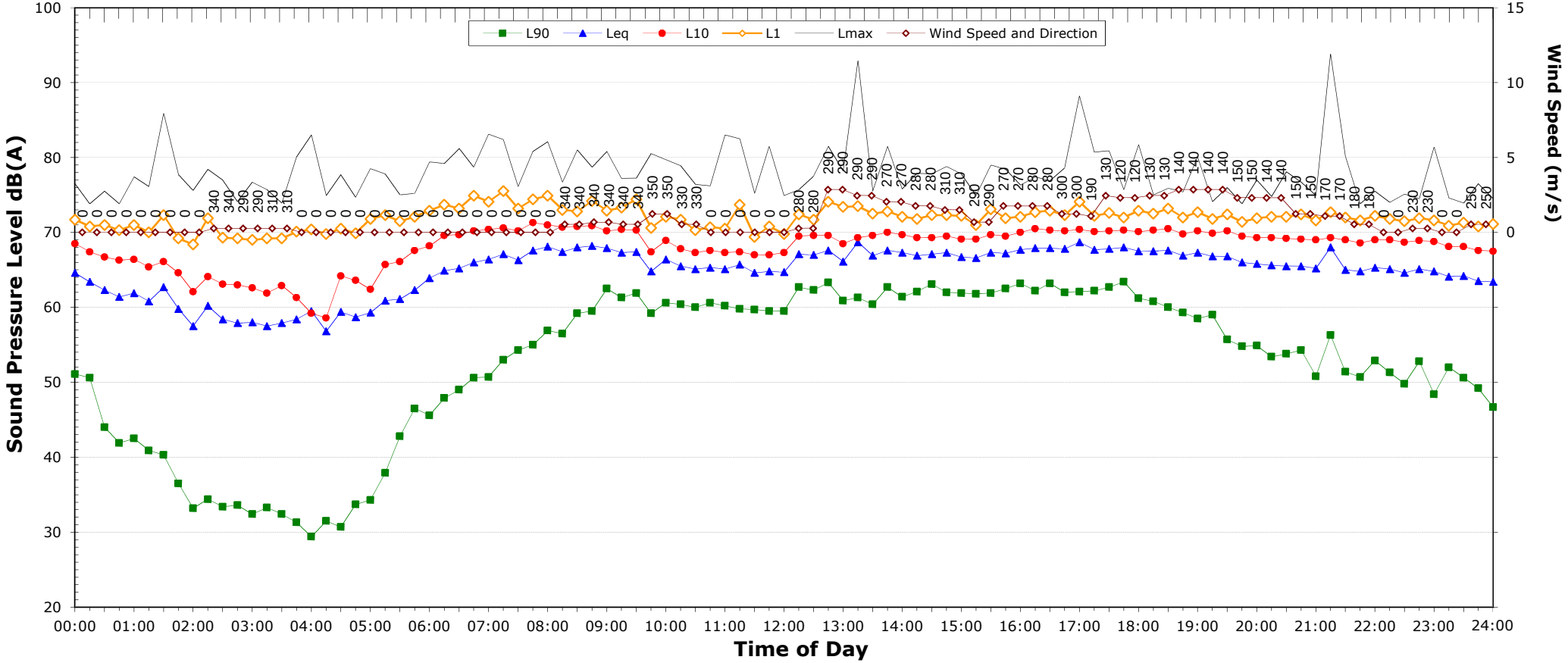
TG356-01.4.3.S06 (rev 2) 115 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

115 Showground Rd

Saturday, 7 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	56.9	50.8	30.6
Leq (see note 3)	64.6	63.8	59.2

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 1m from facade; tabulated results free-field 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)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	66.9	61.7
$L_{eq\ 1hr}$ upper 10 percentile	68.0	64.9
$L_{eq\ 1hr}$ lower 10 percentile	65.1	56.3

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	73.4	to	82.9
Lmax - Leq (Range)	16.5	to	21.0

Data File: 2013-09-06_SLM_000_123_Rpt_Report.txt

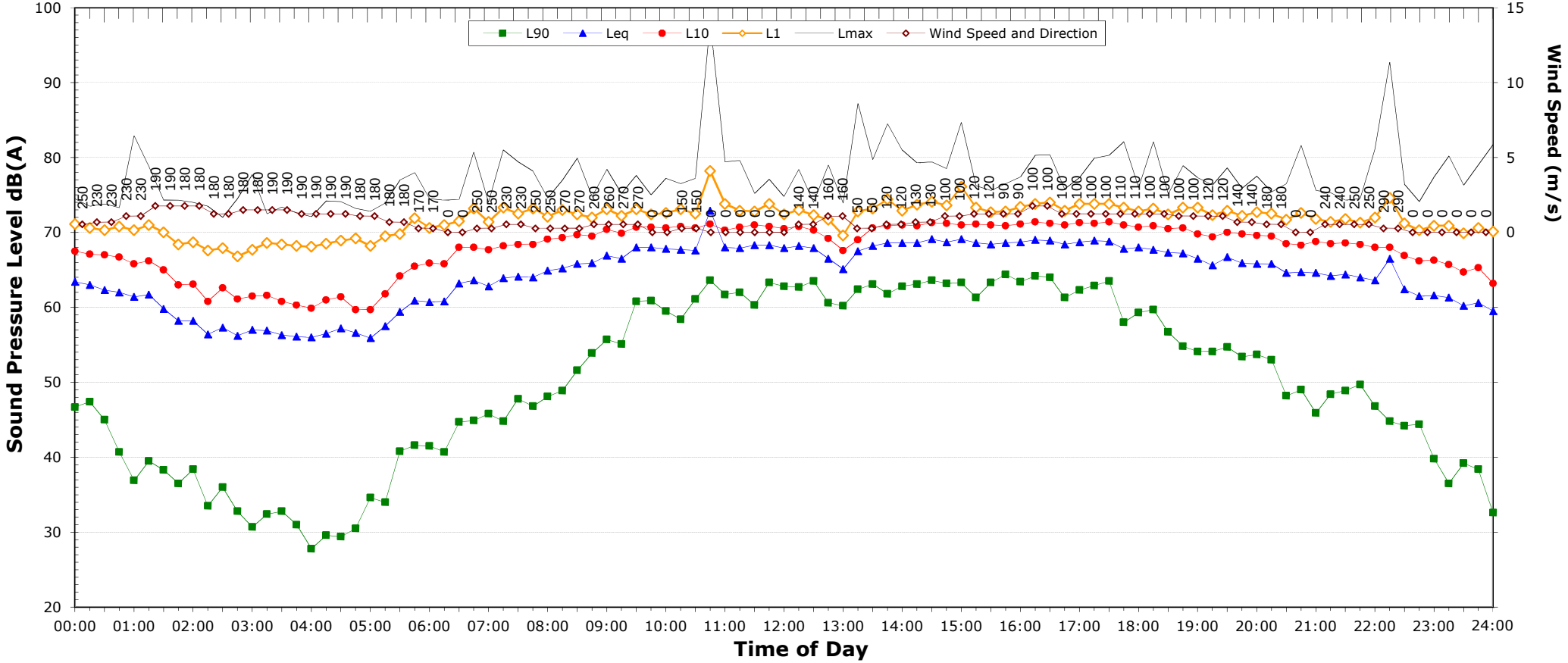
TG356-01.4.3.S06 (rev 2) 115 Showground Rd

Template QTE-05B (rev 104) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

115 Showground Rd

Sunday, 8 September 2013



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	55.4	46.8	27.5
Leq (see note 3)	65.7	63.2	60.7

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 1m from facade; tabulated results free-field 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)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	67.5	63.2
$L_{eq\ 1hr}$ upper 10 percentile	69.3	68.7
$L_{eq\ 1hr}$ lower 10 percentile	64.2	55.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	76.8	to	92.7
Lmax - Leq (Range)	20.2	to	29.1