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PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

NOISE AND VIBRATION ASSESSMENT

29 September 2015

SMEC Australia Pty Ltd

TG555-02F01 (r9) Noise and Vibration Assessment

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1 Introduction

Roads and Maritime propose to upgrade about 2.4 kilometres of the Pacific Highway through the town centre of Wyong, NSW. The planned upgrade extends from the Johnson Road intersection with the Pacific Highway to about 300 metres north of Cutler Drive.

Renzo Tonin & Associates were engaged to conduct an environmental noise and vibration assessment for the proposed Pacific Highway upgrade. Noise emissions from road traffic have been modelled and assessed at the potentially most affected residential receivers in accordance with the EPA's NSW Road Noise Policy (RNP) and the Roads and Maritime's Noise Criteria Guideline (NCG), Noise Mitigation Guideline (NMG) and Environmental Noise Management Manual (ENMM).

Noise and vibration associated with the construction phase of the proposal 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. Appendix A contains a glossary of acoustic terms used in this report.

2 Proposal Description

2.1 Key Proposal Features

Roads and Maritime propose to upgrade around 2.4 kilometres of the Pacific Highway from the intersection with Johnson Road, Wyong to about 150 metres north of Cutler Drive, Wyong.

The proposal would generally involve the following:

- Widening of the Pacific Highway between Johnson Road, Wyong to about 150 metres north of Cutler Drive, Wyong to a two lane carriageway in each direction
- Provision of a central median (separation of the northbound and southbound carriageways) between Johnson Road and just north of Cutler Drive
- Replacement of the existing Pacific Highway road bridge over the Wyong River with two new road bridges over the Wyong River, one for northbound traffic, pedestrians and cyclists and one for southbound traffic, pedestrians and cyclists
- Provision of a shared cycle/pedestrian path along the Pacific Highway between Johnson Road and Cutler Drive
- Reconfiguration of car parking provisions throughout the proposal area including provision of a dedicated rail commuter car park east of Wyong Station
- Provision of a pedestrian refuge to assist crossing of the Pacific Highway, and the partial closure of Bakers Lane to vehicles at the highway
- Provision of a new pedestrian bridge connecting the new shared path on the eastern side of the Pacific Highway to the existing Wyong Station pedestrian overbridge, providing a new western entrance to the station
- Upgrade of Pacific Highway intersections with McPherson Road, Church Street, Rose Street, Anzac Avenue, North Road and Cutler Drive
- Intersection adjustments at River Road, Alison Road and Apex Park
- Replacement of the Rose Street bridge over the rail line with a new bridge that is longer and wider
- Upgrade of Howarth Street intersections at Rose Street and Warner Avenue
- Dedicated bus stops along the Pacific Highway in both directions and relocation of bus layover facilities to the east of Wyong Station
- Provision of improved disabled parking and taxi services east of Wyong Station located close to station access lifts and stairs
- Provision of a dedicated rail commuter parking facility east of Wyong Station

- Improvements to River Road, Panonia Road and South Tacoma Road that include pedestrian footpaths
- Demolition and removal of the locally heritage listed former Station Master's Cottage and Warner Shops
- Urban design improvements and landscaping throughout the proposal area, including relocation of existing palm trees along the Pacific Highway where feasible
- Retaining walls of various heights and locations
- Property adjustments.

2.2 Land Uses

The proposal is located within the Wyong Shire local government area (LGA) and Roads and Maritime's Central Coast Region. The study area within which the proposal site is located includes a mix of residential, commercial, place of worship, active recreation, education and scattered industrial land uses. The proposal site is located mainly within the existing road corridor of the Pacific Highway.

The proposal site is surrounded mainly by residential and commercial land uses and other sensitive receivers. Adjoining land uses are described in Table 1 and include but are not limited to:

- Detached residential dwellings, residential apartment buildings, scattered commercial activities and other sensitive receivers including, passive and active recreation, education receivers, community centres and hotels with accommodation, to the east.
- passive and active recreation, education receivers, place of worship
- Detached residential dwellings, residential apartment buildings and commercial activities within the town centre and other sensitive receivers including, passive and active recreation, education receivers and place of worship, to the west.
- Detached residential dwellings, active recreation, education facility and commercial activities surrounding Rose Street commuter car park.

3 Existing Noise Environment

3.1 Noise Catchment Areas

To facilitate the assessment of noise impacts from the proposed Pacific Highway 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 proposal are described in Table 1 and shown on Figure 1.

Table 1: Noise Catchment Areas

NCA	Location	Description
NCA 1	Johnson Road - McPherson Road (western side of Pacific Highway)	• Commercial and industrial receivers • Typical setbacks of approximately 15-50 metres from main carriageway • Elevation of receiver floor level typically similar to road level
NCA 2	Panonia Road - Warner Avenue (eastern side of Pacific Highway)	• Detached residential dwellings and multi-story residential apartments, place of worship and educational receivers • Typical setbacks of approximately 50-100 metres from main carriageway • Elevation of receiver floor level varies, lower than road level near Panonia Road, above road level near Warner Avenue
NCA 3	Warner Avenue - Howarth Street (eastern side of Pacific Highway)	• Detached residential dwellings, educational, active recreational and commercial/industrial receivers • Typical setbacks of approximately 100 metres from main carriageway • Elevation of receiver floor level typically lower than road level
NCA 4	McPherson Road - North Road (primarily western side Pacific Highway)	• Scattered residential, commercial receivers, educational receivers, community centres and hotels with accommodation • Typical setbacks of typically less than 10 metres from main carriageway • Elevation of receiver floor level typically similar to road level
NCA 5	North Road - Watanobbi Road (eastern side of Pacific Highway)	• Detached residential dwellings, double story residential apartments, passive and active recreational and educational receiver • Typical setbacks of approximately 35-50 metres from main carriageway • 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 affected by traffic noise from the Pacific Highway. Long-term noise monitoring was conducted to quantify existing 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 proposal.

In addition, short-term monitoring was also conducted away from the Pacific Highway, in the vicinity of proposed construction sites and compounds, in order to establish background noise levels for the setting of construction noise goals for the proposal.

3.2.1 Noise Monitoring Locations

Long-term noise monitoring was conducted from Tuesday 29 April to Tuesday 13 May 2014 and short-term noise monitoring was conducted on Tuesday 29 April 2014 and Friday 9 May 2014. The following monitoring locations were selected as being representative of the various NCAs along the proposal route. The noise monitoring locations are shown in Table 2.

Table 2: Noise Monitoring Locations

Location	NCA	Address	Description[1]
Long Term Monitoring			
M1	2	19 Howarth Street, Wyong	Eastern side of Pacific Highway. Noise monitor installed in front yard in the free field. Distance to Pacific Highway approx. 80 metres. Dominant noise source: Pacific Highway traffic and some local road traffic along Howarth Street.
M2	3	3/142 Pacific Highway, Wyong	Western side of Pacific Highway. Noise monitor installed on the balcony of front facade facing Pacific Highway. Distance to Pacific Highway approx. 35 metres. Dominant noise source: Pacific Highway traffic followed by neighbourhood noise and commercial premises patron noise from down stairs.
M3	4	14/1A Cutler Drive, Wyong	Western side of Pacific Highway. Noise monitor installed in backyard in the free field near property boundary. Distance to Pacific Highway approx. 50 metres. Dominant noise source: Pacific Highway traffic..
M4	5	2 Watanobbi Road, Wyong	Western side of Pacific Highway. Noise monitor placed on the footpath in the free field. Distance to Pacific Highway approx. 50 metres. Dominant noise source: Pacific Highway traffic and some local road traffic along Watanobbi Road.

Notes:
1. Distances are from the **nearest** edge of the Pacific Highway carriageway.
2. Noise monitors were set in the free-field, at least 3.5m from any building facades.

3.2.2 Measured Noise Levels

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

Table 3: Results of Long Term and Short 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
Long Term Monitoring						
M1[2]	19 Howarth Street, Wyong	61	57	51	47	40
M2	3/142 Pacific Highway, Wyong	65	60	56	45	35
M3[2]	14/1A Cutler Drive, Wyong	60	56	50	43	36
M4[1,2]	2 Watanobbi Road, Wyong	66	-	53	-	-

Note 1. Long-term unattended noise monitoring was not possible at location M4. Therefore short-term attended measurements were conducted during daytime. No measurements where conducted at night at M4.

2. Free-field locations have been corrected to account for facade reflections; ie. +2.5dB(A) to the monitored noise levels

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Figure 1
Noise Catchment Areas and
Noise Monitoring Locations
(Section 1 of 3)

Reference: TG555-02_CA01_S01 (rev 1)

Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3

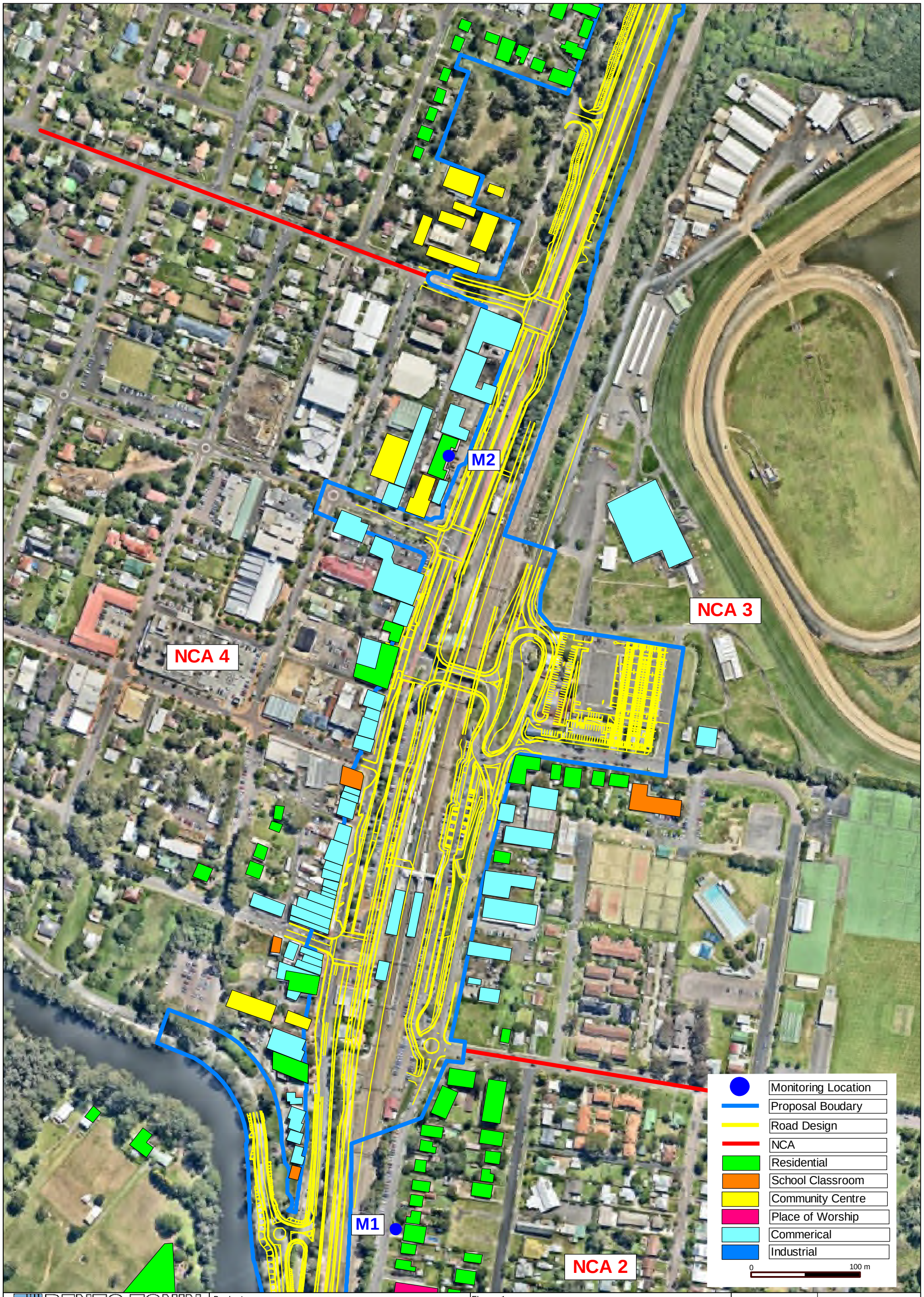

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Figure 1
Noise Catchment Areas and
Noise Monitoring Locations
(Section 2 of 3)

Reference: TG555-02_CA01_S02 (rev 1)

Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3

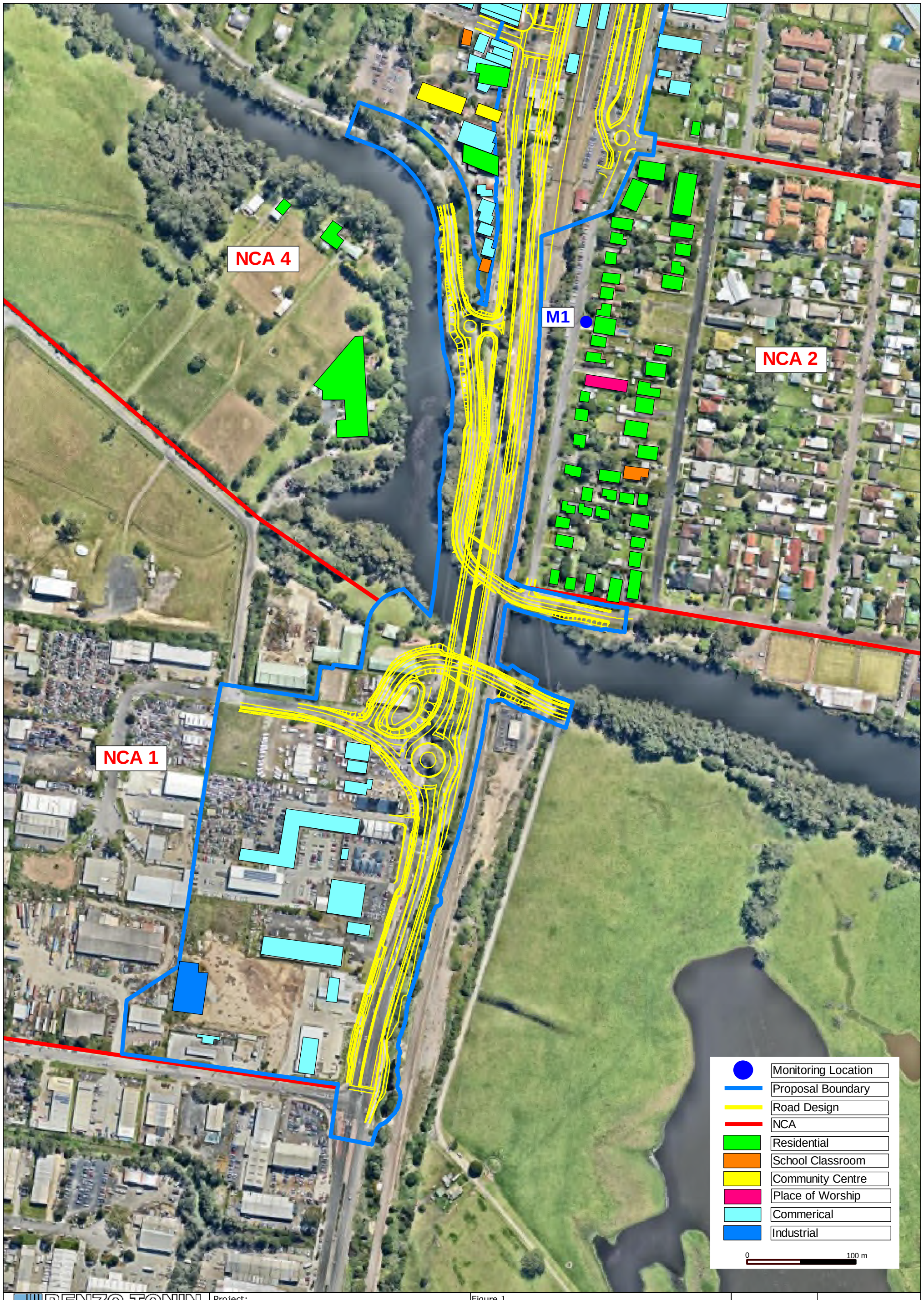

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Figure 1
Noise Catchment Areas and Noise Monitoring Locations (Section 3 of 3)

Reference: TG555-02_CA01_S03 (rev 1)

Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3

4 Operational Road Traffic Noise Criteria

Noise criteria are assigned to sensitive receivers using RMS' Noise Criteria Guideline (NCG). RMS' NCG provides guidance on how to apply the NSW Road Noise Policy. The assessment timeframe for the criteria are in the year of opening and 10 years after opening.

The study area for the proposed upgrade extends 600m metres from the centre line of the outermost traffic lane on each side of the subject road, except along adjoining side streets where the project added no more than 2 dB(A) to the total noise level. The study area boundary was then expanded to include any receivers where the project contribution exceeded 65 dB(A) $L_{Aeq,15hr}$ and 60 dB(A) $L_{Aeq,9hr}$. In addition, at locations where noise levels were clearly below the project's base noise criteria (i.e. due to shielding provided by intervening houses) predictions were not undertaken beyond these properties.

Residences may be assigned new, redeveloped, transition zone or relative increase criteria depending on how the project will influence noise levels. For each façade of the residence the most stringent applicable criteria will be used in the assessment.

Criteria are based on the road development type a residence is affected by due to the road project.

In some instances residences may be exposed to noise from new and redeveloped roads or different functional classes. In this instance the proportion of noise from each road is used to establish transition zone criteria and provides a smooth change in noise criteria between adjacent residences.

A further check is made to prevent large increases in noise level using the relative increase criteria.

The project is considered to be redeveloped for its entirety under the NCG. There are multiple transition zones between the road project and existing roads. Transition zones occur where the road project meets the existing Pacific Highway at the northern end of the road project, north of Cutler Drive and at the southern end of the road project at Johnson Street. Transition zones also occur where the road project meets side streets, which occurs multiple times along the length of the road project. Since all existing roads have been classified as arterial/sub-arterial and the road project is considered as a redeveloped road project, all project affected residential receivers have the same NCG assessment criteria.

The criteria for residences are summarised in Table 4.

Table 4 NCG criteria - residential

Road Category	Type of Project/Land Use	Assessment Criteria (dB)	
		Daytime (7 am - 10 pm)	Night-time (10 pm - 7 am)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
	2. Existing residences affected by noise from existing freeway/arterial/sub-arterial roads where no redeveloped is taking place[1]	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)

Road Category	Type of Project/Land Use	Assessment Criteria (dB)	
		Daytime (7 am - 10 pm)	Night-time (10 pm - 7 am)

Note 1: The criteria assigned to a façade dependent on the proportion of noise coming from the existing road. Please see RMS' Noise Criteria Guideline for further information.

The criteria for other sensitive receivers are presented in Table 5.

Table 5 NCG criteria – other sensitive 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.	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.
3.	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.
4.	Open space (passive use)	$L_{Aeq,15hour}$ 55 (external) when in use		
5.	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 residential 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 to internal noise levels has been adopted to allow an external assessment.

For non-residential receivers, external to internal noise level reductions have been estimated based on each receiver type's building construction, and these reductions range from 10 to 20dB(A). A 15dB(A) external-to-internal noise level reduction is assumed for airconditioned buildings with windows and doors normally shut and the building facade incorporates commercial glazing. A 20dB(A) external-to-internal noise level reduction is assumed for airconditioned buildings with windows and doors normally shut and the building façade being of masonry construction with small window areas. These assumed external-to-internal noise level reductions are conservatively low and it is expected that in practice greater reductions could be achieved.

Where estimation has not been possible a conservative 10dB(A) reduction from external-to-internal noise levels has been adopted to allow an external assessment. Receivers nominated with external-to-internal noise level reductions of 15dB(A) and 20dB(A) are identified in Appendix D.

The noise model predict noise levels for $L_{Aeq,15hr}$ and $L_{Aeq,9hr}$ periods for day and night respectively.

The criteria applicable to noise sensitive receivers identified in the project assessment areas are shown in Figure 1 and Appendix D.

5 Guidance for the Evaluation of Feasible and Reasonable Noise Mitigation for Road Traffic Generated Noise

The Noise Mitigation Guideline (NMG) provides guidance in managing and controlling road traffic generated noise and describes the principles to be applied when reviewing noise mitigation. The NMG recognises that the criteria recommended by the NCG are not always practicable and that it is not always feasible or reasonable to expect that they should be achieved.

The NMG notes that the most effective way of minimising noise from vehicles and traffic is to control vehicle noise at the source. Where source measures are not practical, or do not provide sufficient noise reduction, additional methods are required to reduce levels to within acceptable margins. Such additional methods may include the use of noise barriers and/or consideration for architectural treatment of residences.

The NMG provides three triggers where a receiver may qualify for consideration of noise mitigation (beyond the adoption of road design and traffic management measures). These are:

Trigger 1

- The predicted Build noise level exceeds the NCG controlling criterion and the noise level increase due to the project (ie the noise predictions for the Build minus the No Build) is greater than 2 dBA.

Trigger 2

- The predicted Build noise level is 5dBA or more above the criteria (exceeds the cumulative limit) and the receiver is significantly influenced by project road noise, regardless of the incremental impact of the project.

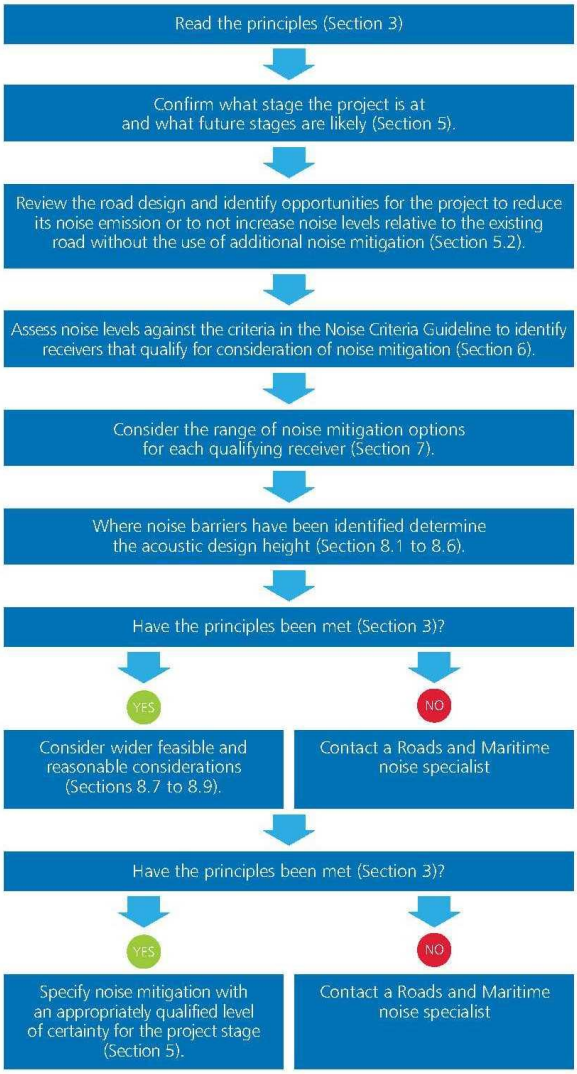
Trigger 3

- The noise level contribution from the road project is acute (daytime $L_{Aeq15hr}$ 65 dB or higher, or night-time L_{Aeq9hr} 60 dB or higher) then it qualifies for consideration of noise mitigation even if noise levels are dominated by another road.

The eligibility of receivers for consideration of additional noise mitigation is determined before the benefit of additional noise mitigation (quieter pavement and noise barriers) is included. The requirement for the project is to provide reasonable and feasible additional mitigation for these eligible receivers to meet the NCG controlling criterion. If the NCG criterion cannot be satisfied with quieter pavement and noise barriers, then the receiver is eligible for consideration of at-property treatment.

Further detail on the process of applying the NMG is presented in Section 6. The NMG process is summarised in the flowchart in Figure 2.

Figure 2: NMG Flowchart – Overall Approach for Noise Mitigation Assessment



6 Operational Traffic Noise Assessment

6.1 Traffic Flow and Composition Summary

6.1.1 Existing Traffic Volumes

Traffic counts of the Pacific Highway within the proposal area were conducted in February 2014 and were also conducted concurrently with the long term noise monitoring in April 2014 and May 2014 to allow validation of the computer noise model. The results of the traffic survey are summarised in Table 6 below.

Table 6: Existing 2014 Traffic Volumes and Compositions

Location	ROAD	Direction	DAY (7:00 – 22:00)				NIGHT (22:00 – 7:00)			
			Volume	HV%	Speed km/h		Volume	HV%	Speed km/h	
					Mean	85%[2]			Mean	85%[2]
T1	Pacific Highway north of North Road	Northbound	605	7.0	55	60	99	8.7	63	69
		Southbound	742	5.1	54	62	145	5.8	60	68
T2	Pacific Highway south of North Road	Northbound	549	7.0	49	55	90	8.7	54	60
		Southbound	673	5.1	49	55	132	5.8	53	60
T3	Pacific Highway south of Church Street	Northbound	695	7.0	51	58	113	8.7	58	65
		Southbound	852	5.1	55	60	167	5.8	59	65
T4	Watanobbi Road	Combined	135	2.7	45	52	9	1.7	46	50
T5	Cutler Drive	Combined	254	3.8	41	49	38	6	42	49

Notes:

1. HV% = percentage of heavy vehicles
2. 85 percentile vehicle speed

6.1.2 Opening and Design Year Traffic Volumes

Traffic data for the Pacific Highway has been provided by SMEC for future years 2021 (Year of Opening) and 2031 (Design Year) and are included in Appendix C. This data was utilised for the purpose of noise modelling predictions.

The proposal is a road redevelopment essentially involving the addition of lanes within the existing road corridor. SMEC has included traffic generation from known future developments into the volume forecasts in addition to the same volume of traffic that will use the road whether or not the proposal is built.

6.2 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 7: Summary of Modelling Inputs

Input Parameters	Data Acquired From
Road design	50% concept design (80% design is shown in figures and appendices for information purposes only)
Traffic volumes and mix	Based on forecast data from SMEC and traffic counts $L_{Aeq,15hr}$ and $L_{Aeq,9hr}$ volumes determined by summing hourly volumes over each period and dividing by the period length
Vehicle speed	Validation model: Based on measured 85th percentile speeds during traffic counting Future Model: 50/70km/h
Gradient of roadway	Topographic data provided by SMEC
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	can vary between 0 (hard surface eg paved areas) to 1 (soft ground eg expansive areas of thick grass, thick vegetation or cultivated fields etc) - predominantly 0 to 0.75 used in this project's model
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	$L_{Aeq,15h}$: -0.7 dB(A) for 'free field' conditions and -1.7 dB(A) for 'at facade' conditions from Australian Road Research Board (ARRB) Transport Research (Saunders et al 1983) $L_{Aeq,9h}$: 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

6.3 Model Validation

The noise model was validated using the long-term noise monitoring results. Table 8 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. Free field measured-to-modelled comparisons were undertaken for measurements conducted in the free field (M1, M3 and M4) and façade measured-to-modelled comparisons were undertaken for measurements conducted at façade (M2).

Table 8: Noise Model Validation

Location	$L_{Aeq,15hr}$ Daytime Noise Level			$L_{Aeq,9hr}$ Night time Noise Level		
	Measured	Modelled	Variation	Measured	Modelled	Variation
M1 -19 Howarth Street, Wyong	58.6	59.6	-1.0	54.3	53.7	0.6
M2 -3_142 Pacific Highway, Wyong	64.6	64.3	0.3	60.2	59.3	0.9
M3 -14_1A Cutler Drive, Wyong	57.3	59.0	-1.7	53.7	53.2	0.5
M4 -2 Watanobbi Road, Wyong[1]	63.8	63.5	0.3	-	-	-
Mean Variation			**-0.5**			**0.7**

Note 1. Long-term unattended noise monitoring was not possible at location M4. Therefore short-term attended measurements were conducted during daytime and used to correlate with measurements at M3. No measurements where conducted at night at M4.

The noise model validation results show that the noise model outputs are in 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 operation noise predictions for future traffic noise scenarios.

6.4 Noise Model Prediction Results

Operational noise modelling has been conducted based on the traffic volumes presented in Section 6.1. The scenarios predicted are:

- **'Opening Year',** where noise levels are the levels produced by the 2021 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 2031 for both the 'build' and 'no-build' options, for the day and night periods.

In accordance with the NMG additional mitigation should be considered when:

1. there is an exceedance of the cumulative limit and/or
2. the total noise level for the 'build' option exceeds the controlling criterion established using the NCG and there is an increase of more than 2.0dBA relative to the 'no-build' option.

The outcomes of noise modelling are:

- The change in noise levels as a result of the project are below 2.0 dB(A) and are considered barely perceptible, with the exception of three properties. The three (3) residences with noise increases exceeding 2dB(A) did not occur at the worst affected facades and are not presented in Appendix D. The receivers were also below the NCG target criteria and are not identified for consideration of noise mitigation.
- Thirteen residential receivers qualify for consideration of noise mitigation where noise levels remain well above the criteria and exceed the cumulative limit.
- Where noise levels at sensitive non-residential receivers exceed the assessment criteria, eight non-residential receivers qualify for consideration of noise mitigation due to either an increase of more than 2.0 dB(A) or due to exceedance of the cumulative limit.

While the assessment was carried out for all facades of buildings, Appendix D presents a summary of predicted noise levels for the worst affected façade at each receiver. A summary of the results at residential receivers and other sensitive receivers is respectively shown in Table 9 and Table 10. Specific properties where further noise mitigation should be considered are identified in Appendix D and a discussion of possible noise mitigation options is presented in Section 6.5. Appendix E presents the 'design' year 2031 noise level contours for day and night.

Table 9: Summary of Operational Noise Model Results at Residential Receivers

NCA	Does proposal increase noise levels by more than 2dB(A)?	Are the noise levels at any residential property at or above the cumulative limit?	Number of properties where further noise mitigation should be considered
1	No	No	0
2	Yes (at 1 receiver)	No	0
3	No	Yes (at 3 receivers)	3
4	Yes (at 1 receiver)	Yes (at 5 receivers)	5
5	Yes (at 1 receiver)	Yes (at 5 receivers)	5
		Total	**13**

Table 10: Summary of Operational Noise Model Results at Other Sensitive Receivers

NCA	Does proposal increase noise levels by more than 2dB(A)?	Are the noise levels at any Other Sensitive Receivers at or above the cumulative limits?	Number of properties where further noise mitigation should be considered
1	No	No	0
2	No	No	0
3	Yes (at 1 receiver)	No	0
4	Yes (at 2 receivers)	Yes (at 6 receivers)	7
5	No	Yes (at 1 receiver)	1
		Total	**8**

In summary, noise mitigation should be considered where design year noise levels are at or above the cumulative limits or where noise levels exceed the NCG criteria and have increased by more than 2.0dB(A) as a result of the proposal following consideration of feasible and reasonable measures.

6.5 Road Traffic Noise Mitigation Options

Although the noise impact of the proposal is minor, some residential properties within the proposal area are already exposed to 'acute' noise levels, and therefore an assessment of feasible and reasonable noise mitigation options is required.

This proposal 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.

The NMG sets out that priority should first be given to reducing noise during corridor planning and road design where there may be greater opportunity to provide cost effective integrated outcomes with better urban design. Following corridor planning and road design, Section 7 of the NMG indicates the following priority order for noise mitigation:

> *"Options for noise mitigation measures ae listed below in the order of preference…"*:
>
> i. Quieter pavement surfaces
>
> ii. Noise mounds
>
> iii. Noise walls
>
> iv. At-property treatments

All reasonable and feasible traffic management and road design opportunities to reduce road traffic noise have been considered within 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.

6.5.1 Quieter Pavements

The NMG sets out that quieter pavement surface is the preferred form of noise mitigation as it reduces source noise levels and provides protection to both external and internal noise levels and also has the least visual impact. Quieter pavement should be considered where there are groups of four or more receivers that exceed the NCG criteria.

In addition to the NMG, 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 proposal for the following reasons:

- The posted speed limit for the upgraded road is to be primarily 50 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.

6.5.2 Noise Barriers

The NMG sets out that like quieter pavement surfaces, a noise mound or noise wall provides protection to both external and internal noise levels. Noise mounds are preferred over a noise barrier because a noise wall typically has a higher visual impact. Noise walls are often more feasible than a mound as the site footprint can be much smaller. Noise barriers should be considered where there are four or more closely spaced receivers.

Noise barriers are reasonable and feasible where residences are closely grouped, where the barriers do not cause access difficulties to properties, and where they are visually acceptable. In accordance with the EMG barriers are not cost-effective for isolated dwellings. In addition, 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.

For this proposal, as the residences considered for at-property treatment are not closely grouped and for some, driveway access is required from the Pacific Highway, noise mitigation in the form of noise barrier is not considered to be reasonable and feasible.

6.5.3 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 NCG noise criteria comprise internal and external noise goals but 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 proposal complied with the NCG 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.

A 15dB(A) external to internal reduction can typically be achieved where buildings incorporate fresh air ventilation systems that meet building code of Australian requirements with the windows and doors shut and the building façade being of solid construction and incorporating commercial glazing units. A 20dB(A) external to internal reduction can typically be achieved where buildings incorporate fresh air ventilation systems that meet building code of Australian requirements with the windows and doors shut and the building façade being of masonry construction with a small window area.

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

- The installation of courtyard screen walls;
- Fresh air ventilation systems that meet building code of Australian requirements with the windows and doors shut;
- Upgraded windows and glazing and solid core doors on the exposed facades of substantial structures only (e.g. masonry or insulated weather board cladding with sealed underfloor). These techniques would be unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls);
- Upgrading window and door seals and appropriately treating sub-floor ventilation;
- Sealing of wall vents, the underfloor below the bearers and eaves.

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

Table 11: Residential At-Property Treatment Options

Treatment	Predicted exceedance of NCG 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.

6.6 Maximum Noise Level Assessment

6.6.1 Assessment Methodology

The upgrade involves widening of the road within the same road corridor but the change in distance from the road to receiver is reducing so an increase in L_{Amax} noise levels in the future is expected. Maximum noise levels generated by road traffic noise have the potential to cause disturbance to sleep. Although noise goals are not provided in the RNP, the RNP includes a review of internal sleep arousal research. The RNP concludes that there appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise. Nevertheless, Roads and Maritime recognises the potential impacts and requires an assessment of maximum noise levels be made where impacts may occur during the night.

Guidance for assessing maximum noise levels are provided in Practice Note iii of the ENMM. The maximum noise assessment should be used as a tool to help prioritise and rank mitigation strategies, but should not be used as a decisive criterion in itself and should not be used to aid in designing the degree of mitigation required.

The assessment considers the following:

- calculation of maximum noise levels;
- the extent to which the maximum noise levels for individual vehicle pass-bys exceed the L_{Aeq} noise level for each hour of the night (i.e. L_{Amax} noise levels greater than 65dBA where $L_{Amax} - L_{Aeq(1hour)} \geq 15$ *dB(A))*.

At locations where road traffic is continuous rather than intermittent, the $L_{Aeq(9hour)}$ criteria for operational noise assessment should sufficiently account for sleep disturbance impacts. However, where the emergence of L_{Amax} over the ambient L_{Aeq} is equal to or greater than 15dBA, the $L_{Aeq(9hour)}$ criteria may not sufficiently account for sleep disturbance impacts.

Taking guidance from Practice Note iii of the ENMM, 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 (2014) and future (2031) traffic volumes data provided by SMEC.
- Evaluate whether maximum noise impacts will reduce or increase for the design year.

6.6.2 Maximum Noise Level Impacts

Table 12 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.

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 2031 has been provided in Table 12. The increase in the number of Lmax events between 2014 and 2031 is in direct proportion to the increase in truck movements at night over the same period.

Table 12: Maximum Noise Levels at Night

Receiver	Measured 2014									Predicted 2031						
	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	
M1 -19 Howarth Street, Wyong	65	90	15	29	0	17	39	72	59	67	92	0	30	68	126	103
M2 -3_142 Pacific Highway, Wyong	70	91	15	32	0	15	20	38	30	74	95	0	18	24	45	36
M3 -14_1A Cutler Drive, Wyong	66	82	16	30	0	19	31	66	51	69	85	0	23	37	79	61

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

Table 12 indicates that L_{Amax} noise levels in the future are predicted to increase by 2 to 4 dB(A). It is noted that the increase in the number of maximum noise level events from 2014 to 2031 shown in Table 12 above, is not a result of the proposal itself, but rather the natural traffic increase which would occur regardless of whether or not the proposal gets built.

With the exception of Rose Street Car Park, at this stage of the concept design the proposal is not expected to significantly alter traffic flow at intersections. The potential for sleep disturbance from Rose Street Car Park is addressed in Section 7.3.2.

7 Rose Street Car Park Noise Level Assessment

The existing single level Rose Street commuter car park is proposed to be upgraded to a double storey carpark to accommodate 498 spaces. The locality of the car park and nearest sensitive receivers are shown in Figure 1 (section 2 of 3) and Appendix D. Car park access driveway is proposed to be moved from Rose Street to Howarth Street, just above the Howarth Street and Rose Street intersection. The car park is proposed to operate 24 hours a day, 7 days per week.

Given that there are no specific criteria for addressing noise from car parks, and the character of noise from car parks differs from general traffic noise, this noise source requires a different approach to assessment and management.

7.1 Noise Criteria

The NSW 'Industrial Noise Policy' (INP, Environment Protection Authority 2000) is not strictly used for the assessment of non-industry based noise emissions, however the application of the criteria may be implemented where guidance on appropriate noise levels is required. Therefore, for the purpose of this assessment, it is appropriate to assess its potential impact on the general noise amenity surrounding the site based on the NSW INP and the EPA's sleep arousal noise guidelines.

7.1.1 NSW INP

The INP sets criteria to protect noise amenity for residential receivers and other land uses. The basis for its policy relies on two components:

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

Intrusive Criteria

The INP recommends that the intrusiveness of a noise source may generally be considered acceptable at any residential receiver if the L_{Aeq} (equivalent continuous A-weighted level of noise) from the source, measured over a 15 minute period, does not exceed the Rating Background Level (RBL) by more than 5dB(A). That is;

$$L_{Aeq,15min} \leq RBL + 5dB(A)$$

Amenity Criteria

The Amenity Criteria are determined in accordance with Chapter 2 of the INP. The INP recommends base acceptable noise levels for various receivers, including residential, commercial, industrial receivers and sensitive receivers such as schools, hospitals, churches and parks. These base noise criteria are then lowered by up to 10dB depending on the extent of existing industrial noise impact upon the receiver. Higher levels of existing industrial noise therefore result in stricter Amenity Criteria applied to any new

industrial development. In this way the cumulative impacts of existing and known future industrial noise sources are minimised.

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the policy, the applicable parts of which are reproduced in Table 13 below.

Table 13: Amenity Criteria – Recommended L_{Aeq} Noise Levels from Industrial Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq(Period)}$ Noise Level	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70

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

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

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

Project Noise Goals

In accordance with the INP, noise impact should be assessed in terms of both intrusiveness and amenity. Based on the background and ambient noise monitoring carried out at the nearest affected residential locations, the industrial noise criteria for the car park are within Table 14 below.

Table 14: Project INP Noise Goals, dB(A)

Nearest Affected Residence	Intrusiveness Criteria[1] $L_{Aeq,15min}$			Amenity Criteria[2] $L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night
5 Rose Street, Wyong	**56**	**52**	**45**	65	55	50
Wyong Pre-School, 9 Rose Street, Wyong	n/a			50[3,5]		
Race Course (active recreation area)	n/a			60[4]		
Baker Park (active recreation area)	n/a			60[4]		
Commercial premises	n/a			70[4]		

Nearest Affected Residence	Intrusiveness Criteria[1] $L_{Aeq,15min}$			Amenity Criteria[2] $L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night

Notes: 1. Based on monitoring location M1

2. Residential location has been categorised as 'Urban'. Given that the existing noise environment is not influenced by existing industry, the Amenity Criteria have not been modified in accordance with Table 2.2, NSW INP.

3. Amenity criteria applicable during the nosiest 1 hour period when the premises is in use

4. Amenity criteria applicable when premises is in use

5. INP suggests that the acceptable noise level impacting a school classroom is 40dB(A) internally inside the school classroom, which equates to an external level of 50dB(A,) assuming 10dB(A) reduction through an open window.

Bold indicates strictest noise criteria

7.1.2 Traffic Noise

7.1.2.1 Residential Land Uses

The NCG is used to assess the potential traffic noise impact on existing residences affected by additional traffic on existing sub-arterial roads generated by land used developments. The criteria for residential type receivers, as set out in the RNP apply and are presented in the table below. This criterion is the same as what was adopted for the operational assessment set out in Section 3.2.2 of this report. These criteria are for assessment of noise levels at 1m from building facades.

Table 15: 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	1. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
	2. Existing residences affected by noise from existing freeway/arterial/sub-arterial roads where no redeveloped is taking place[1]	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)

Note 1: The criteria assigned to a façade dependent on the proportion of noise coming from the existing road. Please see RMS' Noise Criteria Guideline for further information.

7.1.2.2 Sensitive Land Use Developments

The NCG also sets guidelines for the assessment of traffic noise on sensitive land uses such as schools and recreation areas. The noise assessment criteria are presented in Table 16 below.

Table 16: 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. 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.
3. Open space (passive use)	$L_{Aeq,15hour}$ 55 (external) when in use		

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

7.1.3 Sleep Disturbance

Noise emanating from the operation of the proposed car park has been assessed for its potential to disturb sleep. The NSW EPA *Application notes – NSW Industrial Noise Policy states*:

> *Sleep disturbance*
>
> *Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*
>
> *Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, the EPA recognised that the current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This*

> *means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:*
>
> - *how often high noise events will occur*
> - *time of day (normally between 10pm and 7am)*
> - *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*
>
> *The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max).*

Section 5.4 of the RNP notes:

> *From the research on sleep disturbance to date it can be concluded that:*
>
> - *maximum internal noise levels below 50-55dB(A) are unlikely to awaken people from sleep*
> - *one or two noise events per night, with maximum internal noise levels of 65-70dB(A), are not likely to affect health and wellbeing significantly.*

In regard to external noise levels, the maximum internal noise level 55dB(A) referenced in the RNP is equivalent to 65dB(A) outside an open window. It is noted that a 10dB(A) reduction from outside to inside is common and typical noise reduction via an open window. The 65dB(A) external noise limit is consistent with the findings of Griefahn [*Acoustics Australia vol 20 No 2 August 1992 pp 43-47*].

The NSW EPA confirm that a sleep disturbance criterion of $L_{A1(1min)} \leq L_{A90(15min)} + 15dB(A)$, should only be used as a first step guide and where the criteria is not met, more detailed analysis is required. The Application Notes of the NSW Industrial Noise Policy (2010) note the detailed analysis should include:

- the extent to which the maximum noise level exceeds the background level,
- the number of times this happens during the night-time period, and
- the time of day (normally between 10pm and 7am).

In summary, the sleep disturbance criteria of $L_{A1(1min)} \leq L_{A90(15min)} + 15dB(A)$ is to be used for initial assessment, however consideration is also given to the 'upper' limit criteria of 65dB(A) in accordance with the RNP. It is noted that the background $L_{A90(15minute)}$ noise level used for establishing the sleep disturbance criteria does not need to exclude other noise from the subject proposal.

The sleep disturbance criteria for the proposal are presented in Table 17.

Table 17: Sleep disturbance criteria

Sleep disturbance criteria, 10:00pm - 7:00am, LA1,1minute, dB(A)	
LA90(15min) + 15[1]	**Upper limit**
40 + 15 = 55	65

Notes 1. Based on monitoring location M1

7.2 Noise Modelling Methodology

On the current drawings the car park will have a capacity of 498 spaces. The car park will be accessed from Howarth Street that has a drive way situated just north of the Howarth Street and Rose Street intersection.

Noise emissions generated by car park activities include vehicle doors closing, vehicle engines starting, vehicles accelerating and vehicles moving. The RLS-90 road traffic noise calculation standard contains algorithms which can predict noise from car parks and has been used for this assessment.

For this concept design stage a detailed analysis determining the number of movements associated with the car park has not been undertaken but will be confirmed at the detailed design stage. For the purpose of noise predictions, it has been assumed that:

- During the daytime the car park will be emptied-from/filled-to full capacity over a 2 hour period (i.e. approximately 60 car spaces will be filled or emptied within a given fifteen minute period).
- During the evening the car park will be emptied-from/filled-to half capacity over a 2 hour period (i.e. approximately 30 car spaces will be filled or emptied within a given fifteen minute period).
- During the night-time the car park will be emptied-from/filled-to quarter capacity over a 2 hour period (i.e. approximately 15 car spaces will be filled or emptied within a given fifteen minute period).

7.3 Rose Street Carpark Predicted Noise Levels

7.3.1 Operational Noise

The results of the noise model predictions are presented below. Noise compliance is achieved at all assessment locations.

Table 18: Predicted Noise Levels for Rose Street Carpark

Nearest Affected Receiver	Criteria			Predicted noise level $L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night	Day	Evening	Night
5 Rose Street, Wyong	56	52	45	48	45	42

Nearest Affected Receiver	Criteria			Predicted noise level $L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night	Day	Evening	Night
Wyong Pre-School, 9 Rose Street, Wyong		50[1]			45	
Race Course (active recreation area)		60[1]			45	
Baker Park (active recreation area)		60[1]			33	
Commercial premises		70[1]			43	

Notes: 1. Criteria applicable when premises is in use

7.3.2 Traffic Noise

The outcomes for the Rose Street Car Park traffic assessment are that the increase in noise levels between the design year 'no build' and 'build' options is not more than 2.0dB(A) and therefore the impact associated with increased noise from the proposal is considered minor.

The predicted noise levels produced by the noise model are shown in detail in Appendix D. A summary of the results is shown in Table 19. Note the three (3) receivers identified within Table 19 are the same receivers identified for NCA3 within Table 9 of this report.

Specific properties where further noise mitigation should be considered are identified in Appendix D and a discussion of possible noise mitigation options is presented in Section 6.5. Appendix E presents the 'design' year 2031 noise level contours for day and night.

Table 19: Summary of Rose St Car Park Traffic Noise Model Results

NCA	Does proposal increase noise levels by more than 2dB(A)?	Are the noise levels at any residential exceed the cumulative limit?	Number of properties where further noise mitigation should be considered
3	No	Yes	3
		Total	3

7.3.3 Sleep Disturbance

There is potential for sleep disturbance due to maximum noise level events such as car door slams or engine starts in the car park prior to 7am and after 10pm. Noise modelling has been conducted based on data from our library files and a sound power level of 95dB(A) for a door slam. This noise level is conservatively higher than the average door slam level that was used for the Leq assessment of the car park as it considers a worst case door slam.

L_{Amax} noise levels at the nearest residences are predicted to be up to approximately 60 dB(A). These events would be most numerous (up to 60 p/hour) during the morning peak which is likely to begin before 7am, but are expected to be much lower outside of peak hours. The predicted L_{Amax} noise level exceeds the EPA's initial assessment level of 'background +15dB' by 5 dB(A) during periods where the car park is in use, but is well below the recommended 65dB(A) maximum assessment level. Therefore, sleep disturbance from car park activities is unlikely.

8 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).

8.1 Construction Hours and Duration

8.1.1 Standard and proposed (extended) Work Hours

Construction of the proposal is anticipated to commence in 2017 and would take about 4 years to complete.

Roads and Maritime is seeking approval for standard construction hours, plus additional time at the start and end of each day (extended construction hours), as described in Table 20. Certain activities would be undertaken during extended construction hours and these hours would apply across the full length of the proposal. Targeted consultation with affected residents is proposed to be undertaken in association with the public exhibition of this REF.

Table 20: Standard and Proposed (extended) Construction Hours

Day	Standard Hours		Proposed (extended) Hours	
	Start Time	Finish Time	Start Time	Finish Time
Monday to Friday	7am	6pm	6am-7am	6pm-8pm
Saturday	8am	1pm	7am-8am	1pm-5pm
Sunday/public holiday	No Work			

Extended construction hours at the start and finish of each working day are considered to be in the greater public interest as they would:

- Shorten the overall construction period by about 6 to 9 months or up to 20%. This would reduce the disruption to road users on the Pacific Highway and to businesses in the Wyong town centre.
- Potentially reduce the overall cost of construction.

Consultation with affected residents would be undertaken prior to work commencing.

8.1.2 Out-of-hours Work

Due to the importance of maintaining through traffic on the Pacific Highway through Wyong, particularly during peak hours, some out of hours work would be required to minimise disruptions to motorists and protect the safety of workers and the travelling public. Work outside of standard construction hours and extended construction hours would be undertaken in accordance with approvals and notification requirements of any Environment Protection Licence (EPL) for construction of the proposal.

8.2 Construction Noise Objectives

8.2.1 Construction Noise Management Levels at Residences

Construction noise management levels are determined by the NSW ICNG. Table 21 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 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 21: 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: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

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 22 identifies the adopted NMLs for receivers within the various NCAs along the route. The NMLs for each NCA are derived from the RBL results of the nearest long term and short term noise monitoring location.

Table 22: Construction Noise Management Levels at Residential Receivers

NCA	L_{A90} RBL			Noise Management Level $L_{Aeq(15min)}$		
	Day	Evening	Night	Day	Evening	Night
NCA 1	51	47	40	61	52	45
NCA 2	51	47	40	61	52	45
NCA 3	51	47	40	61	52	45
NCA 4	56	45	35	66	50	40
NCA 5	50	43	36	60	48	41

Notes: 1. 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.

8.2.2 Construction Noise Management Levels at Other Sensitive Land Uses

Table 23 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 23: 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 proposal construction route are detailed in the following table.

Table 24: Other Sensitive Receivers

ID	NCA	Address	Receiver	Receiver Type
S1	1	2 Johnson Road	Caltex Service Station	Commercial
S2	1	186 Pacific Highway	CSR Gyprock	Industrial
S3	1	188 Pacific Highway	Various Commercial Premises	Commercial
S4	1	190 Pacific Highway	ParkTrent Real Estate	Commercial
S5	1	192 Pacific Highway	Mitsubishi Dealership	Commercial
S6	1	194 Pacific Highway	Hyundai Dealership	Commercial
S7	1	198 Pacific Highway	Coromal Caravans Dealership & Repairs	Commercial
S8	1	200 Pacific Highway	Tuggerah Lakes Autos Dealership	Commercial
S9	1	202 Pacific Highway	FriendLee Auto's Dealership	Commercial
S10	2	13A, Howarth Street	Central Coast Islamic Cultural Centre	Place of Worship
S11a	2	6_2 Byron Street	Small World Preschool	Educational
S11	3	37 - 41 Howarth Street	Trackside Automotive	Commercial
S12	3	43 Howarth Street	Lifeline Shop	Commercial
S13	3	45 - 47 Howarth Street	St Vincent de Paul	Commercial
S14	3	49 - 51 Howarth Street	Complete Bearing Suppliers	Commercial
S15	3	55 Howarth Street	Pro Disc Caravan & RV Accessories	Commercial
S16	3	57 Howarth Street	ASI Lamps	Commercial
S17	3	59 Howarth Street	Camping World	Commercial
S18	3	61 Howarth Street	Commercial Block (Wand Printing/ Funeral Services etc)	Commercial
S19	3	71 - 75 Howarth Street	Wyong Race Club	Active Recreation
S20	3	319 Pacific Highway	Wyong Golf Club	Active Recreation
S21	3	9 Rose Street	Wyong Pre School	Educational
S22	3	Wyong Racecourse & Showground	Rescue Squad Offices	Commercial
S23	4	3 Pacific Highway	Commercial Block (Railway Square Shops)	Commercial
S24	4	10 Pacific Highway	Wyong Adult & Community Education	Commercial
S25	4	12 Pacific Highway	Cats Accountants	Commercial
S26	4	14 - 16 Pacific Highway	Commercial Block (Accountants, Capital One Real Estate etc)	Commercial
S27	4	18 - 20 Pacific Highway	Wyong Skin Cancer Clinic	Commercial
S28	4	22-32 Pacific Highway	Commercial Block (First National, Bottle O etc)	Commercial
S29	4	34 - 36 Pacific Highway	Commercial Block (G.J. Garnder, Tonkin Drysdale Partners etc)	Commercial
S30	4	38 Pacific Highway	UnitingCare Burnside	Community Centre
S31	4	38A Pacific Highway	Wyong Community Health Centre	Community Centre
S32	4	40 - 44 Pacific Highway	Royal Hotel Wyong	Commercial
S33	4	46 Pacific Highway	Wynstan Blinds & Doors	Commercial
S34	4	48 Pacific Highway	Commercial Block (Book Shop, Take Away Food)	Commercial
S35	4	50 - 52 Pacific Highway	Chinese Restaurant	Commercial

ID	NCA	Address	Receiver	Receiver Type
S36	4	1 Church Street	Wyong Dental Centre	Commercial
S37	4	4 Church Street	Second Hand Sales	Commercial
S38	4	5 Church Street	Central Coast Community College	Educational
S39	4	54 Pacific Highway	Commercial Block (Pelican Take Away, MHS Recruitment & Consulting)	Commercial
S40	4	56 - 64 Pacific Highway	Doctors Surgery	Commercial
S41	4	56 - 64 Pacific Highway	Commercial Block (Legends Bakery, Computer Shop etc)	Commercial
S42	4	66 - 68 Pacific Highway	The Little Frog Restaurant	Commercial
S43	4	70 Pacific Highway	Optometrist	Commercial
S44	4	72 Pacific Highway	Locksmith	Commercial
S45	4	74 Pacific Highway	Blooms Pharmacy	Commercial
S46	4	76 - 78 Pacific Highway	Pawnbroker	Commercial
S47	4	80 - 82 Pacific Highway	LJ Hooker	Commercial
S48	4	84 - 88 Pacific Highway	Commercial Block (Break Thru People Solutions, Bendigo Bank, Simplicity Funerals)	Commercial
S49	4	90 - 96 Pacific Highway	Commercial Block (Coast & Country Meats, Global One etc)	Commercial
S50	4	98 Pacific Highway	Commercial Block (H&R Block, GE Money etc)	Commercial
S51	4	100 - 104 Pacific Highway	Commercial Block (CBD Law Solicitors & Attorneys, STR Body Modifications, Tattoo Studio, Pizza in the Pan)	Commercial
S52	4	102 Pacific Highway	Dental Surgery	Commercial
S53	4	106 Pacific Highway	Evocca College	Educational
S54	4	108 Pacific Highway	Joanne's Café	Commercial
S55	4	112 - 116 Pacific Highway	Commercial Block (Dominos, D.&.A Wood Appliances)	Commercial
S56	4	118 - 120 Pacific Highway	Commercial Block (Barber, Chinese Restaurant)	Commercial
S57	4	124 Pacific Highway	St Vincent de Paul Society	Commercial
S58	4	126 Pacific Highway	The Grand Hotel	Commercial
S59	4	128 Pacific Highway	Commercial – Ambulance Station	Commercial
S60	4	130 - 136 Pacific Highway	Crossley Real Estate	Commercial
S61	4	138 Pacific Highway	Nissan/Mazda Dealership	Commercial
S62	4	11-13 Hely Street	Roads and Maritime Services Office	Commercial
S63	4	140 Pacific Highway	Caltex Petrol Station	Commercial
S64	4	4 Anzac Avenue	The Salvation Army Community Centre	Community Centre
S65	4	15 - 23 Hely Street	The Salvation Army Oasis Youth Centre	Community Centre
S66	4	142 Pacific Highway	Commercial Block (Newsagency, Hairdresser etc)	Commercial
S67	4	144 Pacific Highway	Beaurepaires	Commercial
S68	4	146 Pacific Highway	Commercial Block	Commercial
S69	4	148 Pacific Highway	Commercial Block	Commercial
S70	5	1 North Road	Community Centre	Community Centre

ID	NCA	Address	Receiver	Receiver Type
S71	5	156 - 168 Pacific Highway	Commercial Block	Commercial

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 21.

8.2.3 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.

8.3 Construction Activities and Equipment

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 proposal. Where applicable, the activities within the following table will be undertaken to construct the proposed carpark.

Table 25: Construction Activity & Equipment List

Activity	Description of Activity	Plant/ Equipment	No. Units	Overall Activity Sound Power Levels, dB(A)	
				L_{Aeq}	L_{Amax}
Site Establishment	Installing construction boundary hoardings/fences and traffic barriers	Truck	2	105	116
		Scissor Lift	2		
		Franna Crane	2		

Activity	Description of Activity	Plant/ Equipment	No. Units	Overall Activity Sound Power Levels, dB(A)	
				L_{Aeq}	L_{Amax}
Clearing & grubbing	General land clearing, tree and stump removal, topsoil stripping, loading	Bulldozer	2	122	124
		Excavator	4		
		Chainsaw	2		
		Tub grinder/ mulcher	2		
		Dump trucks	3		
Bulk earthworks	Excavation of soil and rock. Hammering/rock breaking. Drilling. Loading. Haulage.	Bulldozer	2	115	116
		Excavator	8		
		Grader	2		
		Dump truck	2		
		Road truck	6		
		Compactor	2		
		Water cart	2		
Drainage infrastructure	Excavation of trenches and pits; Delivery and placement of precast pipes and pits; filling and compacting.	Backhoe	3	110	116
		Excavator	3		
		Dump truck Concrete	4		
		Truck Compressor	1		
		Road trucks	4		
Bridge works	Casting; concrete pours; Placement of pre-cast elements; Piling (mainly bored); and Demolition.	Crane	1	118	125
		Bored piling rig	1		
		Agitators	4		
		Concrete pump	2		
		Concrete truck	2		
		Compressor	2		
		Generator	2		
		Pneumatic hammer	2		
		Welding equipment	2		
Paving/ asphalting (inc concrete sawing)	Delivery of raw materials. Placement of surface material. Saw cutting.	Paver	2	117	118
		Road truck	4		
		Asphalt truck & sprayer	2		
		Roller	2		
		Concrete saw	1		
Compounds	Deliveries. Plant and equipment. Maintenance. Office areas. Storage areas.	Excavator	2	111	116
		Dump trucks	4		
		Compressor	2		
		Welding equipment	4		
		Light vehicles	40		
		Heavy vehicles.	10		
		Generators	2		
Road furniture installation	Signposting and line marking	Truck	2	110	116
		Scissor Lift	2		
		Franna Crane	2		
		Line marking truck	2		

The specific equipment associated with proposed extended hours and out-of-hours work has yet to be finalised. The below sections do however provide a description of the activities.

8.3.1 Extended hours

Activities that would be undertaken during extended construction hours are as follows, and potential noise impacts are described and assessed in Section 8.5.

- Compound operation including stockpiling and general office duties
- Deliveries of materials, such as bridge girders, and oversized construction materials such as cranes
- Establishment of temporary traffic facilities and traffic switches to enable highway traffic flows to be maintained during construction
- Bridge demolition at Wyong Bridge
- Removal of existing pavements
- Haulage of material
- Earthworks, including haulage, placement and compaction
- Asphalting
- Construction outside shops along Pacific Highway in the town centre, including footpaths and pavement sheeting
- Pile driving and/or boring at bridges and retaining walls
- Utility adjustments and relocations
- Finishing works

8.3.2 Out-of-hours work

These types of activities would need to be undertaken outside of normal and extended construction hours to minimise road safety risks, minimise disruption to regional and local traffic flows and/or for technical and timetabling reasons. Possible reasons for out-of-hours work and typical justifications would include:

- Where it is necessary to minimise traffic impacts, such as pavement replacement and line marking works in the town centre.
- Completion of tie-ins at the extents of the proposal, and completion of temporary diversions and traffic switches – justified because completing or installing these items at night when traffic flows on the Pacific Highway are lower would minimise disruption to regional and local traffic and minimise any potential safety conflict between construction personnel and traffic.
- Bridge demolition activities at Wyong River where the bridge crosses over the operational Panonia Road and South Tacoma Road – justified because during construction demolition activities would need to occur across operating roadways. Due to the potential safety risks to

road users and construction personnel associated with operating over the existing alignment, these works would need to be undertaken at night when there are lower traffic flows. Avoiding peak periods would also minimise the disruption to traffic.

- Delivering large pre-cast components, such as bridge girders – justified because it would minimise disruption to highway and local traffic flows.
- Utility adjustments - justified because utility adjustments usually need to be undertaken during out of hours work periods to minimise the impact on consumers, road traffic and to protect the safety of workers involved.
- All out-of-hours works would be undertaken in accordance with Practice Note VII 'Roadworks outside normal working hours' presented in RMS's ENMM and all reasonable and feasible measures would be undertaken to manage noise impacts.
- Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm
- As agreed through consultation between Roads and Maritime and potentially affected sensitive receivers. Any such agreement would be recorded in writing and a copy kept on-site for the duration of the works

8.3.3 Rail Possession Periods

Demolition and construction of some elements of the Rose Street bridge would be required to be undertaken during rail shut-down periods for reasons of safety and in accordance with Sydney Trains procedures. Rail possession periods are usually granted for a period of up to 36 hours and work would be required 24 hours per day during this period. Typically there are only three scheduled rail shut down periods in a calendar year, usually over long-weekends.

A Construction Noise Management Plan and Community Consultation Plan would be prepared to provide a framework for managing any out of hours work. These would be implemented in conjunction with the EPL for the proposal, and would provide for appropriate notification periods. All feasible and reasonable mitigation measures would be implemented so that the potential for adverse impact on the local community is minimised.

8.4 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 proposal.

Table 26: Typical Construction Equipment & Sound Power Levels

Plant Description	Sound Power Levels, dB(A)	
	L_{Aeq}	L_{Amax}
Asphalt Truck Sprayer	103	116
Agitators	108	116
Backhoe	101	108
Bored Piling Rig	112	115
Bulldozer	109	115
Chainsaws	119	124
Compactor	110	116
Concrete Pump	102	104
Concrete Saw	115	118
Concrete Truck	106	116
Dump Trucks	105	116
Franna Crane	99	102
Grader	107	115
Light Vehicle	100	103
Line Marking Truck	108	112
Mobile Crane	110	116
Pavement Laying Machine	109	118
Pneumatic Hammer	115	120
Power Generator	100	106
Rock Breaker	117	125
Rollers	104	110
Scissor Lift	98	101
Tracked Excavator	107	115
Truck Compressor	75	78
Truck (>20tonne)	103	116
Tub Grinder	119	124
Water Cart	104	116
Welding Equipment	97	100

Note: L_{Amax} 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.

8.5 Predicted Noise Levels

Noise emissions were determined by modelling the noise sources, receiver locations, and operating activities as outlined above. The construction of the proposed extension of the Rose Street car park is included in this assessment. 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.

Construction equipment associated with proposed extended hours and out-of-hours work has yet to be finalised. Conservatively, the construction activities within Table 25 have been assessed against all time periods to give an indication of the potential noise impacts should construction occur out of standard hours. Specific noise predictions pertaining to extended hours and out-of-hours work will need to be undertaken at the detailed design stage and for the generation of a Construction Noise & Vibration Management Plan (CNVMP).

Table 27 presents the typical setback distances from NCAs and construction activities. Appendix F can also be referred to.

Table 28 presents a summary of the predicted range of L_{Aeq} noise levels at residential receivers for each activity associated with the construction phase for residential receivers. The lower value of the range is based on quietest equipment item of an activity only operating and the higher value of the range is based on all equipment items for that activity operating concurrently. The assessment point is at the residential boundary.

Table 29 presents a summary of the predicted range of L_{Aeq} noise levels for each activity associated with the construction phase for other sensitive receivers. The lower value of the range is based on quietest equipment item of an activity only operating and the higher value of the range is based on all equipment items for that activity operating concurrently. The most affected type of sensitive receiver within each NCA is presented. The assessment point is at the most affected occupied point of the premises, typically at the front façade.

Table 30 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.

Appendix F presents the predicted L_{Aeq} noise level contours for each activity associated with the construction phase.

Table 27: Typical Setback Distances from Construction Activities

Activity	Typical Setback Distances (metres)				
	NCA 1	NCA 2	NCA 3	NCA 4	NCA 5
Site Establishment	15 -50	50 -100	100	<10	35 - 50
Clearing & grubbing	15 -50	50 -100	100	<10	35 - 50
Bulk earthworks	15 -50	50 -100	100	<10	35 - 50

Activity	Typical Setback Distances (metres)				
	NCA 1	NCA 2	NCA 3	NCA 4	NCA 5
Drainage infrastructure	15 -50	50 -100	100	<10	35 - 50
Bridge works[1]	40	25	70	50	350
Paving/ asphalting (inc concrete sawing)	15 -50	50 -100	100	<10	35 - 50
Compounds[1]	<10	120	95	25	<10
Road furniture installation	15 -50	50 -100	100	<10	35 - 50

Notes:

1. Distance to nearest receiver

Table 28: Predicted L_{Aeq} Construction Noise Levels (Residential)

Activity		NCA 1[3]	NCA 2	NCA 3	NCA 4	NCA 5
NML	Day	61	61	61	66	60
	Evening	52	52	52	50	48
	Night	45	45	45	40	41
Site Establishment		n/a	47 - 54	50 - 57	64 - 71	53 - 60
Clearing & grubbing		n/a	55 - **72**	57 - **74**	**72** - **89**	60 - **77**
Bulk earthworks		n/a	52 - 64	55 - 67	70 - **82**	58 - 70
Drainage infrastructure		n/a	51 - 60	53 - 62	68 - **77**	56 - 65
Bridge works		n/a	47 - 68	40 - 61	52 - 73	<30 - 47
Paving/ asphalting (inc concrete sawing)		n/a	52 - 66	54 - 68	69 - **83**	58 - **72**
Compounds		n/a	36 - 50	34 - 48	53 - 67	54 - 68
Road furniture installation		n/a	47 - 59	49 - 61	54 - 68	53 - 65

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.
3. No Residential receivers with NCA 1.

Table 29: Predicted L_{Aeq} Construction Noise Levels (Other Sensitive Receivers)

Name	NCA 1		NCA 2		NCA 3			NCA 4			NCA 5	
	S2	S4	S10	S11a	S14	S20	S21	S30	S53	S48	S70	S71
Receiver Type	Industrial	Commercial	Worship	Classroom	Commercial	Active Rec	Classroom	Community	Classroom	Commercial	Community	Commercial
Criteria	75	70	55	55	70	65	55	55	55	70	55	70
Site Establishment	53 - 60	61 - 68	49 - 56	44 - 51	44 - 51	44 - 51	45 - 52	65 - **72**	65 - **72**	65 - 72	50 - 57	65 - 72
Clearing & grubbing	60 - **77**	68 - **85**	57 - **74**	51 - **68**	52 - 69	51 - 68	52 - **69**	**72** - **89**	**73** - **90**	73 - **90**	57 - **74**	73 - **90**
Bulk earthworks	58 - 70	66 - **78**	54 - **66**	49 - 61	50 - 62	49 - 61	50 - 62	**70** - **82**	**71** - **83**	71 - **83**	55 - **67**	71 - **83**
Drainage infrastructure	56 - 65	64 - 73	53 - 62	47 - 56	48 - 57	47 - 56	48 - 57	**68** - **77**	**69** - **78**	69 - **78**	53 - 62	69 - **78**

Name	NCA 1		NCA 2		NCA 3			NCA 4			NCA 5	
	S2	S4	S10	S11a	S14	S20	S21	S30	S53	S48	S70	S71
Receiver Type	**Industrial**	**Commercial**	**Worship**	**Classroom**	**Commercial**	**Active Rec**	**Classroom**	**Community**	**Classroom**	**Commercial**	**Community**	**Commercial**
Bridge works	<30 - 50	40 - 61	41 - 62	34 - 55	36 - 57	<30 - 44	36 - 57	31 - 52	52 - **73**	52 - 73	31 - 52	<30 - 40
Paving/ asphalting (inc concrete sawing)	58 - 72	65 - **79**	54 - **68**	48 - 62	49 - 63	48 - 62	49 - 63	**69** - **83**	**70** - **84**	70 - **84**	55 - **69**	70 - **84**
Compounds	55 - 69	46 - 60	37 - 51	<30 - 41	30 - 44	33 - 47	<30 - 41	<30 - 42	36 - 50	34 - 48	55 - **69**	<30 - 43
Road furniture installation	53 - 65	60 - 72	49 - 61	44 - 56	44 - 56	44 - 56	44 - 56	65 - **77**	65 - **77**	65 - **77**	50 - 62	65 - **77**

Notes:

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 30: Predicted L_{Amax} Construction Noise Levels for Night Works (Residential)

Activity		NCA 1[3]	NCA 2	NCA 3	NCA 4	NCA 5
Sleep Disturbance Upper Limit	**Night**	**65**	**65**	**65**	**65**	**65**
Site Establishment		n/a	**65**	**68**	**82**	**71**
Clearing & grubbing		n/a	**73**	**76**	**90**	**79**
Bulk earthworks		n/a	**65**	**68**	**82**	**71**
Drainage infrastructure		n/a	**65**	**68**	**82**	**71**
Bridge works		n/a	**74**	**67**	**80**	54
Paving/ asphalting (inc concrete sawing)		n/a	**67**	**70**	**84**	**73**
Compounds		n/a	55	53	**72**	**74**
Road furniture installation		n/a	**65**	**68**	**82**	**71**

Notes:

1. **Bold** font represents exceedance of night time sleep disturbance upper limit.
2. Noise level predictions for L_{Amax} sleep disturbance have been made at the building façade.
3. No Residential receivers with NCA 1.

8.6 Discussion

8.6.1 Standard Hours

The predictions show that construction phase noise levels at residences are expected to exceed the NMLs at residences. Residences within NCA 4 are predicted to be "highly noise affected" for the majority of construction activities and residences within NCA 5 are predicted to be "highly noise affected" during clearing and grubbing. The chainsaw and tub grinder/mulcher are the loudest equipment items that are proposed to be used during the clearing and grubbing activity.

Commercial receivers (within NCA 1, 4 and 5), Wyong Community Health Centre (NCA 4) and Central Coast Community College (NCA4) are also predicted to be "highly noise affected". Clearing and grubbing is the nosiest activity but this activity should be limited within the town centre.

8.6.2 Extended hours and Out-of-hours Work

A conservative assessment has been undertaken for extended hours and OOHW and indicative predictions have been produced. The predictions show that construction phase noise levels at residences are expected to exceed the NMLs at residences during the evening and night-time periods. Residences within NCA 4 are predicted to be "highly noise affected" for the majority of construction activities and residences within NCA 5 are predicted to be "highly noise affected" during clearing and grubbing.

Clearing and grubbing and the associated use of chainsaw and tub grinder/mulcher is unlikely to be used during extended hours and should be restricted to standard hours. Bulk earthworks and paving/asphalting are also particularly noisy activities and the noise mitigation measures discussed with Section 8.7 will have to be adopted to minimise potential impacts.

Other sensitive receivers are expected to be slightly less affected than residences as they generally only operate during the day (with the exception of restaurants and hotels). Nonetheless many of the sensitive receivers, particularly within NCA 4, are also predicted to be "highly noise affected".

For the assessment of sleep disturbance, it can be seen that predicted L_{Amax} noise levels exceed the upper limit of 65dB(A) at residences for almost all activities. Therefore, in accordance with the requirements of the ICNG, construction works should not occur over more than two consecutive nights to allow respite to nearby residences.

Nevertheless, a reasonable and feasible approach towards noise management measures would be required to reduce noise levels as much as possible to manage the impact from construction noise during night time periods. Noise mitigation measures are discussed in Section 8.7.

8.7 Construction Noise Mitigation Options

The following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. The implementation of noise control solutions and noise and vibration management measures (i.e. letter box drops, monitoring and individual briefings etc) are to follow the detailed design and a Construction Noise and Vibration Management Plan (CNVMP).

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.

8.7.1 Standard Noise and Vibration Management Measures

Table 31 sets out standard noise and vibration mitigation to be implemented on the proposal as required.

Table 31: 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 8.7.6

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 should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods if practicable.
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) should 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.

8.7.2 Noise Control Measures

Implementation of noise control measures, such as those suggested in Australian Standard 2436-2010 "Guide to Noise Control on Construction, Demolition and Maintenance Sites", are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C presents typical examples of noise reductions achievable after treatment of various noise sources. Table C3 in Appendix C presents the relative effectiveness of various forms of noise control treatment.

Table 32 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 32: Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.
Distance	Doubling of distance between source and receiver	6	6
Screening	Acoustic barriers such as earth mounds, temporary, mobile or permanent noise barriers	5 to 10	5 to 10
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	5 to 10	5 to 10
Engine Silencing	Residential class mufflers	15 to 25	10 to 20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436, for this project.

Table 33 below identifies possible noise control measures, which are applicable for the construction plant likely to be used on site.

Table 33: Noise Control Measures for Likely Construction Plant

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Concrete Saw	✔	✖	✔	✖
Crane	✔	✖	✔	✖
Hand Compactor	✔	✖	✔	✖
Hand-held Equipment	✔	✔	✖	✖
Asphalt Mill and Paver	✔	✖	✔	✖
Excavator	✔	✖	✔	✖

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Concrete Agitator Truck	✔	✖	✔	✖
Padfoot and Smooth Drum Rollers	✔	✖	✔	✖
Tree Mulcher	✔	✖	✔	✖
Truck and Trailer	✔	✖	✔	✖
Chainsaw	✔	✖	✔	✖
Generator	✔	✔	✔	✖
Light Towers	✔	✔	✔	✖
Linemarking Equipment	✔	✖	✔	✖

To ensure efficient noise attenuation performance is achieved using any of the methods listed above, it is recommended acoustic engineers work closely with the construction contractors and carry out preliminary testing prior to commencement of works.

8.7.3 Additional Airborne Noise Mitigation Measures

Additional mitigation measures to be considered in preparing the CNVMP 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 circumstances where construction activities are expected to cause potential noise impacts at nearby residences, the additional mitigation measures presented in Table 34 is to be considered. The measures should be read in conjunction with the indicative level of exceedance to assist with the determination of

additional mitigation measures to be implemented where feasible and reasonable. Further guidance on the use of this table is documented in the TfNSW Construction Noise Strategy.

Table 34: Additional Airborne Noise Mitigation Measures

Time Period		Mitigation Measures/Predicted $L_{Aeq(15min)}$ 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: TfNSW Construction Noise Strategy, V2, April 2012

8.7.4 Roadworks outside Normal Working Hours

For works conducted outside normal working hours the procedures contained within ENMM Practice (vii) are to be adopted. The procedures include minimum roadwork programming requirements

If roadworks are proposed and it is likely that sensitive receptors will be affected by noise and vibration above guideline levels, and/or receivers are within minimum distance setbacks set out in the management plan:

- Program the work so that noise and vibration at night will not affect any single dwelling or group of dwellings, flats, units and other places of residence on more than two consecutive nights, or on more than a total of six nights over a period of one calendar month.
- If programmed night work is postponed for any reason, the work should be re-programmed and the programming requirements described above apply again.
- Very noisy activities should be programmed for normal working hours. If the work cannot be undertaken during the day, it should be completed before 11:00 pm.

- Where practicable, work should be scheduled to avoid major student examination periods and times when students are studying for examinations, such as before and during the Higher School Certificate and at the end of higher education semesters.

Consultation and procedural requirements

- Evaluate all available, feasible and reasonable noise and vibration management measures and include the preferred management measures in the CNVMP.
- Apply for a Road Occupancy or Road Development Licence
- If the work is the subject of an Environment Protection Licence, contact the EPA and advise the work proposed to be undertaken, its location, the days and dates of the work, the hours involved and the "after hours" contact name and telephone number.
- Update the CNVMP to include any additional noise and vibration management strategies and any additional EPA requirements.
- Contact the local community potentially affected by the proposed out-of-hours-work noise/vibration (residents, businesses, etc) and inform them by letter of the proposed work, the location and type of work, the day(s) and date(s) of work and the hours involved.

8.7.5 Managing High Noise Impact Activities

Construction noise levels presented in Table 28 and Table 29 indicate predicted noise levels at the receiver locations may potentially at times exceed the ICNG 'highly noise affected' noise management level of 75dB(A). In addition to the noise mitigation and management measures discussed above, it is recommended that extensive consultation be carried out with residences experiencing noise above the highly noise affected level of 75dB(A), to manage the potential noise impacts to these properties.

It may be necessary to restrict the times during which construction activities occur in the immediate vicinity of these properties or to offer respite periods by taking into account:

- Times identified by the residents when they are less sensitive to noise, for example between 9am and 3pm when residents are likely to be at work/ school etc; and
- If the residents are prepared to accept a longer period of construction in exchange for restrictions on construction times (ie. respite periods).

8.7.6 Regular Periodic Noise Monitoring

The following approach would be adopted with regard to noise monitoring procedures.

- Where potential noise impacts are predicted to be 20 to 30dB(A) above the RBL, 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 30dB(A) above the RBL, the potential construction noise nuisance is considered to be **high**. All reasonable and feasible noise control measures should be implemented prior to the commencement of construction works. Noise compliance monitoring for all major equipment and activities on the sites should 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) should be implemented eg. restrict working hours, use silencing equipment.

8.7.7 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.

9 Construction Vibration Assessment

9.1 Construction Vibration Objectives

9.1.1 Disturbance to buildings occupants

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the NSW EPA's (ex DECC) '*Assessing Vibration; a technical guideline*' (DECC, 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 '*Evaluation of human exposure to vibration in buildings (1-80Hz)*'. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'.

Vibration sources are defined as Continuous, Impulsive or Intermittent. Table 35 provides a definition and examples of each type of vibration.

Table 35: 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, Department of Environment & Climate Change, 2006

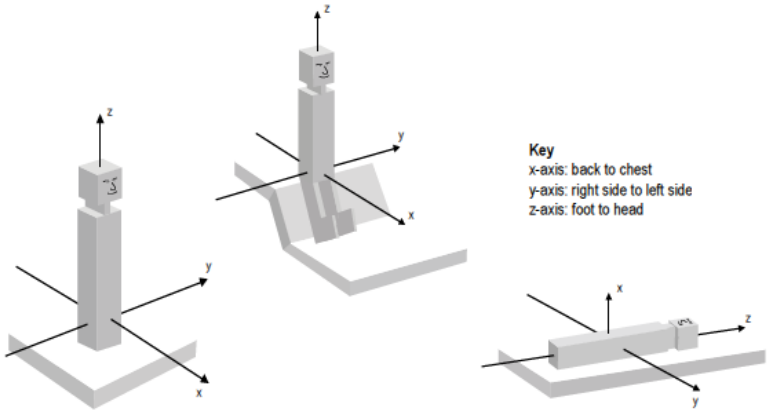
The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *'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 the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore, application of the criteria requires consideration of the position of the people being assessed, as illustrated in

Figure 3. For example, vibration measured in the horizontal plane is 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.

Figure 3: Orthogonal axes for human exposure to vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 36.

Table 36: 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 (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 (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 (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 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
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

9.1.2 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 37 below and are generally recognised to be conservative.

Table 37: 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

9.2 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 38 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 proposal will be dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver structure.

Table 38: Typical Ranges of Construction Plant Vibration Levels

Plant Noise Source	Typical PPV Vibration (mm/s) at distance (metres) from plant							
	5	10	15	20	30	40	50	100
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	-	-	-		
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 proposal as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

9.3 Potential Vibration Impacts to Residential and Commercial Uses

Based on the vibration data presented in Section 9.2 above, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 39 below. The assessment is relevant to all residential and commercial use buildings, and other similar type structures in the proposal area.

Table 39: Potential Vibration for Residential/Commercial Properties

NCA	Approx. distance to nearest buildings from works	Type of Nearest Sensitive Buildings	Assessment on Potential Vibration Impacts		
			Structural Damage Risk	Human Disturbance	Vibration Monitoring
1	10 – 15 metres	Commercial	Medium risk of structural damage from construction works.	High risk of adverse comment as a result of construction works.	Vibration monitoring shall be conducted.
2	<10 – 15 metres	Residential	High to Medium risk of structural damage from construction works.	High risk of adverse comment as a result of construction works.	Vibration monitoring shall be conducted.
3	<10 – 30 metres	Residential	High to Medium risk of structural damage from construction works.	High risk of adverse comment as a result of construction works.	Vibration monitoring shall be conducted.
	<10 – 30 metres	Commercial	Medium risk of structural damage from construction works.	High risk of adverse comment as a result of construction works.	Vibration monitoring shall be conducted.
4	<10 metres	Residential	High to Medium risk of structural damage from construction works.	High risk of adverse comment as a result of construction works.	Vibration monitoring shall be conducted.
	<10 metres	Commercial	Medium risk of structural damage from construction works.	High risk of adverse comment as a result of construction works.	Vibration monitoring shall be conducted.
5	<10 – 15 metres	Commercial	Medium risk of structural damage from construction works.	High risk of adverse comment as a result of construction works.	Vibration monitoring shall be conducted.

Recommendations for reduction potential vibration impacts, including minimum working distances for construction pant are provided in Section 9.4 below.

9.4 Potential Vibration Impacts to Heritage Listed Properties

There are seven properties in the proposal area that are heritage listed and these are identified in Table 40. Vibration generated by construction plant associated with the road works was estimated at various distances and expected vibration impacts have been determined.

Table 40: Potential Vibration for Heritage Properties

Property	Approximate distance from works	Assessment on Potential Vibration Impacts
Shops on north west corner of Pacific Highway & Church Street	<5 metres	Building damage from construction works is possible.
74 Pacific Highway	<5 metres	Building damage from construction works is possible.
98 Pacific Highway	<5 metres	Building damage from construction works is possible.
19 Rankens Court	70 metres	Building damage very unlikely
10-12 Alison Road (Police Station)	45 metres	Building damage unlikely
128 Pacific Highway (Ambulance Station)	<5 metres	Building damage from construction works is possible.
7-8 Railway Square (Wyong Railway Station)	<5 metres	Building damage from construction works is possible.

There is potential for building damage at six of the seven heritage buildings. Further comment on vibration management is provided in Section 9.5.2.

9.5 Vibration Mitigation

9.5.1 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 as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver. Accordingly, based on a database containing vibration measurements from past projects and library information, Table 41 below presents the recommended minimum working distances for high vibration generating plant.

Table 41: Recommended Minimum Working Distances for Vibration Intensive Plant

Plant Item	Rating / Description	Minimum Working Distance in Metres	
		Cosmetic Damage	Human Response
Vibratory Roller[1]	< 50 kN (Typically 1-2 tonnes)	5	15m – 20
	< 100 kN (Typically 2-4 tonnes)	6	20
	< 200 kN (Typically 4-6 tonnes)	12	40
	< 300 kN (Typically 7-13 tonnes)	15	100

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

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

Site specific buffer distances should 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 building damage should be determined by site measurements and maintained.

9.5.2 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 building damage vibration limits:

1. A management procedure should be implemented to deal with vibration complaints. Each complaint should be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures should be put in place to mitigate future occurrences.

2. Where vibration is found to be excessive, management measures should 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 should 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 with notable vibration emissions in close proximity to these properties to determine proposal specific buffer distances.

    - Shops on north west corner of Pacific Highway & Church Street
    - 74 Pacific Highway
    - 98 Pacific Highway
    - 19 Rankens Court
    - 10-12 Alison Road
    - 128 Pacific Highway
    - 7-8 Railway Square

    Where work must be conducted within the proposal specific buffer distances, then vibration monitoring is recommended during the course of the works.

10 Conclusion

Renzo Tonin & Associates have completed a noise and vibration assessment of the proposed upgrade of Pacific Highway through the town centre of Wyong, NSW. Noise from the operation of the upgraded road has been assessed, along with noise and vibration associated with the proposal construction activities.

The findings of this study are:

Traffic Noise Assessment

- Traffic noise levels at the design year for the 'build' option, with the exception of three (3) residences, are predicted to be within 2dB(A) of the 'no build' option and therefore the noise impact of the proposal is considered acceptable with regard to operational noise. The three (3) residences with noise increases exceeding 2dB(A) are below the NCG target criteria and are not identified for consideration of noise mitigation.
- Existing and future traffic noise levels are at or above the cumulative limits at a number of receivers along the proposal route and therefore according to Roads and Maritime 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 proposal 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 the Pacific Highway with minimal shielding and distance to the road. All reasonable and feasible noise mitigation should 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, although there is a higher risk for some nearest receivers. There is generally a high risk of adverse comment from the nearest receivers for tactile 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 site specific buffer distances.

References

1. NSW Road Noise Policy (NSW DECCW, March 2011)
2. RTA Environmental Noise Management Manual (RTA, December 2001)
3. Noise Criteria Guideline (Roads and Maritime, December 2014)
4. Noise Mitigation Guideline (Roads and Maritime, December 2014)
5. NSW Interim Construction Noise Guideline (DECC, 2009)
6. Assessing Vibration: A Technical Guideline (DECC, 2006)
7. British Standard 6472-1992, Evaluation of human exposure to vibration in buildings (1-80Hz)
8. German Standard DIN 4150 – Part 3, Structural vibration in buildings - Effects on Structures
9. NSW Industrial Noise Policy (NSW EPA, January 2000)
10. Application notes - NSW industrial noise policy, http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm

    (NSW EPA, Page last updated: 12 June 2013).

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B 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

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 Opening & Design Year Traffic Volumes

Table C.1 Year of Opening Traffic Data

Pacific Highway Location	Direction	2021 (Year of Opening) No Build					2021 (Year of Opening) Build				
		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%	
Pacific Highway north of Cutler Drive	NB	11670	4.0	1200	4.2	70	12420	3.4	1280	3.9	70
	SB	12770	4.1	1320	4.5	70	12670	3.8	1310	3.8	70
Pacific Highway south of Cutler Drive	NB	12130	4.8	1250	4.8	70/50	13740	4.2	1420	4.2	70/50
	SB	12560	4.5	1300	4.6	70/50	13560	3.8	1400	4.3	70/50
Pacific Highway south of North Road	NB	10170	5.2	1050	5.7	50	11600	4.7	1200	5.0	50
	SB	11060	4.8	1140	5.3	50	11950	4.5	1230	4.9	50
Pacific Highway south of Anzac Avenue	NB	10500	5.0	1080	5.6	50	12250	4.6	1260	4.8	50
	SB	11870	4.9	1220	4.9	50	12020	5.2	1240	5.6	50
Pacific Highway south of Howarth Street	NB	10470	6.8	1080	7.4	50	12020	7.1	1240	7.3	50
	SB	14940	4.1	1540	4.5	50	15360	5.3	1590	5.7	50
Pacific Highway south of Alison Road	NB	11980	8.0	1240	8.1	50	13210	5.8	1360	5.9	50
	SB	11250	3.2	1160	3.4	50	15390	5.5	1590	5.7	50
Pacific Highway south of Church Street	NB	12790	7.1	1320	7.6	50	13900	5.8	1430	6.3	50
	SB	17070	4.3	1760	4.5	50	18290	4.5	1890	4.8	50
Pacific Highway south of River Road	NB	19330	5.6	1990	6.0	50	19750	5.2	2040	5.4	50
	SB	17670	4.2	1820	4.4	50	18300	4.5	1890	4.8	50
Pacific Highway south of Tacoma Road	NB	18650	5.7	1930	5.7	50	19140	5.4	1970	5.6	50
	SB	17320	4.3	1790	4.5	50	17860	4.6	1840	4.9	50
Pacific Highway south of Johnson Road	NB	17830	5.5	1840	6.0	50	18080	5.3	1870	5.3	50

Pacific Highway Location	Direction	2021 (Year of Opening) No Build					2021 (Year of Opening) Build				
		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%	
	SB	16740	4.3	1730	4.6	50	17130	4.8	1770	5.1	50
Cutler Drive west of Pacific Highway	EB	1590	3.1	160	6.3	50	2210	3.2	230	4.3	50
	WB	2270	5.7	230	4.3	50	2570	7.4	270	7.4	50
North Road west of Pacific Highway	EB	2630	3.4	270	3.7	50	2820	3.9	290	3.4	50
	WB	2150	2.8	220	4.5	50	2270	2.6	230	4.3	50
Anzac Avenue west of Pacific Highway	EB	2180	3.7	220	4.5	50	2900	5.2	300	6.7	50
	WB	1370	1.5	140	0	50	3440	2.6	350	2.9	50
Anzac Avenue west of Margaret Street	EB	1950	2.6	200	0	50	2350	2.6	240	4.2	50
	WB	1310	0	130	0	50	1430	1.4	150	0	50
Howarth Street Bridge	EB	1570	12.7	160	12.5	50	3010	14.3	310	16.1	50
	WB	4820	1.0	500	2.0	50	6560	5.2	680	5.9	50
Howarth Street south of Rose Street	NB	1520	0.7	160	0	50	1010	1.0	100	0	50
	SB	1130	18.6	120	16.7	50	1050	32.4	110	36.4	50
Rose Street east of Howarth Street	EB	580	5.2	60	0	50	700	17.1	70	14.3	50
	WB	3460	2.6	360	2.8	50	3240	3.7	330	3.0	50
Warner Avenue east of Howarth Street	EB	920	22.8	100	20.0	50	620	12.9	60	16.7	50
	WB	1340	0.7	140	0	50	1420	0.7	150	0	50
Alison Road west of Pacific Highway	WB	1550	5.8	160	6.3	40	1300	5.4	130	7.7	40
Alison Road west of Margaret Street	EB	2250	3.1	230	4.3	50	2600	2.3	270	3.7	50
	WB	2280	7.5	230	8.7	50	2500	5.6	260	7.7	50
Church Street west of Pacific Highway	EB	3680	3.3	380	2.6	50	3920	4.3	400	5.0	50
	WB	1600	4.4	170	5.9	50	1510	2.6	160	0	50

Pacific Highway Location	Direction	2021 (Year of Opening) No Build					2021 (Year of Opening) Build				
		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%	
River Road west of Pacific Highway	EB	6830	2.6	700	2.9	50	6450	3.6	670	3.0	50
	WB	1200	0.8	120	0	50	1040	0	110	0	50
Tacoma Road west of Pacific Highway	EB	920	1.1	90	0	50	770	0	80	0	50
	WB	570	0	60	0	50	590	0	60	0	50
Johnson Road west of Pacific Highway	EB	4470	7.2	460	6.5	50	4780	6.1	490	6.1	50
	WB	4260	5.9	440	6.8	50	4480	5.4	460	6.5	50

Table C.2 Design Year Traffic Data

Pacific Highway Location	Direction	2031 (Design Year) No Build					2031 (Design Year) Build				
		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%	
Pacific Highway north of Cutler Drive	NB	12840	3.3	1320	3.8	70	13420	4.2	1380	4.3	70
	SB	13060	4.0	1350	4.4	70	13900	4.5	1430	4.9	70
Pacific Highway south of Cutler Drive	NB	13870	3.5	1430	3.5	70/50	14710	4.6	1520	4.6	70/50
	SB	12900	4.0	1330	3.8	70/50	14580	4.3	1500	4.7	70/50
Pacific Highway south of North Road	NB	11970	3.8	1230	4.1	50	12260	4.4	1260	4.8	50
	SB	11680	4.1	1200	4.2	50	12800	5.0	1320	5.3	50
Pacific Highway south of Anzac Avenue	NB	12580	3.8	1300	3.8	50	13350	4.2	1380	4.3	50
	SB	12320	4.6	1270	4.7	50	12840	5.4	1330	5.3	50
Pacific Highway south of Howarth Street	NB	12440	6.0	1280	6.3	50	12780	7.3	1320	7.6	50
	SB	17360	3.7	1790	3.9	50	18190	4.7	1880	4.8	50
Pacific Highway south of Alison Road	NB	14270	7.1	1470	7.5	50	13830	6.2	1430	6.3	50
	SB	12880	3.5	1330	3.8	50	18220	4.9	1880	5.3	50
Pacific Highway south of Church Street	NB	14870	5.6	1530	5.9	50	14570	6.0	1500	6.0	50
	SB	19420	4.0	2000	4.0	50	21110	4.2	2180	4.1	50
Pacific Highway south of River Road	NB	21770	4.8	2250	4.9	50	21470	5.4	2220	5.4	50
	SB	19830	4.0	2050	4.4	50	21100	4.2	2180	4.6	50
Pacific Highway south of Tacoma Road	NB	21010	4.9	2170	5.1	50	20580	5.5	2120	5.7	50
	SB	19400	4.1	2000	4.0	50	20520	4.3	2120	4.7	50
Pacific Highway south of Johnson Road	NB	20020	4.8	2070	4.8	50	19480	5.2	2010	5.5	50
	SB	18420	3.9	1900	4.2	50	19690	4.1	2030	4.4	50
Cutler Drive west of Pacific Highway	EB	1630	2.5	170	0	50	2240	1.3	230	0	50

Pacific Highway Location	Direction	2031 (Design Year) No Build					2031 (Design Year) Build				
		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%	
	WB	2770	4.0	290	3.4	50	2830	4.2	290	3.4	50
North Road west of Pacific Highway	EB	2740	1.8	280	3.6	50	3220	5.0	330	6.1	50
	WB	2070	2.9	210	4.8	50	2540	0.4	260	0	50
Anzac Avenue west of Pacific Highway	EB	2100	5.2	220	4.5	50	3120	3.2	320	3.1	50
	WB	1730	2.9	180	5.6	50	4180	1.9	430	2.3	50
Anzac Avenue west of Margaret Street	EB	2320	2.2	240	0	50	2520	2.4	260	3.8	50
	WB	1700	1.8	180	0	50	1890	1.6	190	0	50
Howarth Street Bridge	EB	2180	15.6	230	17.4	50	3720	12.9	380	13.2	50
	WB	7520	2.0	770	2.6	50	9620	2.9	990	3.0	50
Howarth Street south of Rose Street	NB	2610	0.8	270	0	50	1700	0.6	180	0	50
	SB	1680	19.0	170	17.6	50	1780	26.4	190	26.3	50
Rose Street east of Howarth Street	EB	780	16.7	80	12.5	50	600	8.3	60	16.7	50
	WB	5200	4.4	540	3.7	50	5380	1.3	550	1.8	50
Warner Avenue east of Howarth Street	EB	1480	21.6	150	20.0	50	1280	15.6	130	15.4	50
	WB	2400	0.8	250	0	50	2390	0.4	250	0	50
Alison Road west of Pacific Highway	WB	2180	5.0	220	4.5	40	1190	7.6	120	8.3	40
Alison Road west of Margaret Street	EB	2370	2.5	240	4.2	50	2790	2.9	290	3.4	50
	WB	2760	5.8	280	7.1	50	2720	4.8	280	3.6	50
Church Street west of Pacific Highway	EB	4000	6.3	410	7.3	50	4250	4.7	440	4.5	50
	WB	1840	3.8	190	5.3	50	1940	1.5	200	0	50
River Road west of Pacific Highway	EB	6860	3.1	710	2.8	50	6960	3.6	720	4.2	50
	WB	690	0	70	0	50	510	0	50	0	50

Pacific Highway Location	Direction	2031 (Design Year) No Build					2031 (Design Year) Build				
		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%	
Tacoma Road west of Pacific Highway	EB	950	1.1	100	0	50	1030	1.0	110	0	50
	WB	600	0	60	0	50	670	0	70	0	50
Johnson Road west of Pacific Highway	EB	4580	6.6	470	6.4	50	5030	5.8	520	5.8	50
	WB	4590	6.3	470	6.4	50	4720	5.3	490	6.1	50

APPENDIX D Operational Noise Predictions (Without Mitigation)

NCA	NCA ID	Receiver Address	Receiver Description	Facade	Opening Year 2021				Design Year 2031				NCG External Noise Criteria		Increase (Build - No Build)				Exceeds Cumulative Limit		Consider further treatment?
					No Build		Build		No Build		Build				2021		2031				
				Floor	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day	Night	
2	2_01	2 Byron St		G	56	50	55	49	56	50	55	50	60	55	-0.6	-0.5	-0.3	-0.2	NO	NO	NO
2	2_02	2A Byron St		G	55	50	55	49	56	50	55	50	60	55	-0.5	-0.5	-0.1	-0.1	NO	NO	NO
2	2_03	4 Byron St		G	56	50	56	50	56	51	56	50	60	55	-0.5	-0.4	-0.2	-0.2	NO	NO	NO
2	2_04	4A Byron St		1	57	51	56	50	57	51	57	51	60	55	-0.5	-0.4	-0.2	-0.2	NO	NO	NO
2	2_04	4A Byron St		G	54	48	54	48	54	48	54	48	60	55	-0.2	-0.1	0.1	0.1	NO	NO	NO
2	2_05	4B_1 Byron St		1	61	55	60	54	61	55	60	54	60	55	-1.3	-1.2	-1	-1	NO	NO	NO
2	2_05	4B_1 Byron St		G	59	53	57	51	59	53	58	52	60	55	-1.4	-1.3	-1.2	-1.2	NO	NO	NO
2	2_06	4B_2 Byron St		1	56	50	56	50	56	50	56	50	60	55	-0.3	-0.2	0.1	0.1	NO	NO	NO
2	2_06	4B_2 Byron St		G	51	45	50	44	51	45	51	45	60	55	-0.8	-0.8	-0.5	-0.5	NO	NO	NO
2	2_07	4B_3 Byron St		1	57	51	56	50	57	51	57	51	60	55	-0.4	-0.4	-0.2	-0.1	NO	NO	NO
2	2_07	4B_3 Byron St		G	54	48	53	48	54	48	54	48	60	55	-0.7	-0.6	-0.4	-0.4	NO	NO	NO
2	2_08	6_1 Byron St		G	57	52	56	50	58	52	56	50	60	55	-1.5	-1.5	-1.2	-1.2	NO	NO	NO
2	2_09	6_2 Byron St	Small World Preschool	G	54	48	53	47	54	48	54	48	50	-	-0.8	-0.8	-0.6	-0.6	NO	-	NO
2	2_10	8 Byron St		G	55	49	55	49	55	50	56	50	60	55	-0.1	0	0.3	0.2	NO	NO	NO
2	2_11	10 Byron St		G	57	51	56	50	57	51	57	51	60	55	-0.7	-0.6	-0.3	-0.3	NO	NO	NO
2	2_12	12 Byron St		G	54	48	54	48	54	49	54	49	60	55	-0.1	-0.1	0	0	NO	NO	NO
2	2_13	14 Byron St		G	55	49	54	49	55	49	55	49	60	55	-0.5	-0.4	-0.3	-0.3	NO	NO	NO
2	2_14	16 Byron St		G	53	47	53	47	54	48	53	47	60	55	-0.4	-0.5	-0.3	-0.3	NO	NO	NO
2	2_15	18 Byron St		G	52	46	52	46	52	47	52	46	60	55	-0.3	-0.2	-0.1	-0.1	NO	NO	NO
2	2_16	26 Byron St		G	54	48	53	47	55	49	54	48	60	55	-0.8	-0.8	-0.8	-0.8	NO	NO	NO
2	2_17	28 Byron St		G	53	47	52	46	53	47	52	46	60	55	-0.8	-0.8	-0.8	-0.8	NO	NO	NO
2	2_18	30 Byron St		G	52	46	51	45	52	46	52	46	60	55	-0.6	-0.5	-0.4	-0.4	NO	NO	NO
2	2_19	32 Byron St		G	52	46	52	46	53	47	52	46	60	55	-0.7	-0.7	-0.8	-0.8	NO	NO	NO
2	2_20	34 Byron St		1	61	55	60	55	63	57	62	57	60	55	-0.5	-0.1	-0.5	-0.2	NO	NO	NO
2	2_20	34 Byron St		G	60	54	60	54	62	56	62	56	60	55	-0.6	-0.3	-0.5	-0.2	NO	NO	NO
2	2_21	1 Howarth St		G	63	57	60	54	63	57	60	55	60	55	-2.8	-2.7	-2.4	-2.4	NO	NO	NO
2	2_22	3 Howarth St		G	63	57	60	54	63	57	60	55	60	55	-2.5	-2.4	-2.3	-2.3	NO	NO	NO
2	2_23	5_1 Howarth St		1	64	58	62	56	64	59	62	57	60	55	-2.3	-2.3	-2	-2	NO	NO	NO
2	2_23	5_1 Howarth St		G	62	56	60	54	62	56	60	54	60	55	-2.3	-2.2	-2	-2	NO	NO	NO
2	2_24	5_2 Howarth St		1	60	55	58	53	61	55	59	53	60	55	-2	-2	-1.8	-1.8	NO	NO	NO
2	2_24	5_2 Howarth St		G	57	51	56	50	57	51	57	51	60	55	-0.6	-0.5	-0.3	-0.3	NO	NO	NO
2	2_25	5_3 Howarth St		1	59	53	58	52	59	53	58	52	60	55	-1.5	-1.5	-1.2	-1.2	NO	NO	NO
2	2_25	5_3 Howarth St		G	57	51	56	50	57	51	56	51	60	55	-0.6	-0.6	-0.3	-0.2	NO	NO	NO
2	2_26	7 Howarth St		G	63	58	62	56	64	58	62	56	60	55	-1.8	-1.7	-1.5	-1.5	NO	NO	NO
2	2_27	9 Howarth St		G	64	58	63	57	64	58	63	58	60	55	-0.9	-0.9	-0.7	-0.7	NO	NO	NO
2	2_28	11 Howarth St		G	64	58	63	57	64	58	64	58	60	55	-0.6	-0.5	-0.4	-0.4	NO	NO	NO
2	2_29	13 Howarth St		G	63	57	63	57	63	58	63	57	60	55	-0.4	-0.4	-0.2	-0.2	NO	NO	NO
2	2_30	13A Howarth St	Central Coast Islamic Cultural Centre[1]	G	63	57	63	57	63	57	63	57	60	60	-0.2	-0.2	0	0	NO	NO	NO
2	2_31	15 Howarth St		G	63	57	63	57	63	57	63	58	60	55	-0.1	-0.1	0.1	0.1	NO	NO	NO
2	2_32	17 Howarth St		G	62	57	62	57	63	57	63	57	60	55	0	0	0.2	0.2	NO	NO	NO
2	2_33	19 Howarth St		G	63	57	62	57	63	57	63	57	60	55	-0.1	-0.1	0.1	0	NO	NO	NO
2	2_34	21 Howarth St		G	62	57	62	56	63	57	63	57	60	55	-0.2	-0.2	-0.1	-0.1	NO	NO	NO
2	2_35	23 Howarth St		G	62	56	62	56	62	56	62	56	60	55	-0.3	-0.2	-0.1	-0.1	NO	NO	NO
2	2_36	25 Howarth St		G	62	56	62	56	62	56	62	56	60	55	-0.2	-0.2	-0.1	-0.1	NO	NO	NO
2	2_37	27 Howarth St		G	61	55	61	55	61	56	61	56	60	55	-0.1	0	0.1	0	NO	NO	NO
2	2_38	29 Howarth St		G	60	54	60	55	60	54	61	55	60	55	0.3	0.4	0.5	0.5	NO	NO	NO
2	2_39	31 Howarth St		1	62	56	62	57	62	56	63	57	60	55	0.4	0.4	0.6	0.5	NO	NO	NO
2	2_39	31 Howarth St		G	60	54	61	55	60	55	61	55	60	55	0.5	0.5	0.6	0.6	NO	NO	NO
2	2_40	2 Panonia Rd		G	65	59	63	57	64	58	63	57	60	55	-1.6	-1.6	-1.3	-1.2	NO	NO	NO
2	2_41	4 Panonia Rd		G	64	58	63	57	64	58	63	57	60	55	-1.4	-1.4	-1.1	-0.9	NO	NO	NO
2	2_42	6 Panonia Rd		G	63	57	62	56	63	57	62	56	60	55	-1.1	-0.9	-0.8	-0.6	NO	NO	NO
2	2_43	8 Panonia Rd		G	64	58	64	58	64	58	64	59	60	55	-0.1	-0.1	0.1	0.3	NO	NO	NO
2	2_44	10 Panonia Rd		1	64	58	64	58	64	58	64	59	60	55	0	0.1	0.3	0.5	NO	NO	NO
2	2_44	10 Panonia Rd		G	63	57	63	57	63	57	63	57	60	55	0.3	0.3	0.5	0.7	NO	NO	NO
2	2_45	1_1 Warner Ave		1	61	55	61	55	61	55	62	56	60	55	0.7	0.7	0.7	0.7	NO	NO	NO
2	2_45	1_1 Warner Ave		G	59	53	60	54	60	54	61	55	60	55	0.7	0.9	0.7	0.7	NO	NO	NO
2	2_46	1_2 Warner Ave		1	62	56	62	56	64	58	64	58	60	55	-0.2	0.2	-0.2	0	NO	NO	NO
2	2_46	1_2 Warner Ave		G	61	55	61	55	63	57	63	57	60	55	-0.2	0.1	-0.3	0	NO	NO	NO
3	3_01	53 Howarth St		G	62	56	62	57	64	58	64	58	60	55	0.4	0.8	0.1	0.4	NO	NO	NO
3	**3_02**	**61 Howarth St**		**1**	**67**	**61**	**67**	**61**	**70**	**64**	**68**	**63**	**60**	**55**	**0.3**	**0.8**	**-2.3**	**-1.2**	**YES**	**YES**	**YES**
3	3_05	71 - 75 Howarth St	Wyong Race Club	G	53	46	53	46	53	47	53	47	60	-	0.1	0.1	-0.1	0	-	-	NO
3	3_06	319 Pacific HWY	Wyong Golf Club	G	59	52	57	51	59	52	58	51	55	-	-1.2	-1.2	-1	-0.9	NO	-	NO
3	**3_08**	**1 Rose St**		**G**	**64**	**57**	**65**	**59**	**68**	**61**	**65**	**61**	**60**	**55**	**1.1**	**1.5**	**-2.3**	**-0.4**	**YES**	**YES**	**YES**
3	**3_09**	**3 Rose St**		**G**	**64**	**57**	**65**	**58**	**67**	**61**	**65**	**60**	**60**	**55**	**1.3**	**1.8**	**-2.1**	**-0.2**	**YES**	**YES**	**YES**
4	**4_01**	**4 Anzac Ave**	**Salvation Army Community Centre[2]**	**G**	**65**	**59**	**67**	**61**	**66**	**60**	**67**	**61**	**55**	**55**	**2**	**2.3**	**1.5**	**1.2**	**YES**	**YES**	**YES**
4	**4_03**	**5 Church St**	**Central Coast Community College**	**G**	**67**	**61**	**67**	**61**	**68**	**62**	**68**	**61**	**50**	-	**0**	**-0.6**	**-0.4**	**-1.1**	**YES**	-	**YES**

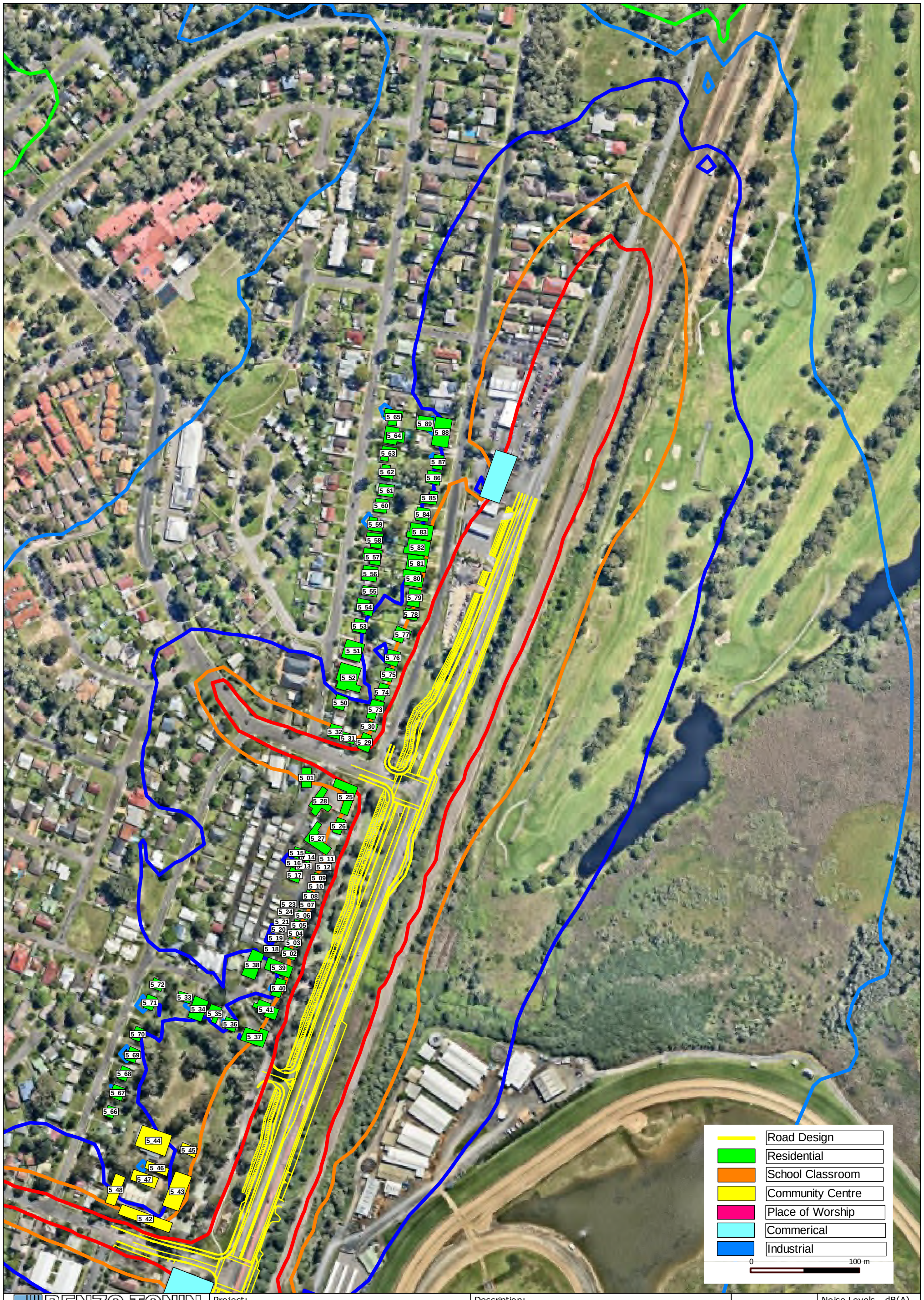
NCA	NCA ID	Receiver Address	Receiver Description	Facade	Opening Year 2021				Design Year 2031				NCG External Noise Criteria		Increase (Build - No Build)				Exceeds Cumulative Limit		Consider further treatment?
					No Build		Build		No Build		Build				2021		2031				
				Floor	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day	Night	
4	4_04	15 - 23 Hely St	Salvation Army Community Centre[2]	G	55	49	58	52	56	50	58	52	55	55	2.7	3.1	2	1.7	NO	NO	YES
4	4_05	35 McPherson Rd	WYONG AGED CARE FACILITY	1	62	56	61	55	62	56	61	55	60	55	-1.5	-1.5	-1.2	-1.2	NO	NO	NO
4	4_05	35 McPherson Rd	WYONG AGED CARE FACILITY	G	62	56	60	54	62	56	60	54	60	55	-1.9	-1.8	-1.6	-1.6	NO	NO	NO
4	4_06	55 McPherson Rd		1	58	52	58	52	58	53	58	52	60	55	-0.7	-0.7	-0.5	-0.5	NO	NO	NO
4	4_06	55 McPherson Rd		G	58	52	57	51	58	52	57	51	60	55	-0.8	-0.8	-0.6	-0.6	NO	NO	NO
4	4_07	65 McPherson Rd		G	56	50	55	49	56	50	56	50	60	55	-0.5	-0.5	-0.2	-0.2	NO	NO	NO
4	4_10	22-32 Pacific HWY		1	73	68	71	65	74	68	72	66	60	55	-2.2	-2.2	-2	-2.1	YES	YES	YES
4	4_11	38 Pacific HWY	Uniting Care Burnside[2]	G	74	68	69	64	74	69	70	64	55	55	-4.8	-4.7	-4.6	-4.6	YES	YES	YES
4	4_12	38A Pacific HWY	Wyong Community Health Centre[2]	1	61	55	60	55	61	55	61	55	55	55	-0.7	-0.7	-0.4	-0.5	YES	NO	YES
4	4_12	38A Pacific HWY	Wyong Community Health Centre[2]	G	60	54	59	53	60	54	59	53	55	55	-0.9	-0.8	-0.6	-0.6	NO	NO	NO
4	4_13	40 - 44 Pacific HWY	Royal Hotel Wyong	1	75	70	72	66	76	70	72	66	60	55	-3.9	-3.9	-3.6	-3.7	YES	YES	YES
4	4_18	126 Pacific HWY	The Grand Hotel	1	73	67	70	65	74	68	71	65	60	55	-2.6	-2.6	-2.8	-2.9	YES	YES	YES
4	4_19	128 Pacific HWY	Ambulance Station	1	72	66	70	64	72	66	70	64	60	55	-1.9	-2	-1.9	-1.9	YES	YES	YES
4	4_19	128 Pacific HWY	Ambulance Station	G	71	65	68	63	71	65	69	63	60	55	-2.3	-2.3	-2.3	-2.2	YES	YES	YES
4	4_20	142 Pacific HWY		1	67	61	67	61	67	61	67	62	60	55	0.4	0.3	0.5	0.6	YES	YES	YES
4	4_22	13 Rankens Court		G	59	53	59	53	60	54	59	53	60	55	0	-0.4	-0.2	-0.6	NO	NO	NO
4	4_23	15 Rankens Court		G	55	49	55	50	55	49	56	50	60	55	0.8	0.7	0.7	0.7	NO	NO	NO
4	4_24	17 Rankens Court		G	55	49	56	50	56	50	57	51	60	55	0.9	1	0.9	0.9	NO	NO	NO
4	4_25	19 Rankens Court		G	55	50	56	50	56	50	57	51	60	55	0.8	0.9	0.6	0.7	NO	NO	NO
4	4_26	106 Pacific HWY	Evocca College	G	73	67	70	64	73	67	70	64	50	-	-3.1	-3	-3.3	-3.4	YES	-	YES
4	4_27	10 Pacific HWY	Wyong Adult & Community Education	G	71	66	69	63	72	66	69	63	50	-	-2.4	-2.4	-2.2	-2.2	YES	-	YES
5	5_01	1 Cutler Drive		G	62	57	64	58	63	56	63	57	60	55	1.1	1.2	0.4	0.6	NO	NO	NO
5	5_02	1A_ Cutler Drive		G	63	57	64	58	63	57	64	58	60	55	1.4	1.3	1.4	1.6	NO	NO	NO
5	5_03	1A_ Cutler Drive		G	62	56	63	58	62	56	64	58	60	55	1.2	1.2	1.4	1.4	NO	NO	NO
5	5_04	1A_ Cutler Drive		G	62	56	63	57	62	56	64	58	60	55	1.3	1.2	1.3	1.5	NO	NO	NO
5	5_05	1A_ Cutler Drive		G	62	56	64	58	62	56	64	58	60	55	1.2	1.3	1.4	1.5	NO	NO	NO
5	5_06	1A_ Cutler Drive		G	62	57	64	58	63	57	64	58	60	55	1.4	1.3	1.4	1.6	NO	NO	NO
5	5_07	1A_ Cutler Drive		G	62	57	64	58	63	57	64	58	60	55	1.3	1.3	1.5	1.5	NO	NO	NO
5	5_08	1A_ Cutler Drive		G	63	57	64	58	63	57	64	58	60	55	1.3	1.3	1.4	1.5	NO	NO	NO
5	5_09	1A_ Cutler Drive		G	63	57	64	58	63	57	64	59	60	55	1.5	1.4	1.6	1.7	NO	NO	NO
5	5_10	1A_ Cutler Drive		G	63	57	64	58	63	57	64	58	60	55	1.4	1.4	1.5	1.5	NO	NO	NO
5	5_11	1A_ Cutler Drive		G	63	57	64	58	63	57	64	59	60	55	1.5	1.4	1.6	1.7	NO	NO	NO
5	5_12	1A_ Cutler Drive		G	63	57	64	58	63	57	64	59	60	55	1.5	1.4	1.6	1.7	NO	NO	NO
5	5_13	1A_ Cutler Drive		G	57	51	58	52	57	51	58	52	60	55	0.8	0.8	1	1	NO	NO	NO
5	5_14	1A_ Cutler Drive		G	57	51	58	52	57	51	58	52	60	55	0.9	0.9	0.9	1.1	NO	NO	NO
5	5_15	1A_ Cutler Drive		G	55	49	56	50	55	49	56	50	60	55	0.9	0.8	0.9	1	NO	NO	NO
5	5_16	1A_ Cutler Drive		G	54	48	55	49	54	48	55	49	60	55	0.9	1	1	1	NO	NO	NO
5	5_17	1A_ Cutler Drive		G	58	52	58	52	58	52	59	53	60	55	0.8	0.8	0.9	1	NO	NO	NO
5	5_18	1A_ Cutler Drive		G	56	50	56	50	56	50	56	50	60	55	0.4	0.3	0.4	0.5	NO	NO	NO
5	5_19	1A_ Cutler Drive		G	56	51	57	51	57	51	57	51	60	55	0.3	0.2	0.3	0.5	NO	NO	NO
5	5_20	1A_ Cutler Drive		G	56	51	57	51	57	51	57	51	60	55	0.4	0.3	0.4	0.5	NO	NO	NO
5	5_21	1A_ Cutler Drive		G	57	51	57	51	57	51	57	51	60	55	0.3	0.4	0.5	0.5	NO	NO	NO
5	5_23	1A_ Cutler Drive		G	57	52	58	52	57	52	58	52	60	55	0.5	0.4	0.6	0.7	NO	NO	NO
5	5_24	1A_ Cutler Drive		G	57	51	57	51	57	51	58	52	60	55	0.5	0.4	0.5	0.6	NO	NO	NO
5	5_25	1A_ Cutler Drive Motel		G	63	58	65	59	64	58	65	59	60	55	1.7	1.7	1.8	1.8	YES	NO	YES
5	5_26	1A_ Cutler Drive Motel		G	63	57	64	58	63	57	64	59	60	55	1.5	1.4	1.5	1.7	NO	NO	NO
5	5_27	1A_ Cutler Drive Motel		G	62	56	63	58	62	56	64	58	60	55	1.6	1.6	1.8	1.8	NO	NO	NO
5	5_28	1A_ Cutler Drive Motel		G	58	53	59	54	58	52	59	53	60	55	1	1	0.6	0.6	NO	NO	NO
5	5_29	2 Cutler Drive		G	64	59	66	60	64	58	66	60	60	55	1.6	1.6	1.6	1.6	YES	YES	YES
5	5_31	4 Cutler Drive		G	63	57	64	59	63	57	64	58	60	55	1.3	1.4	0.9	0.9	NO	NO	NO
5	5_32	6 Cutler Drive		G	63	57	64	58	63	57	64	57	60	55	1.2	1.2	0.6	0.7	NO	NO	NO
5	5_33	1 Ingram St		G	54	48	53	48	54	48	54	48	60	55	-0.1	-0.1	-0.1	0.1	NO	NO	NO
5	5_34	2 Ingram St		G	55	49	55	49	55	49	56	50	60	55	0.7	0.6	0.8	0.8	NO	NO	NO
5	5_35	3 Ingram St		G	55	50	56	50	56	50	57	51	60	55	0.9	0.8	1	1	NO	NO	NO
5	5_36	4 Ingram St		G	56	50	57	51	56	50	57	51	60	55	1.1	1	1.2	1.3	NO	NO	NO
5	5_37	5 Ingram St		G	63	57	64	58	63	57	64	59	60	55	1.2	1.2	1.4	1.5	NO	NO	NO
5	5_38	6-8_1 Ingram St		G	56	50	56	50	56	50	56	50	60	55	-0.2	-0.2	0	0	NO	NO	NO
5	5_39	6-8_2 Ingram St		1	64	59	66	60	65	59	66	60	60	55	1.3	1.2	1.3	1.5	YES	YES	YES
5	5_39	6-8_2 Ingram St		G	63	57	64	59	63	57	65	59	60	55	1.2	1.1	1.4	1.4	YES	NO	YES
5	5_40	6-8_3 Ingram St		G	63	57	64	58	63	57	64	58	60	55	1.3	1.2	1.3	1.5	NO	NO	NO
5	5_41	6-8_4 Ingram St		1	64	58	66	60	64	58	66	60	60	55	1.3	1.3	1.5	1.5	YES	YES	YES
5	5_41	6-8_4 Ingram St		G	63	57	65	59	63	57	65	59	60	55	1.4	1.4	1.5	1.6	YES	NO	YES
5	5_42	1 North Rd	Community Centre	1	64	58	64	59	64	58	65	59	50	50	0.6	0.5	1.1	0.8	YES	YES	YES
5	5_42	1 North Rd	Community Centre	G	63	57	63	58	63	57	64	58	50	50	0.5	0.4	1	0.7	YES	YES	YES
5	5_43	1 North Rd	Community Centre	G	60	55	61	55	60	55	61	55	50	50	0.6	0.5	0.7	0.8	YES	YES	YES

NCA	NCA ID	Receiver Address	Receiver Description	Facade	Opening Year 2021				Design Year 2031				NCG External Noise Criteria		Increase (Build - No Build)				Exceeds Cumulative Limit		Consider further treatment?
					No Build		Build		No Build		Build				2021		2031				
				Floor	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day dB(A)	Night dB(A)	Day	Night	
5	5_44	1 North Rd	Community Centre	1	59	53	59	54	59	53	60	54	50	50	0.2	0.2	0.4	0.4	YES	NO	YES
5	5_44	1 North Rd	Community Centre	G	57	51	57	51	57	51	57	52	50	50	0.3	0.3	0.5	0.5	YES	NO	YES
5	5_45	1 North Rd	Community Centre	G	60	54	61	55	60	54	61	55	50	50	0.6	0.6	0.8	0.9	YES	YES	YES
5	5_46	1 North Rd	Community Centre	G	54	48	54	48	54	48	55	49	50	50	0.2	0.2	0.4	0.5	YES	NO	YES
5	5_47	1 North Rd	Community Centre	G	53	47	53	47	53	47	54	48	50	50	0.1	0	0.2	0.3	NO	NO	NO
5	5_48	1 North Rd	Community Centre	G	59	54	60	54	59	54	60	55	50	50	0.7	0.5	1.2	0.8	YES	YES	YES
5	5_49	1 North Rd	Community Centre Passive Recreation	G	60	54	61	54	60	54	61	54	55	-	0.5	0.5	0.7	0.7	YES	-	YES
5	5_50	1 Northcott Ave		G	56	50	57	51	56	50	57	51	60	55	0.7	0.7	0.4	0.5	NO	NO	NO
5	5_51	3-7_1 Northcott Ave		G	56	50	56	50	56	50	56	50	60	55	0.2	0.2	0.3	0.4	NO	NO	NO
5	5_52	3-7_2 Northcott Ave		G	56	50	56	50	56	50	56	51	60	55	0.4	0.4	0.4	0.5	NO	NO	NO
5	5_53	9 Northcott Ave		G	56	50	56	50	56	50	56	50	60	55	0.2	0.1	0.2	0.3	NO	NO	NO
5	5_54	11 Northcott Ave		1	59	53	59	53	59	53	60	54	60	55	0.2	0.3	0.4	0.4	NO	NO	NO
5	5_54	11 Northcott Ave		G	56	50	56	50	56	50	56	50	60	55	0.2	0.1	0.2	0.4	NO	NO	NO
5	5_55	13 Northcott Ave		G	54	48	54	48	54	48	54	49	60	55	0	0	0.2	0.2	NO	NO	NO
5	5_56	15 Northcott Ave		G	53	47	53	47	53	47	53	47	60	55	-0.1	-0.2	0	0	NO	NO	NO
5	5_57	17 Northcott Ave		G	52	46	52	46	52	46	53	47	60	55	0	0.1	0.2	0.2	NO	NO	NO
5	5_58	19 Northcott Ave		G	52	46	52	46	52	46	52	46	60	55	0.1	0.1	0.2	0.3	NO	NO	NO
5	5_59	21 Northcott Ave		G	52	46	52	46	52	46	53	47	60	55	0.1	0.1	0.2	0.3	NO	NO	NO
5	5_60	23 Northcott Ave		G	53	47	53	47	53	47	53	47	60	55	0.2	0.1	0.2	0.4	NO	NO	NO
5	5_61	25 Northcott Ave		G	53	47	53	47	53	47	53	48	60	55	0.2	0.1	0.2	0.4	NO	NO	NO
5	5_62	27 Northcott Ave		G	53	47	53	47	53	47	53	47	60	55	0.1	0.1	0.3	0.3	NO	NO	NO
5	5_63	29 Northcott Ave		G	52	46	52	46	52	46	53	47	60	55	0.2	0.1	0.2	0.4	NO	NO	NO
5	5_64	31 Northcott Ave		G	52	46	52	46	52	46	52	46	60	55	0.2	0.2	0.3	0.4	NO	NO	NO
5	5_65	33 Northcott Ave		G	54	48	54	48	54	48	54	49	60	55	0.2	0.2	0.4	0.4	NO	NO	NO
5	5_66	5 Owen Ave		G	54	49	55	49	55	49	55	49	60	55	0.4	0.4	0.5	0.5	NO	NO	NO
5	5_67	7 Owen Ave		G	55	49	55	49	55	49	55	50	60	55	0.4	0.4	0.6	0.6	NO	NO	NO
5	5_68	9 Owen Ave		G	55	49	55	49	55	49	56	50	60	55	0.4	0.4	0.6	0.6	NO	NO	NO
5	5_69	11 Owen Ave		G	55	49	56	50	55	50	56	50	60	55	0.4	0.4	0.5	0.5	NO	NO	NO
5	5_70	13 Owen Ave		G	55	50	56	50	55	50	56	50	60	55	0.3	0.3	0.5	0.5	NO	NO	NO
5	5_71	15 Owen Ave		G	55	50	56	50	56	50	56	50	60	55	0.3	0.2	0.3	0.5	NO	NO	NO
5	5_72	17 Owen Ave		G	55	50	55	50	55	50	56	50	60	55	0.1	0.1	0.3	0.3	NO	NO	NO
5	**5_73**	**2 Watanobbi Rd**		**1**	**64**	**59**	**66**	**60**	**65**	**59**	**66**	**60**	**60**	**55**	**1.3**	**1.2**	**1.4**	**1.5**	**YES**	**YES**	**YES**
5	**5_73**	**2 Watanobbi Rd**		**G**	**63**	**57**	**65**	**59**	**63**	**57**	**65**	**59**	**60**	**55**	**1.4**	**1.3**	**1.5**	**1.5**	**YES**	**NO**	**YES**
5	5_74	4 Watanobbi Rd		G	63	57	64	58	63	57	64	59	60	55	1.3	1.3	1.4	1.5	NO	NO	NO
5	5_75	6 Watanobbi Rd		G	63	57	64	58	63	57	64	59	60	55	1.2	1.3	1.4	1.4	NO	NO	NO
5	5_76	8 Watanobbi Rd		G	63	57	64	58	63	57	64	59	60	55	1.2	1.2	1.4	1.4	NO	NO	NO
5	5_77	10 Watanobbi Rd		G	63	57	64	58	63	57	64	59	60	55	1.4	1.4	1.5	1.5	NO	NO	NO
5	5_78	12 Watanobbi Rd		G	62	57	64	58	63	57	64	58	60	55	1.4	1.4	1.6	1.6	NO	NO	NO
5	5_79	14 Watanobbi Rd		G	62	56	63	57	62	56	63	57	60	55	1.3	1.3	1.4	1.5	NO	NO	NO
5	5_80	16 Watanobbi Rd		1	63	57	64	58	63	57	64	59	60	55	1.3	1.3	1.5	1.5	NO	NO	NO
5	5_80	16 Watanobbi Rd		G	61	55	62	57	61	55	63	57	60	55	1.4	1.3	1.5	1.6	NO	NO	NO
5	5_81	18 Watanobbi Rd		1	62	57	64	58	63	57	64	58	60	55	1.4	1.3	1.5	1.5	NO	NO	NO
5	5_81	18 Watanobbi Rd		G	61	55	62	56	61	55	63	57	60	55	1.5	1.4	1.6	1.6	NO	NO	NO
5	5_82	20 Watanobbi Rd		1	62	56	63	57	62	56	63	57	60	55	1.2	1.2	1.4	1.4	NO	NO	NO
5	5_82	20 Watanobbi Rd		G	60	54	61	56	60	54	62	56	60	55	1.3	1.3	1.4	1.5	NO	NO	NO
5	5_83	22 Watanobbi Rd		1	62	56	63	57	62	56	63	57	60	55	1	0.9	1.2	1.2	NO	NO	NO
5	5_83	22 Watanobbi Rd		G	60	54	61	55	60	54	61	55	60	55	1	1.1	1.2	1.2	NO	NO	NO
5	5_84	24 Watanobbi Rd		G	58	52	59	53	58	52	59	53	60	55	0.9	0.8	1.1	1.1	NO	NO	NO
5	5_85	26 Watanobbi Rd		G	59	53	60	54	59	53	60	54	60	55	0.8	0.7	1	1	NO	NO	NO
5	5_86	28 Watanobbi Rd		G	58	53	59	53	59	53	59	54	60	55	0.7	0.7	0.8	0.9	NO	NO	NO
5	5_87	30 Watanobbi Rd		G	58	52	59	53	58	52	59	53	60	55	0.7	0.6	0.8	0.9	NO	NO	NO
5	5_88	30-32 Watanobbi Rd		1	59	54	60	54	60	54	60	54	60	55	0.6	0.6	0.8	0.8	NO	NO	NO
5	5_88	30-32 Watanobbi Rd		G	58	52	58	52	58	52	59	53	60	55	0.6	0.5	0.7	0.8	NO	NO	NO
5	5_89	34 Watanobbi Rd		G	53	47	54	48	53	47	54	48	60	55	0.3	0.3	0.4	0.5	NO	NO	NO

Note: 1 Based on building construction an external noise level to internal noise level reduction of 20 dB(A) has been applied

2 Based on building construction an external noise level to internal noise level reduction of 15 dB(A) has been applied

APPENDIX E Operational Noise Contours



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Project:
PACIFIC HWY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON RD TO CUTLER DRIVE

Description:
LAeq (15hr) Daytime at 1.5m height
Design Year - 2031
Section 1 of 3

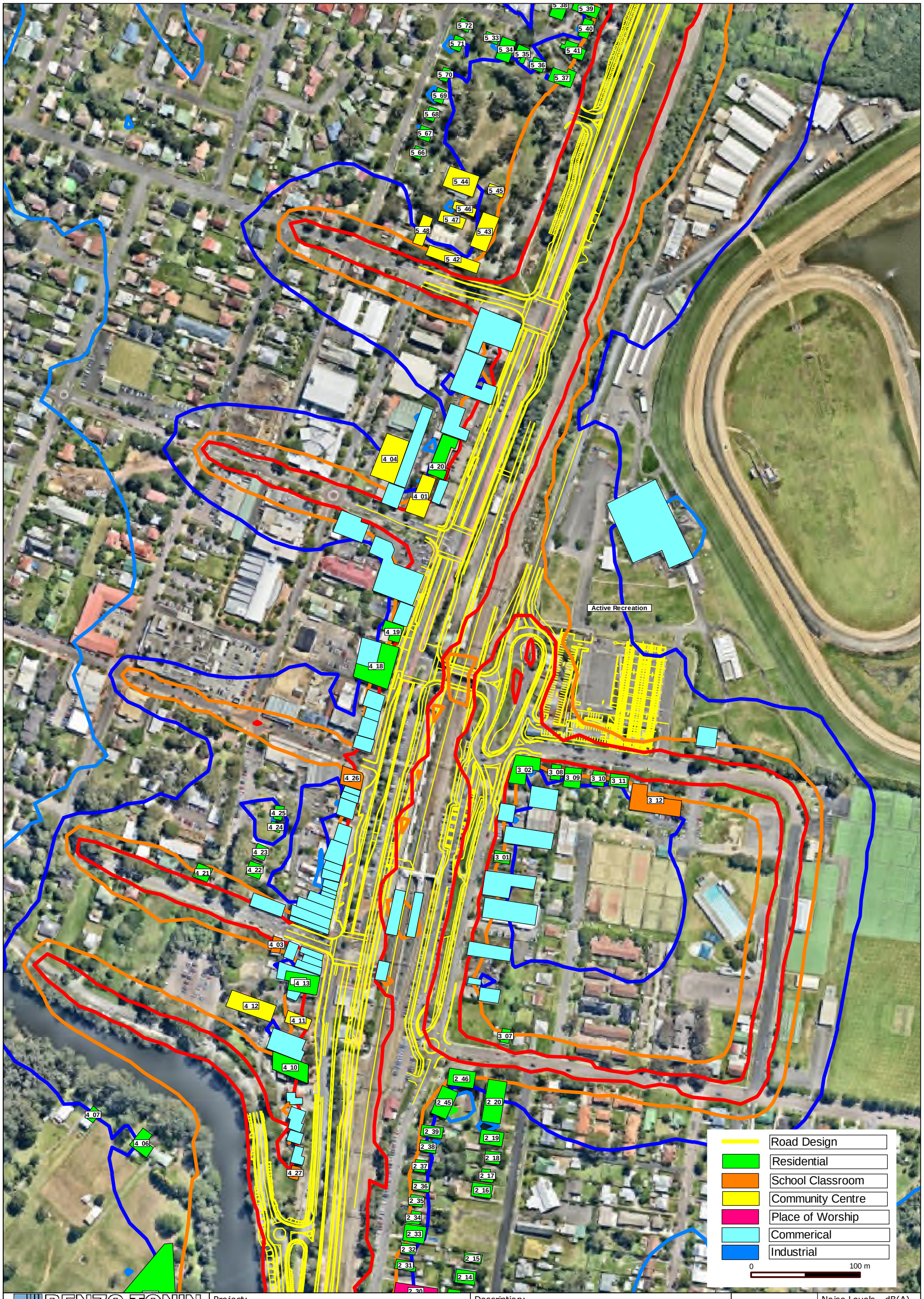
Noise Levels - dB(A)
= 45
= 50
= 55
= 60
= 65

Reference: TG555-02_CA01_P01 (r1)
Gr# 03C_DES-BLD_D_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3



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Project:
**PACIFIC HWY UPGRADE -
VIA WYONG TOWN CENTRE -
JOHNSON RD TO CUTLER DRIVE**

Description:
LAeq (15hr) Daytime at 1.5m height
Design Year - 2031
Section 2 of 3

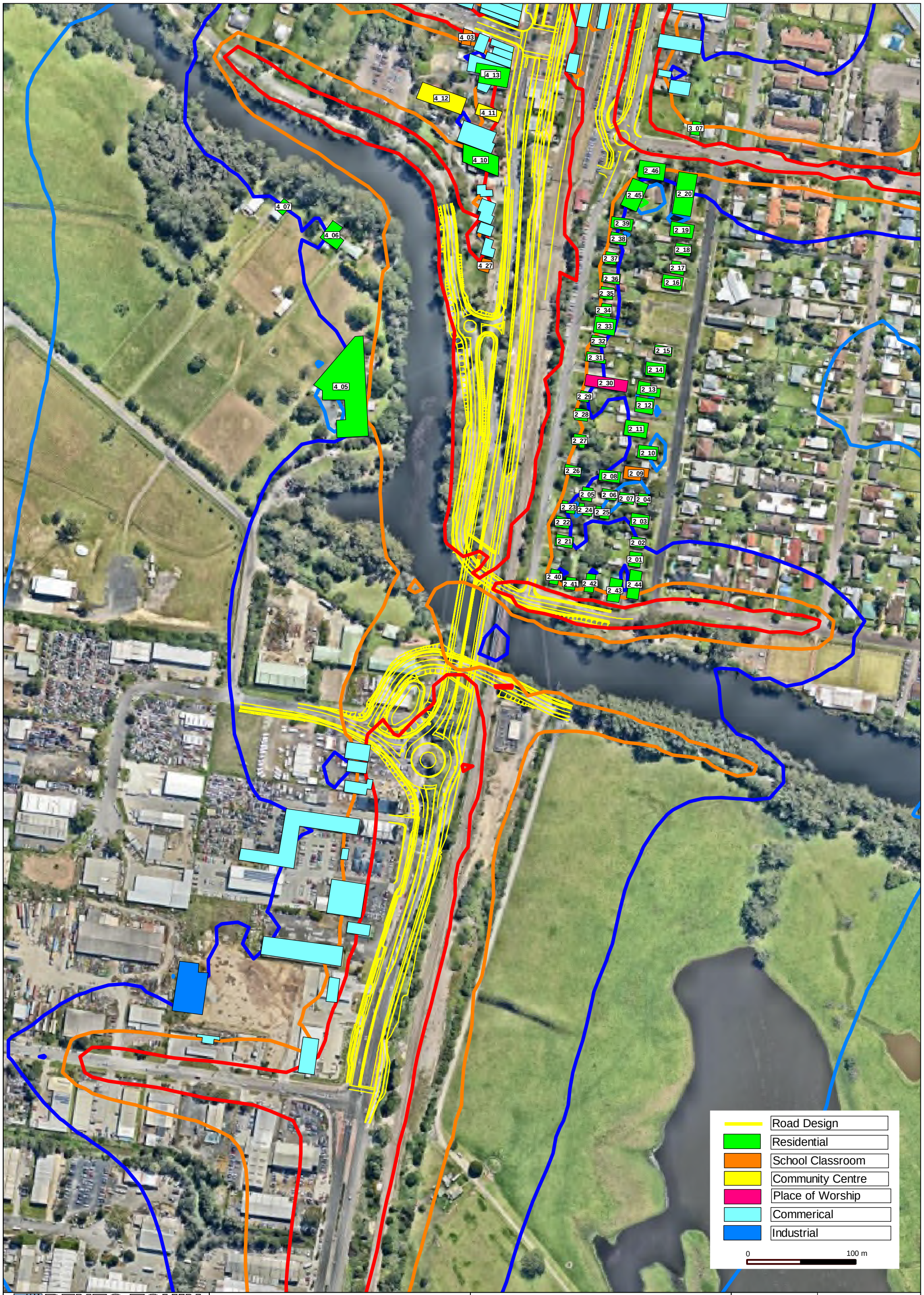
Noise Levels - dB(A)
= 45
= 50
= 55
= 60
= 65

Reference: TG555-02_CA01_P02 (r1)
Gr# 03C_DES-BLD_D_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3



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Project:
PACIFIC HWY UPGRADE -
VIA WYONG TOWN CENTRE -
JOHNSON RD TO CUTLER DRIVE

Description:
LAeq (15hr) Daytime at 1.5m height
Design Year - 2031
Section 3 of 3

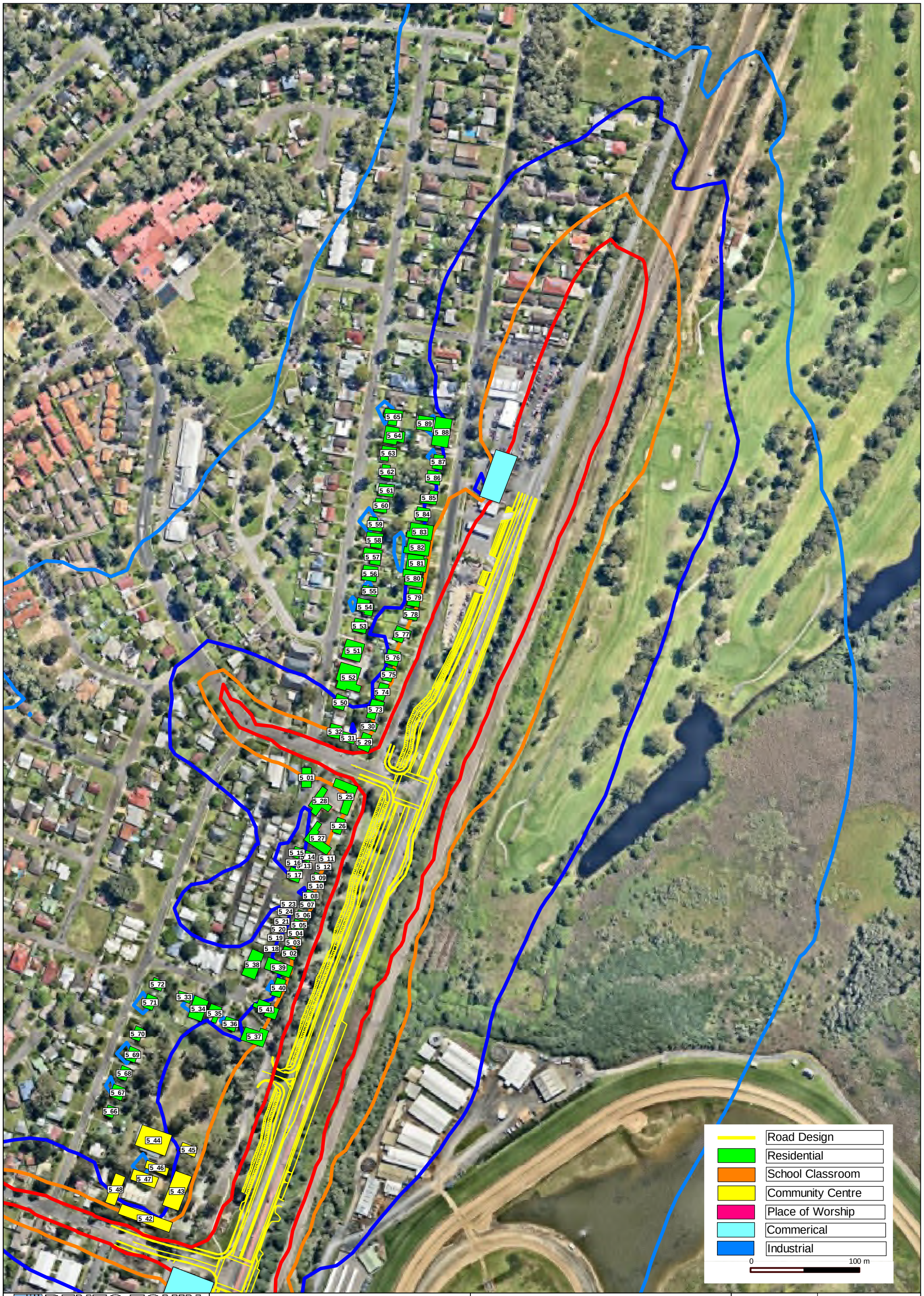
Noise Levels - dB(A)
= 45
= 50
= 55
= 60
= 65

Reference: TG555-02_CA01_P03 (r1)
Gr# 03C_DES-BLD_D_LEQ

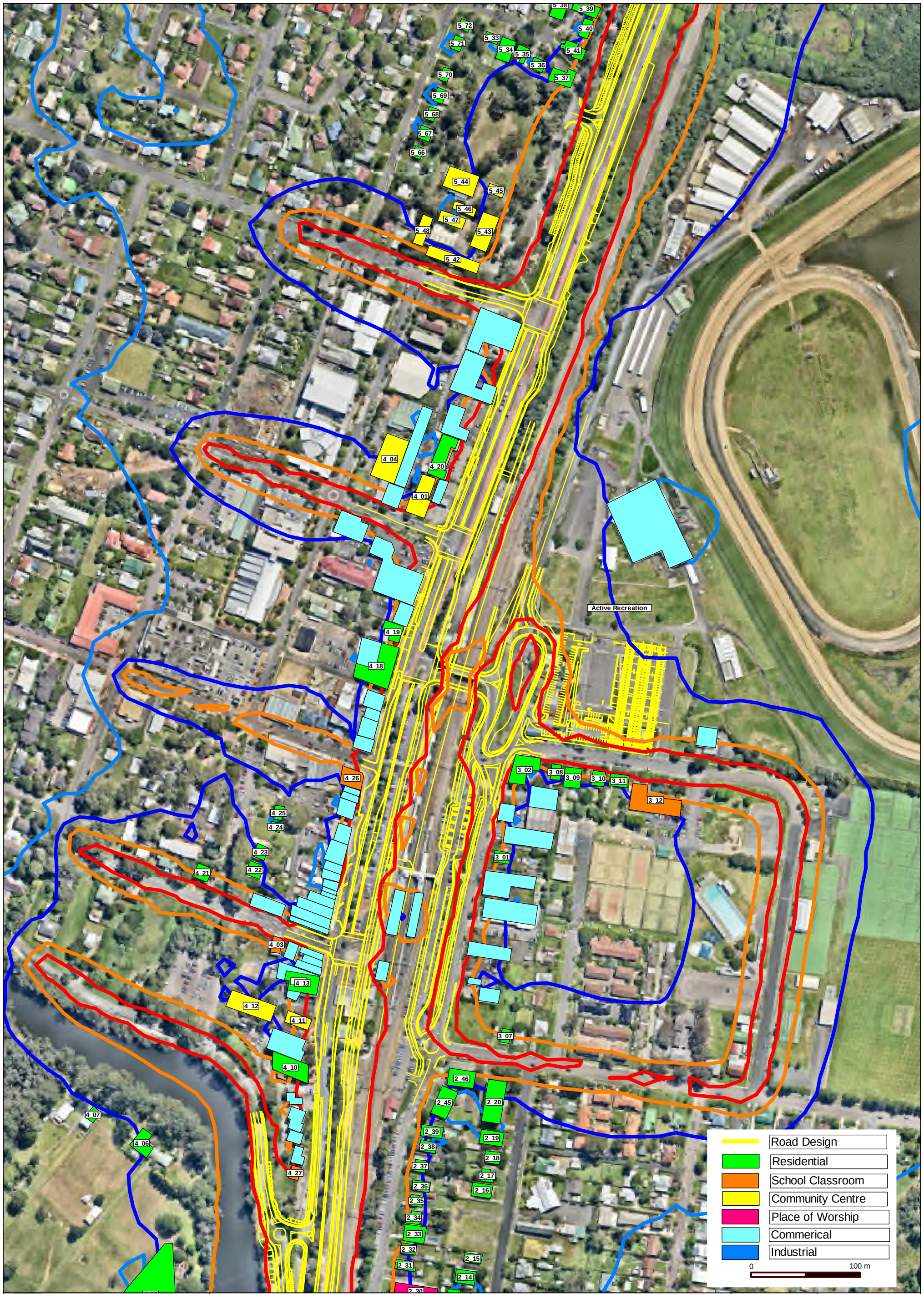
Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3



RENZO TONIN & ASSOCIATES *inspired to achieve* Acoustics, Vibration & Structural Dynamics Sydney Melbourne Brisbane Gold Coast Kuwait	Project: **PACIFIC HWY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON RD TO CUTLER DRIVE**	Description: LAeq (9hr) Night-time at 1.5m height Design Year - 2031 Section 1 of 3	N	legend: = 45 = 50 = 55 = 60
Reference: TG555-02_CA01_P04 (r1) Gr# 04C_DES-BLD_N_LEQ	Client: SMEC Australia Ptd Ltd	Date: 2015.07.24	Scale: 1: 3200 A3	



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Project:
**PACIFIC HWY UPGRADE -
VIA WYONG TOWN CENTRE -
JOHNSON RD TO CUTLER DRIVE**

Description:
LAeq (9hr) Night-time at 1.5m height
Design Year - 2031
Section 2 of 3

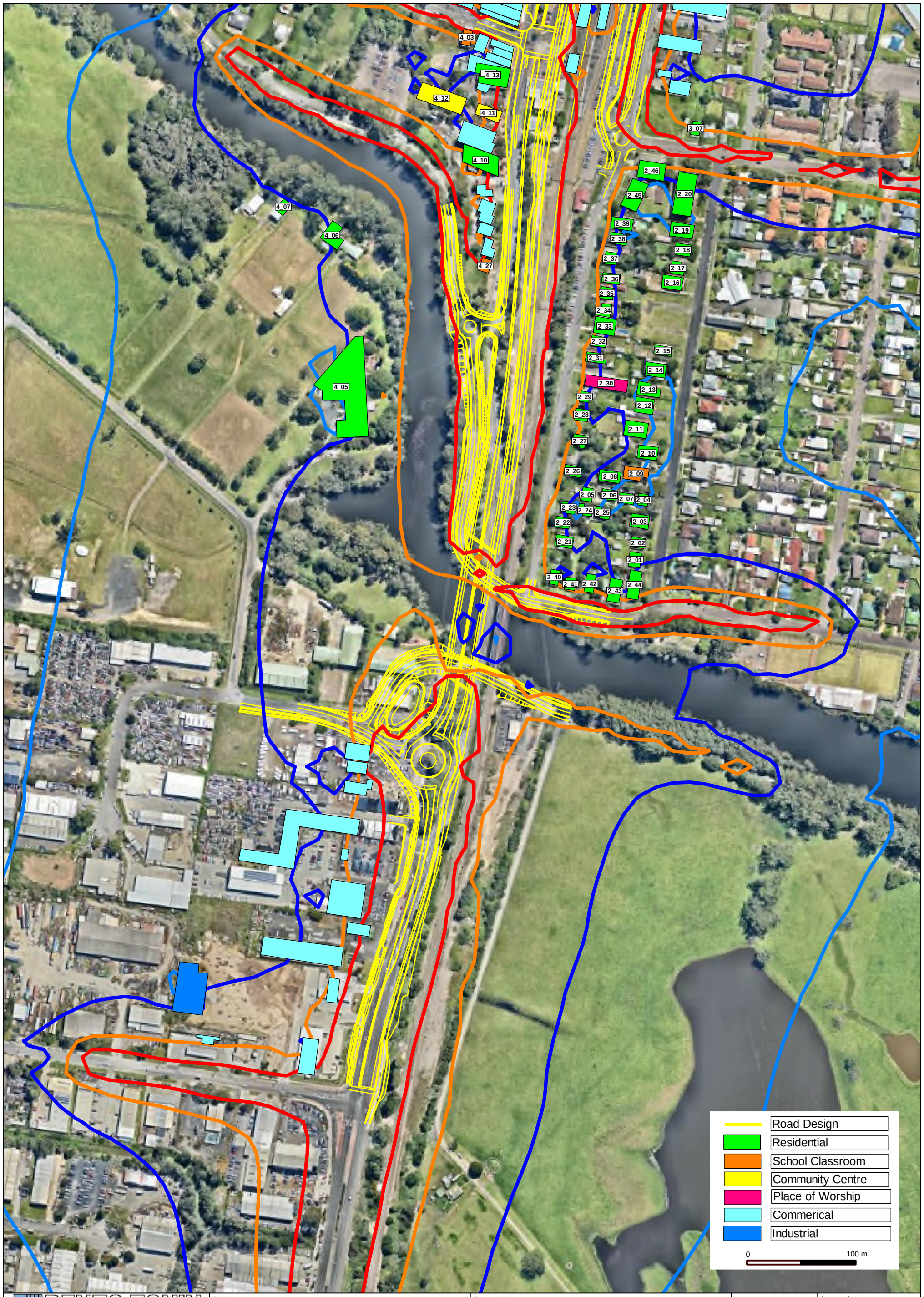
legend:
= 45
= 50
= 55
= 60

Reference: TG555-02_CA01_P05 (r1)
Gr# 04C_DES-BLD_N_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3



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Project:
PACIFIC HWY UPGRADE -
VIA WYONG TOWN CENTRE -
JOHNSON RD TO CUTLER DRIVE

Description:
LAeq (9hr) Night-time at 1.5m height
Design Year - 2031
Section 3 of 3

legend:
= 45
= 50
= 55
= 60

Reference: TG555-02_CA01_P06 (r1)
Gr# 04C_DES-BLD_N_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.24

Scale: 1: 3200 A3

APPENDIX F Construction Noise Contours

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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Site Establishment
Section 1 of 2

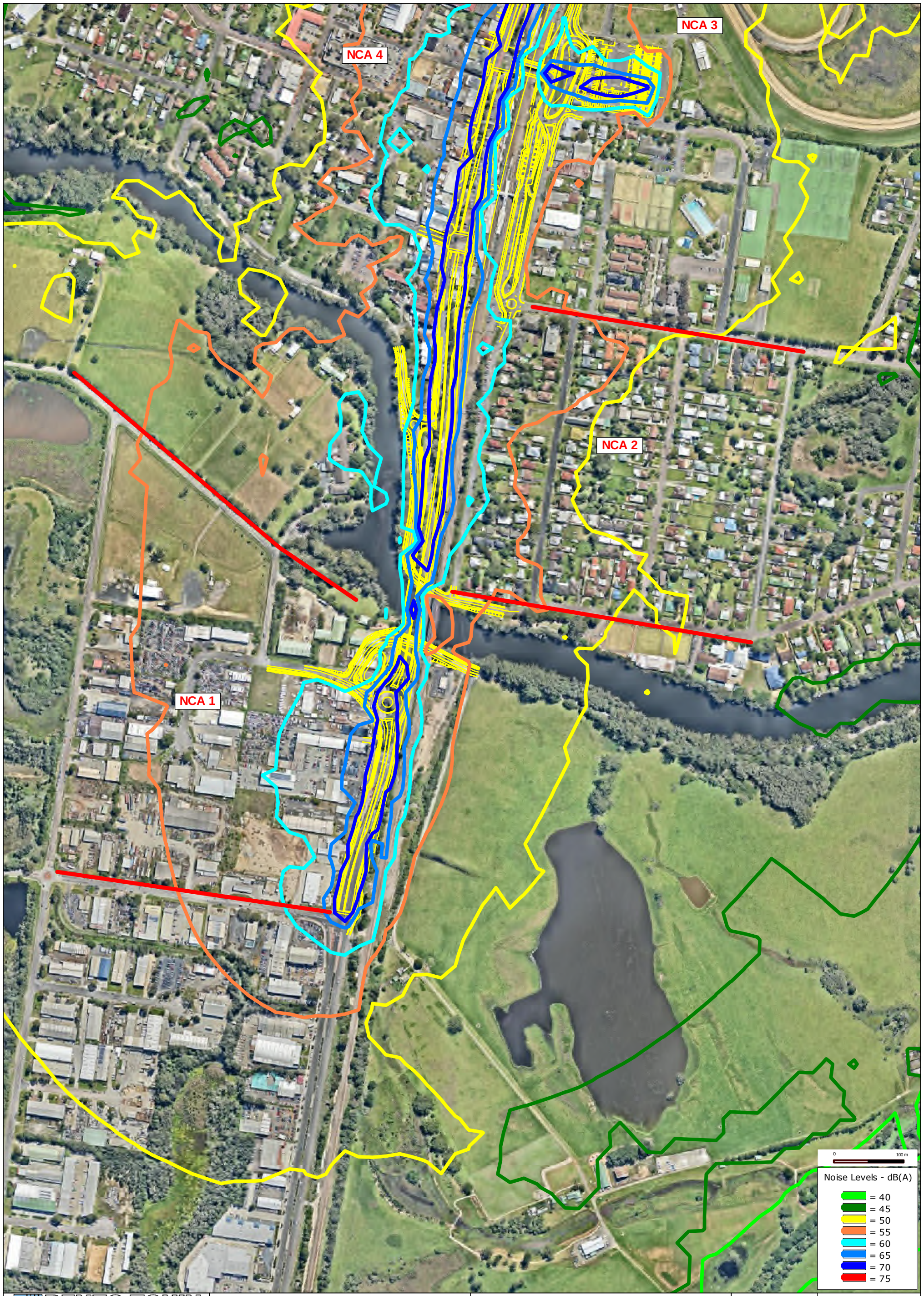
legend:

Reference: TG555-02_CA01_P05 (r1)
Gr# 01_CON-SE_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Site Establishment
Section 2 of 2

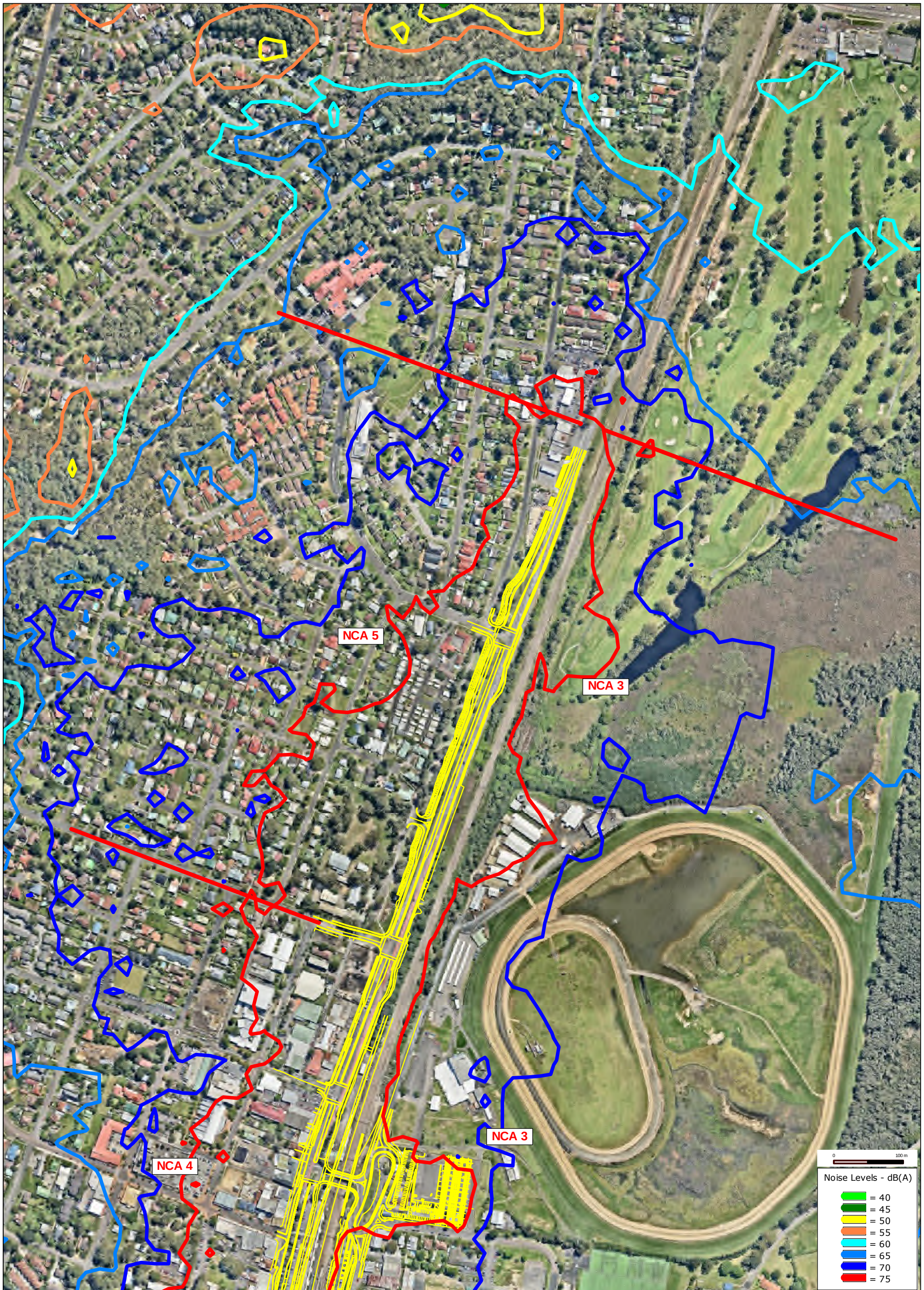
legend:

Reference: TG555-02_CA01_P06 (r1)
Gr# 01_CON-SE_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Clearing & Grubbing
Section 1 of 2

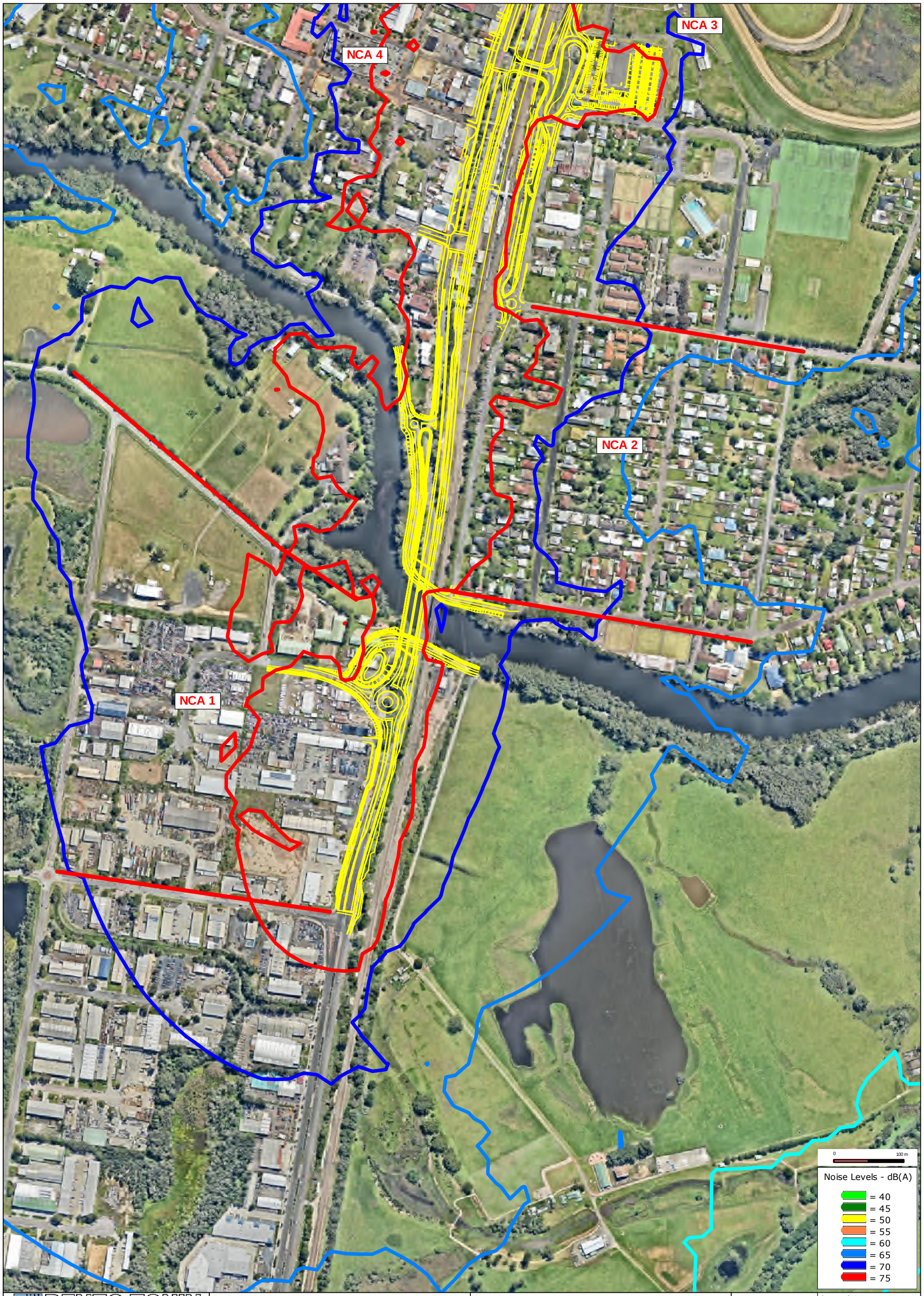
legend:

Reference: TG555-02_CA01_P07 (r1)
Gr#02_CON-CG_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Clearing & Grubbing
Section 2 of 2

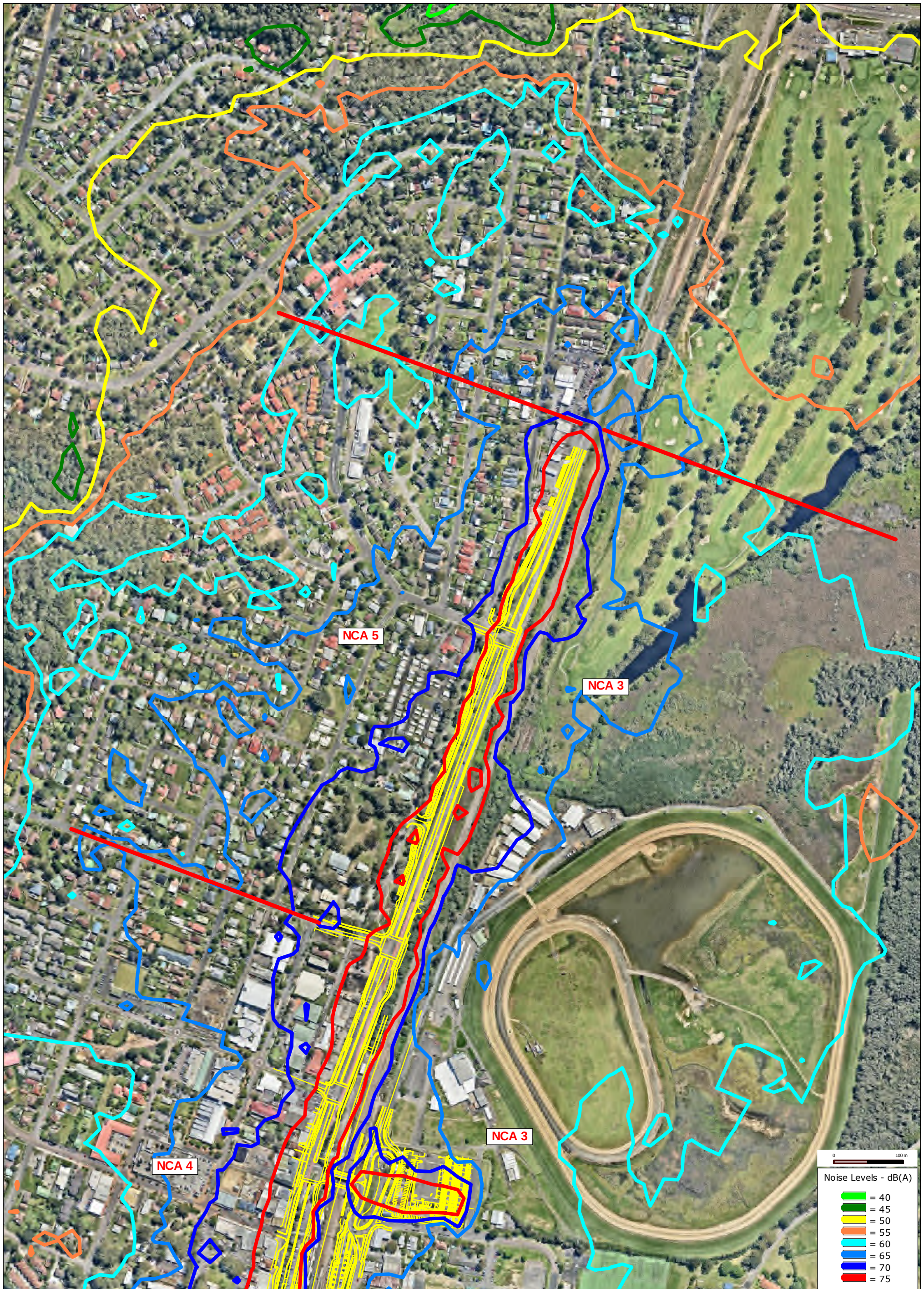
legend:

Reference: TG555-02_CA01_P08 (r1)
Gr#02_CON-CG_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Bulk Earthworks
Section 1 of 2

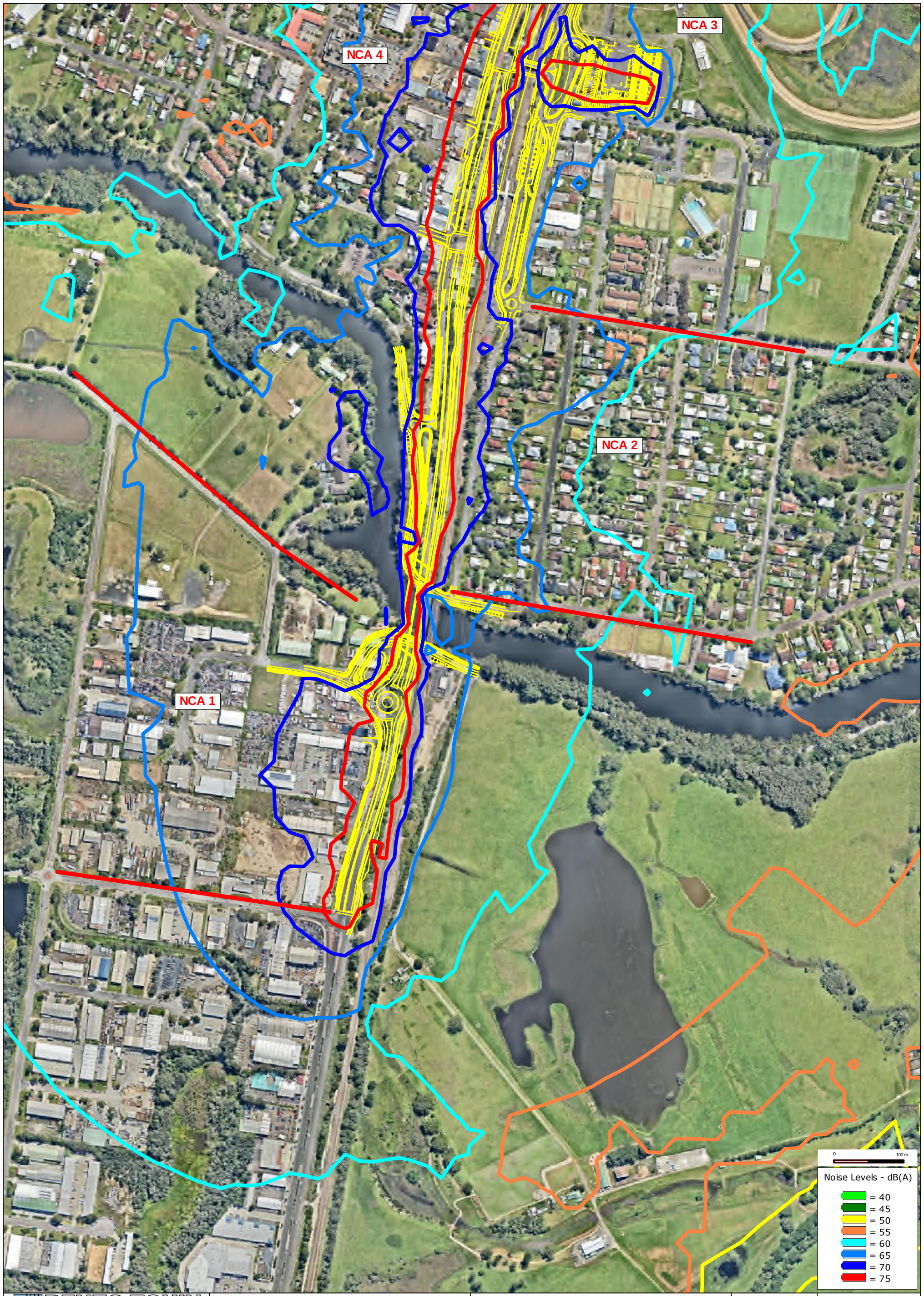
legend:

Reference: TG555-02_CA01_P09 (r1) Gr#03_CON-BE_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Bulk Earthworks
Section 2 of 2

legend:

Reference: TG555-02_CA01_P10 (r1)
Gr#03_CON-BE_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3

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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Drainage Infrastructure
Section 1 of 2

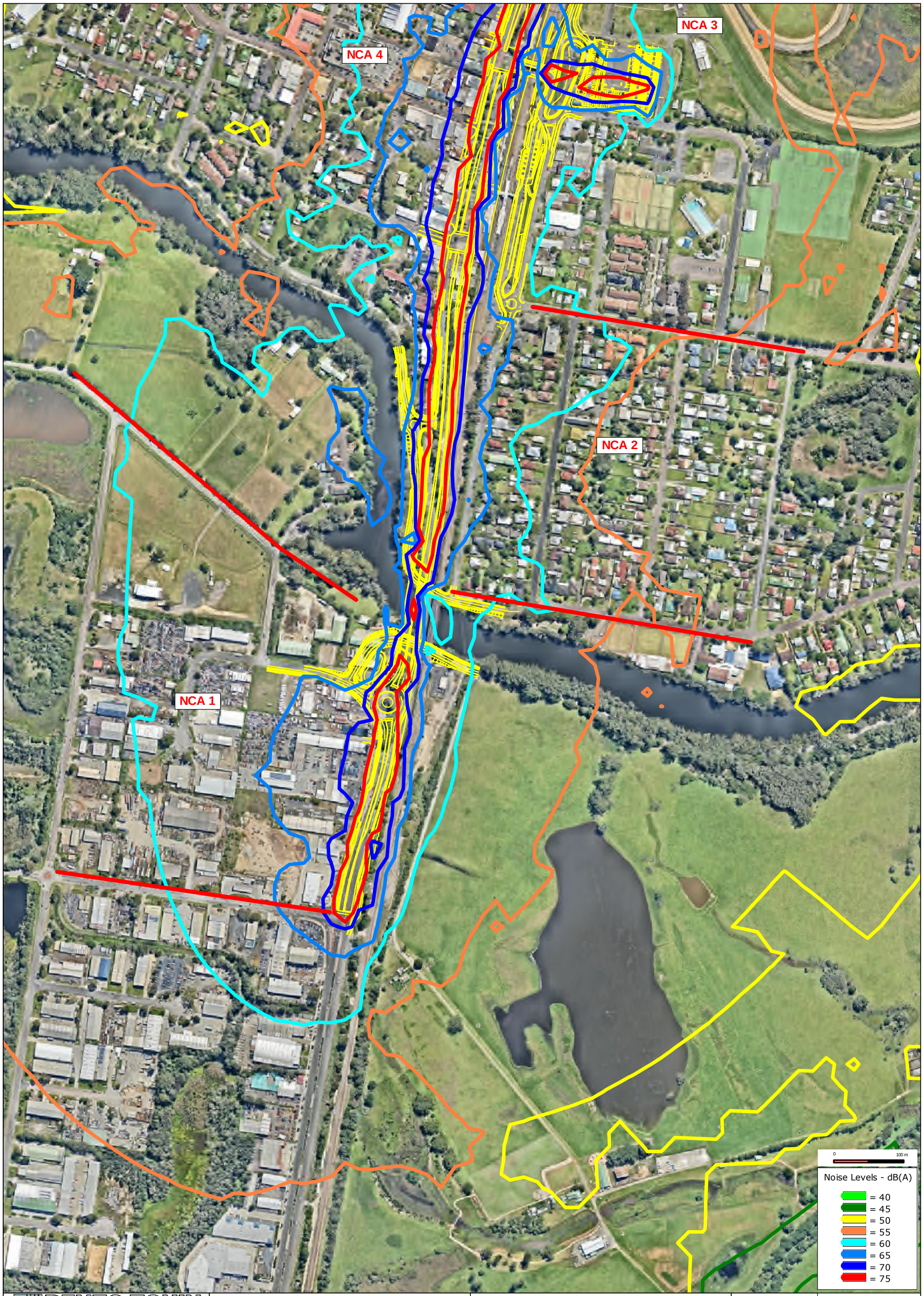
legend:

Reference: TG555-02_CA01_P11 (r1) Gr#04_CON-DI_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Drainage Infrastructure
Section 2 of 2

legend:

Reference: TG555-02_CA01_P12 (r1)
Gr#04_CON-DI_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3

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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Bridge Works
Section 1 of 2

legend:

Reference: TG555-02_CA01_P13 (r1) Gr#05_CON-BR_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3

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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Bridge Works
Section 2 of 2

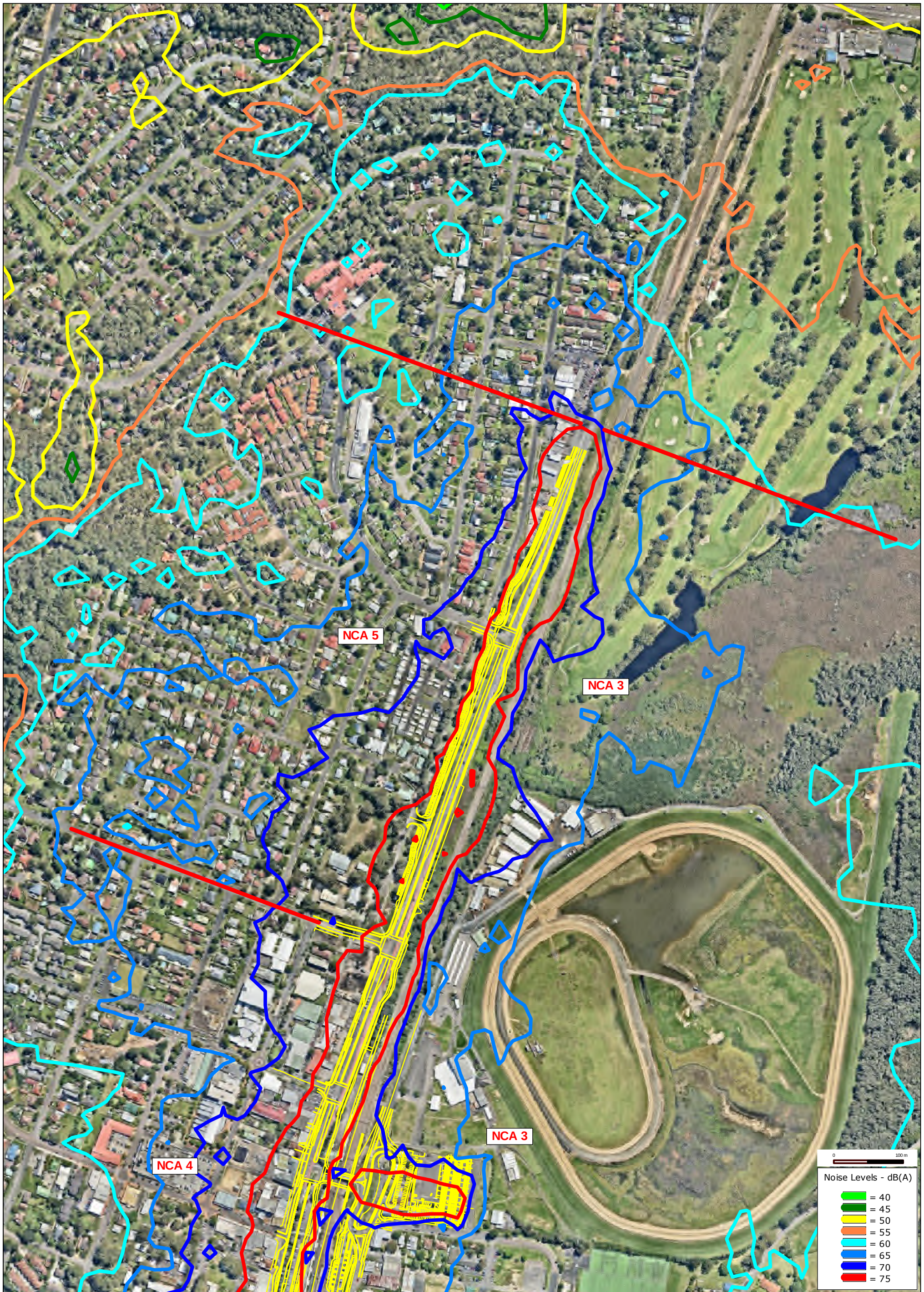
legend:

Reference: TG555-02_CA01_P14 (r1)
Gr#05_CON-BR_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Paving/Asphalting
Section 1 of 2

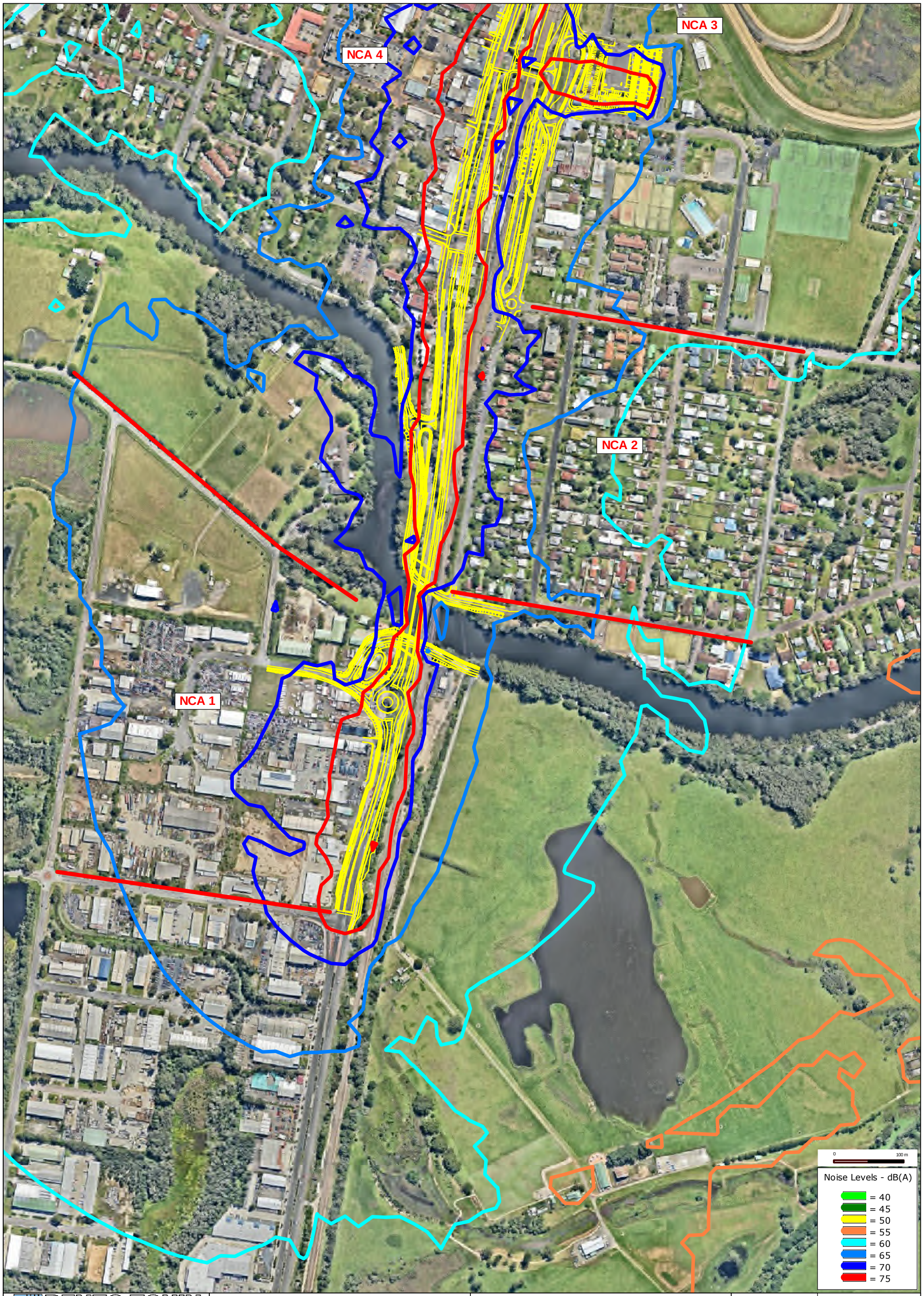
legend:

Reference: TG555-02_CA01_P15 (r1)
Gr#06_CON-PA_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Paving/Asphalting
Section 2 of 2

legend:

Reference: TG555-02_CA01_P16 (r1) Gr#06_CON-PA_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3

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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Compounds
Section 1 of 2

legend:

Reference: TG555-02_CA01_P17 (r1) Gr#07_CON-COM_LEQ r1

Client: SMEC Australia Ptd Ltd

Date: 2015.07.23

Scale: 1: 5000 A3

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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Compounds
Section 2 of 2

legend:

Reference: TG555-02_CA01_P18 (r1)
Gr#07_CON-COM_LEQ r1

Client: SMEC Australia Ptd Ltd

Date: 2015.07.23

Scale: 1: 5000 A3

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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Road Furniture Installation
Section 1 of 2

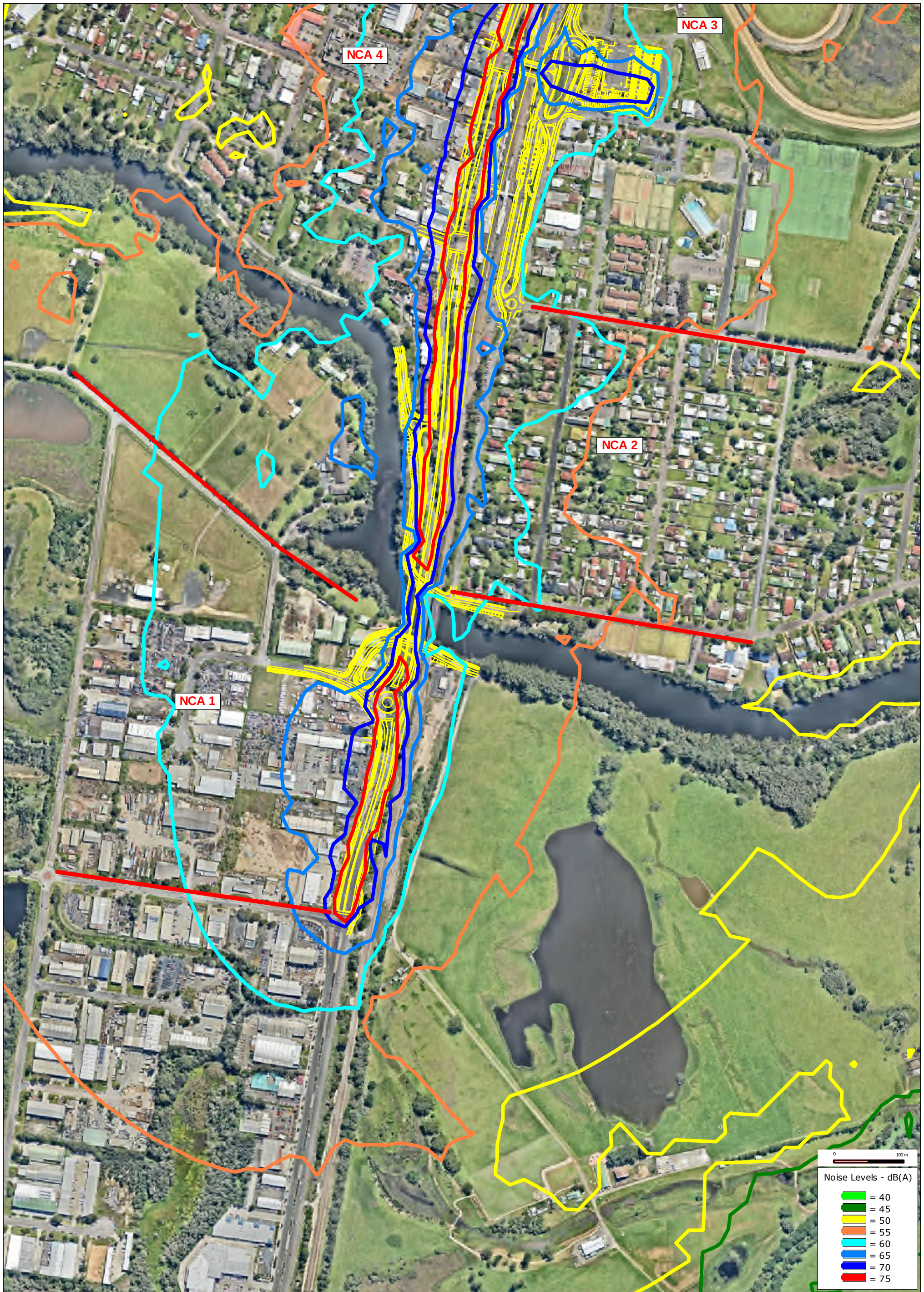
legend:

Reference: TG555-02_CA01_P19 (r1)
Gr#08_CON-RF_LEQ

Client: SMEC Australia Ptd Ltd

Date: 2015.07.17

Scale: 1: 5000 A3



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Project:
PACIFIC HIGHWAY UPGRADE - VIA WYONG TOWN CENTRE - JOHNSON ROAD TO CUTLER DRIVE

Description:
LAeq (15min) at 1.5m height
Construction - Road Furniture Installation
Section 2 of 2

legend:

Reference: TG555-02_CA01_P20 (r1)
Gr#08_CON-RF_LEQ

Client: SMEC Australia Ptd Ltd

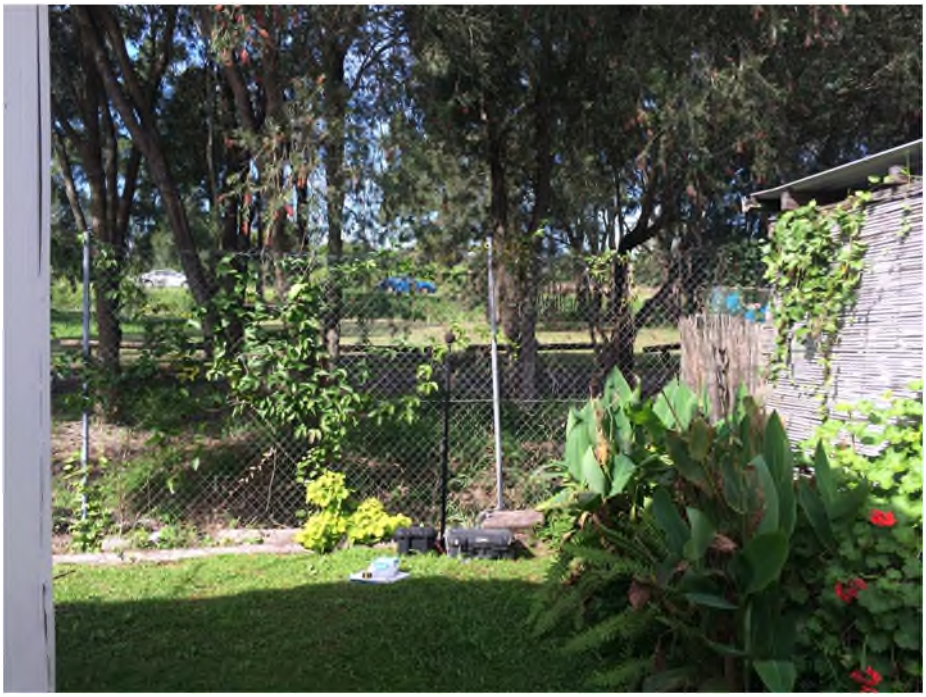
Date: 2015.07.17

Scale: 1: 5000 A3

APPENDIX G Long Term Noise Monitoring Results

Long Term Monitoring location - M1	
1. Address	19 Howarth Street, Wyong
2. Terrestrial Photos	
	Looking south (Pacific Highway and Howarth Street to the right)
	
	Looking north (Pacific Highway and Howarth Street to the left)
3. Distance of Logger from Pacific highway	80 metres from the nearest edge of carriageway

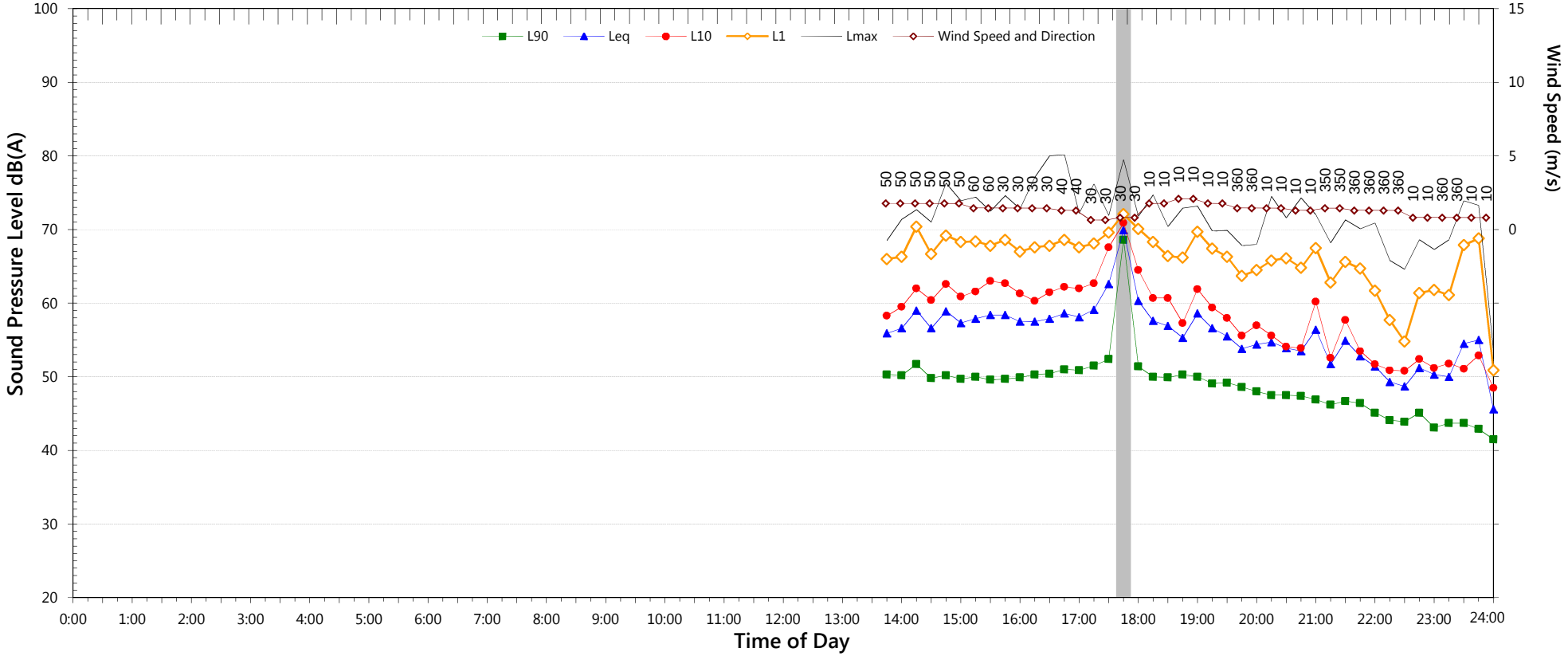
Long Term Monitoring location – M2	
1. Address	3/142 Pacific Highway, Wyong
2. Terrestrial Photos	
	Looking east towards Pacific Highway
	
	Looking north (Pacific Highway to the right)
3. Distance of Logger from Pacific highway	35 metres from the nearest edge of carriageway

Long Term Monitoring location – M3	
1. Address	14/1A Cutler Drive, Wyong
2. Terrestrial Photos	
	Looking east towards Pacific Highway
	
	Looking north (Pacific Highway to the right)
3. Distance of Logger from Pacific highway	50 metres from the nearest edge of carriageway

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Tuesday, 29 April 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	46.2	-
Leq	-	55.3	-

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)

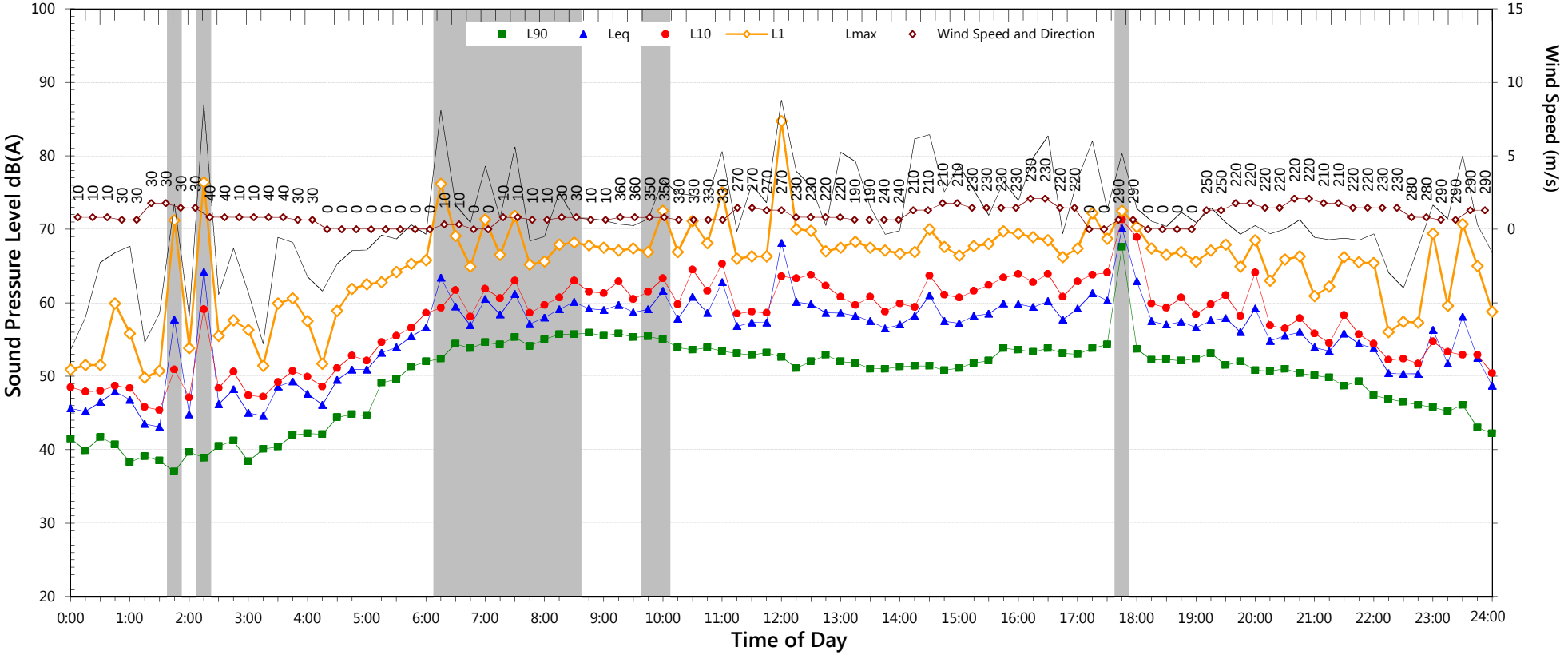
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.8	53.1
$L_{eq\ 1hr}$ upper 10 percentile	63.4	57.5
$L_{eq\ 1hr}$ lower 10 percentile	55.4	46.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	67.2	to	73.9
Lmax - Leq (Range)	15.6	to	21.3

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Wednesday, 30 April 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	48.7	38.2
Leq	-	56.4	53.9

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)

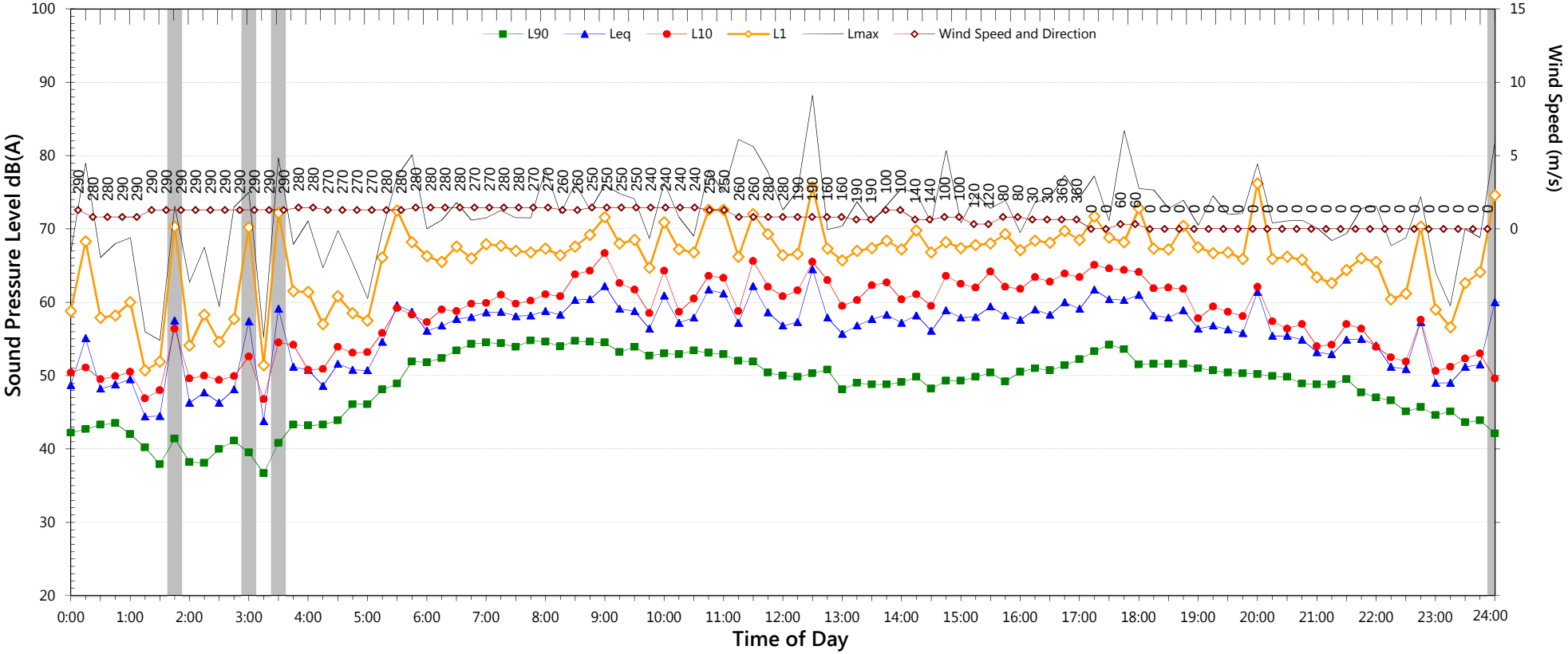
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.7	56.4
$L_{eq\ 1hr}$ upper 10 percentile	65.0	60.3
$L_{eq\ 1hr}$ lower 10 percentile	57.2	47.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	69.8	to	80.1
Lmax - Leq (Range)	15.8	to	27.6

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Thursday, 1 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	49.0	47.7	-
Leq	59.3	56.7	-

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)

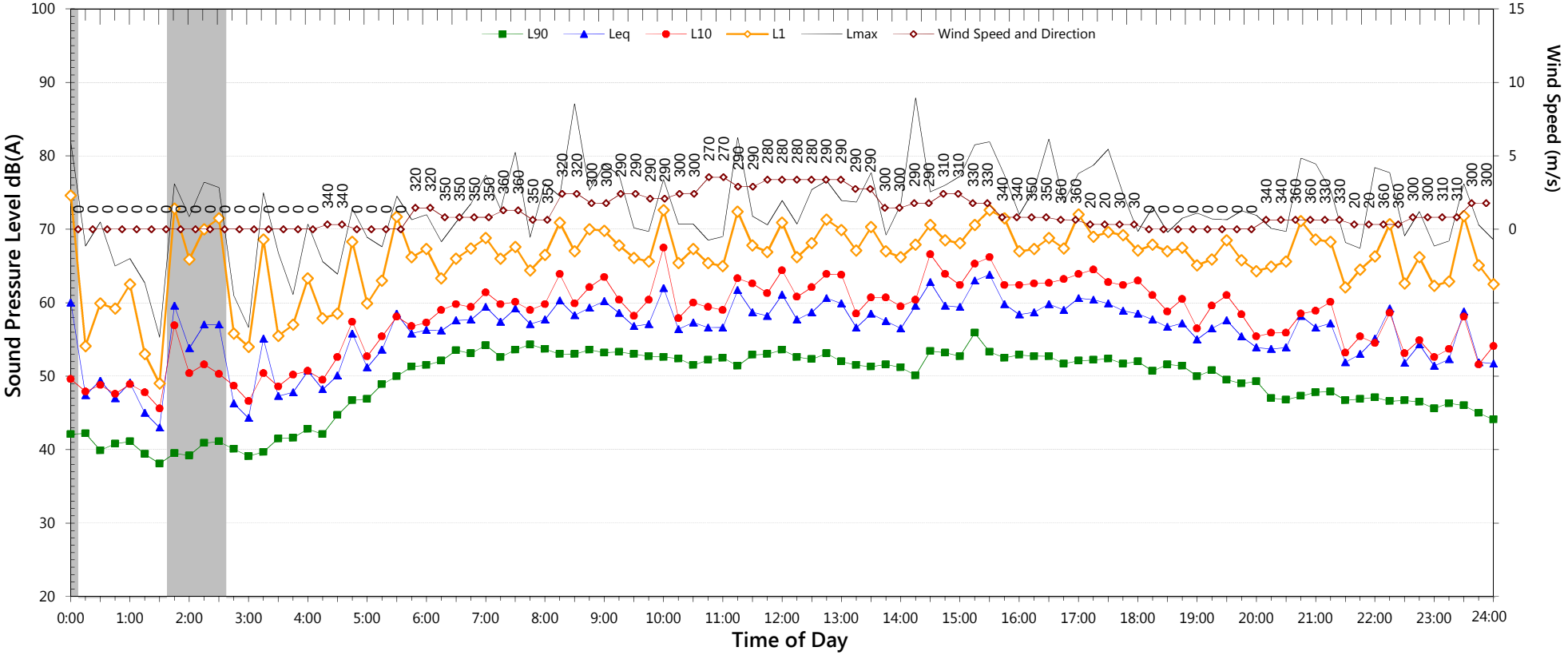
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.3	56.1
$L_{eq\ 1hr}$ upper 10 percentile	63.2	60.4
$L_{eq\ 1hr}$ lower 10 percentile	57.1	46.6

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.0	to	77.4
Lmax - Leq (Range)	15.6	to	23.6

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Friday, 2 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	51.5	46.8	-
Leq	59.5	56.0	-

NOTES:

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

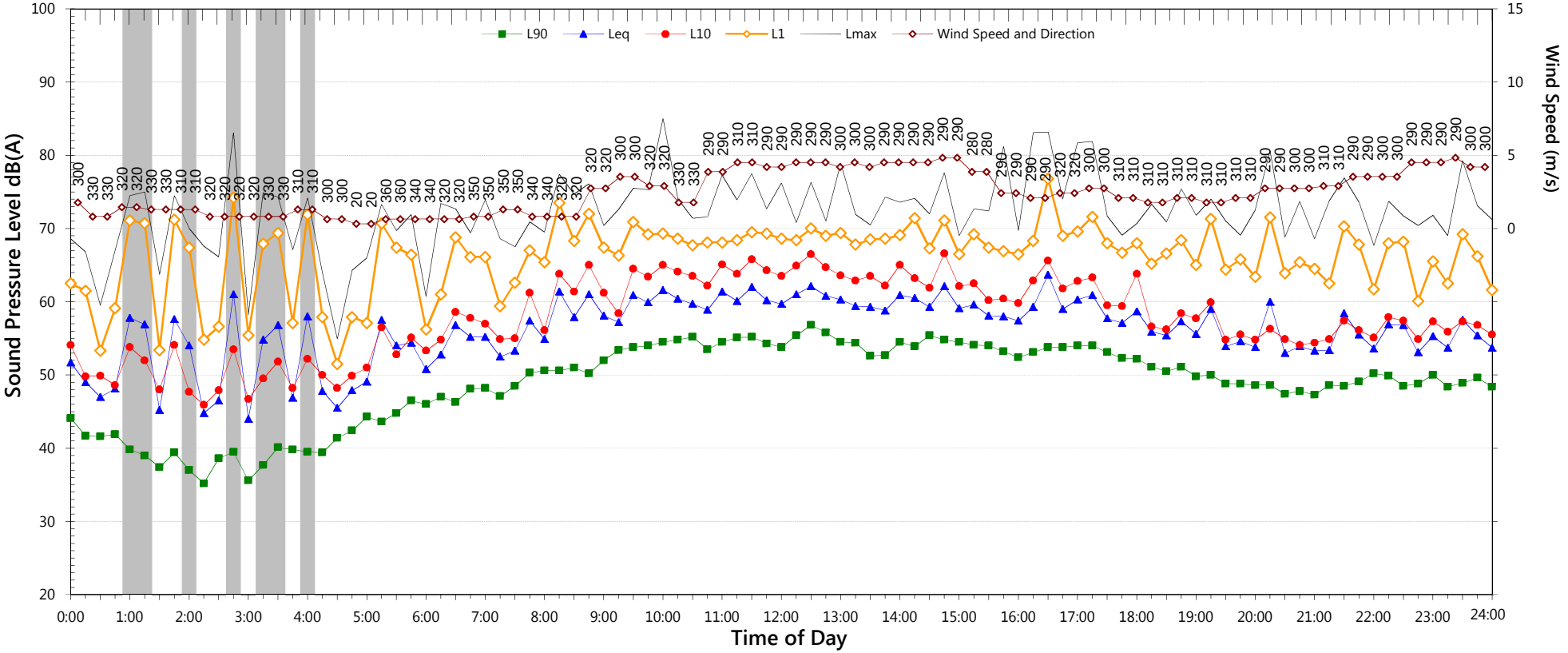
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.3	55.9
$L_{eq\ 1hr}$ upper 10 percentile	63.7	57.9
$L_{eq\ 1hr}$ lower 10 percentile	57.9	47.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	66.0	to	77.7
Lmax - Leq (Range)	18.2	to	22.4

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Saturday, 3 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.6	47.4	-
Leq	59.8	56.0	-

NOTES:

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

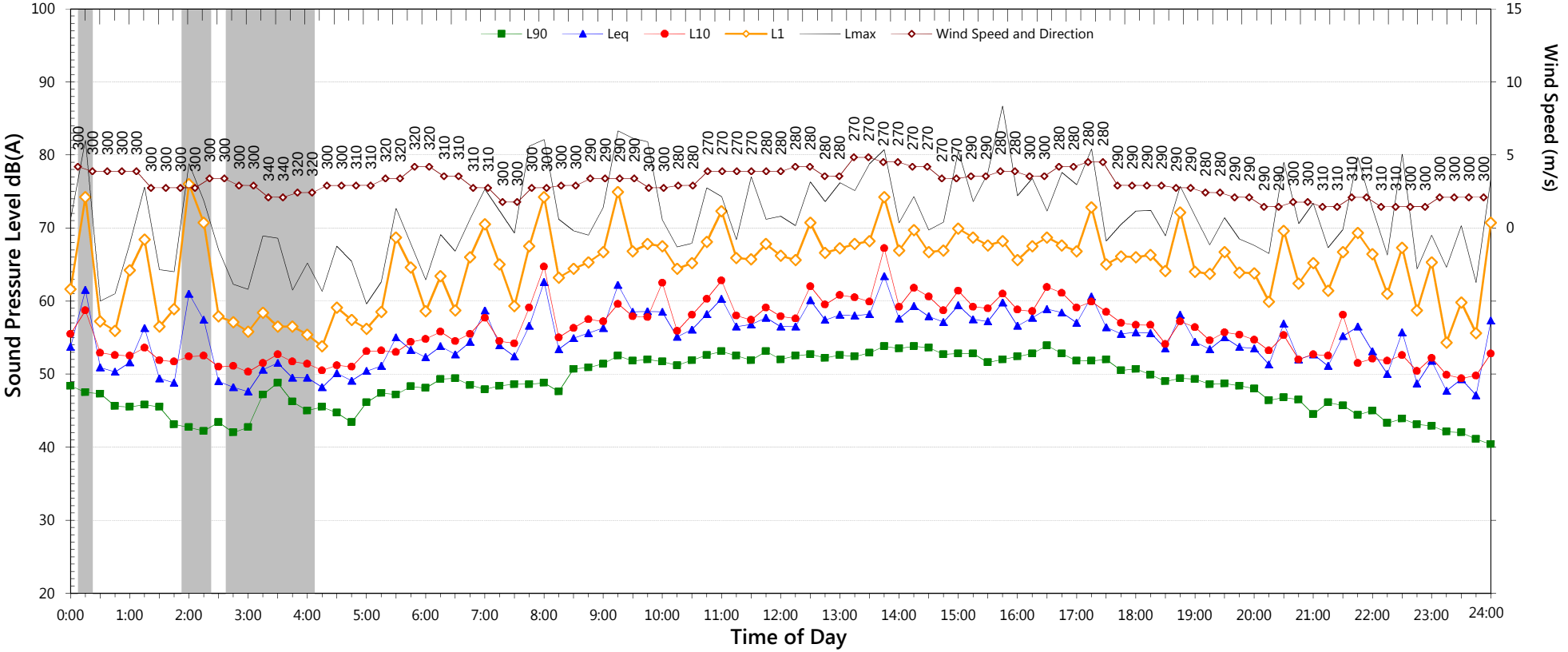
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.6	57.3
$L_{eq\ 1hr}$ upper 10 percentile	63.6	58.3
$L_{eq\ 1hr}$ lower 10 percentile	57.9	51.5

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	67.0	to	79.3
Lmax - Leq (Range)	16.8	to	23.9

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Sunday, 4 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.8	44.5	39.6
Leq	58.2	54.6	53.9

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)

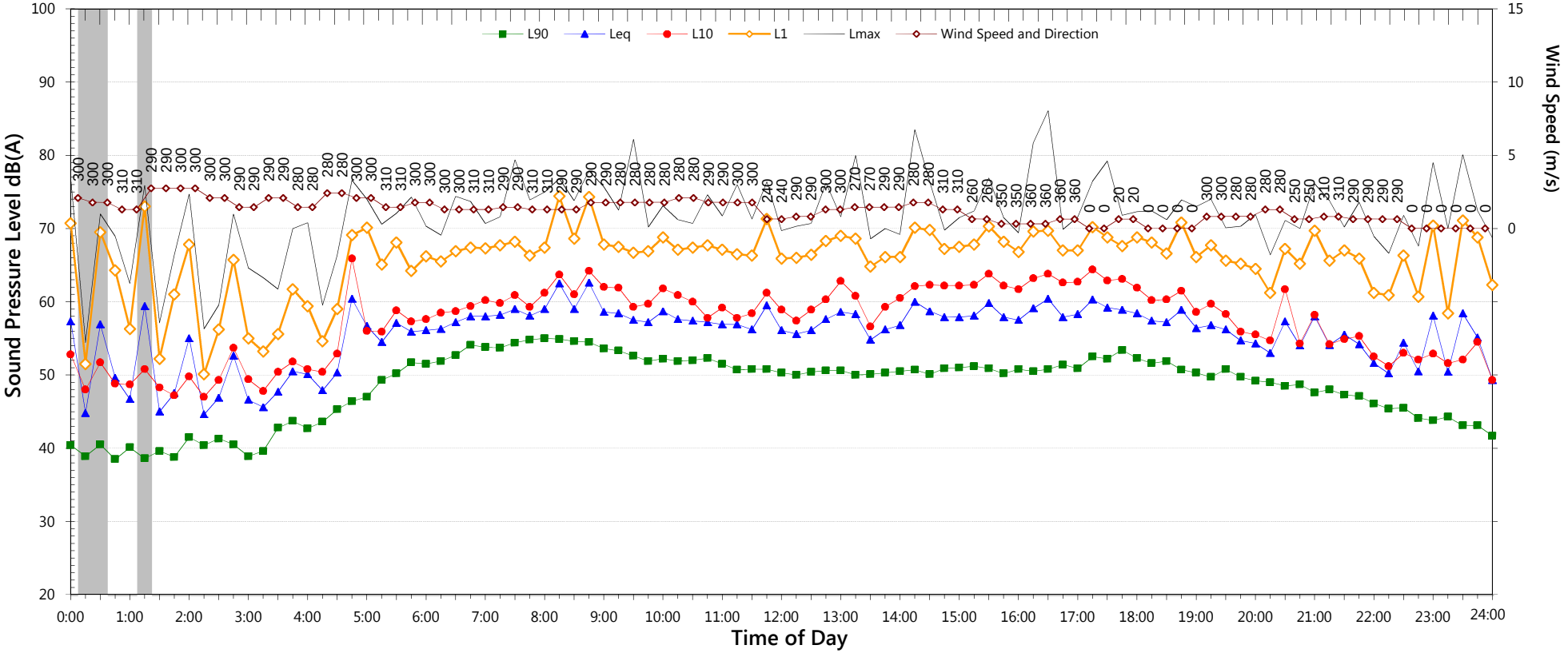
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.0	56.4
$L_{eq\ 1hr}$ upper 10 percentile	62.4	59.9
$L_{eq\ 1hr}$ lower 10 percentile	56.4	50.9

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.9	to	80.1
Lmax - Leq (Range)	17.0	to	27.7

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Monday, 5 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.2	47.1	41.5
Leq	58.5	56.0	54.9

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)

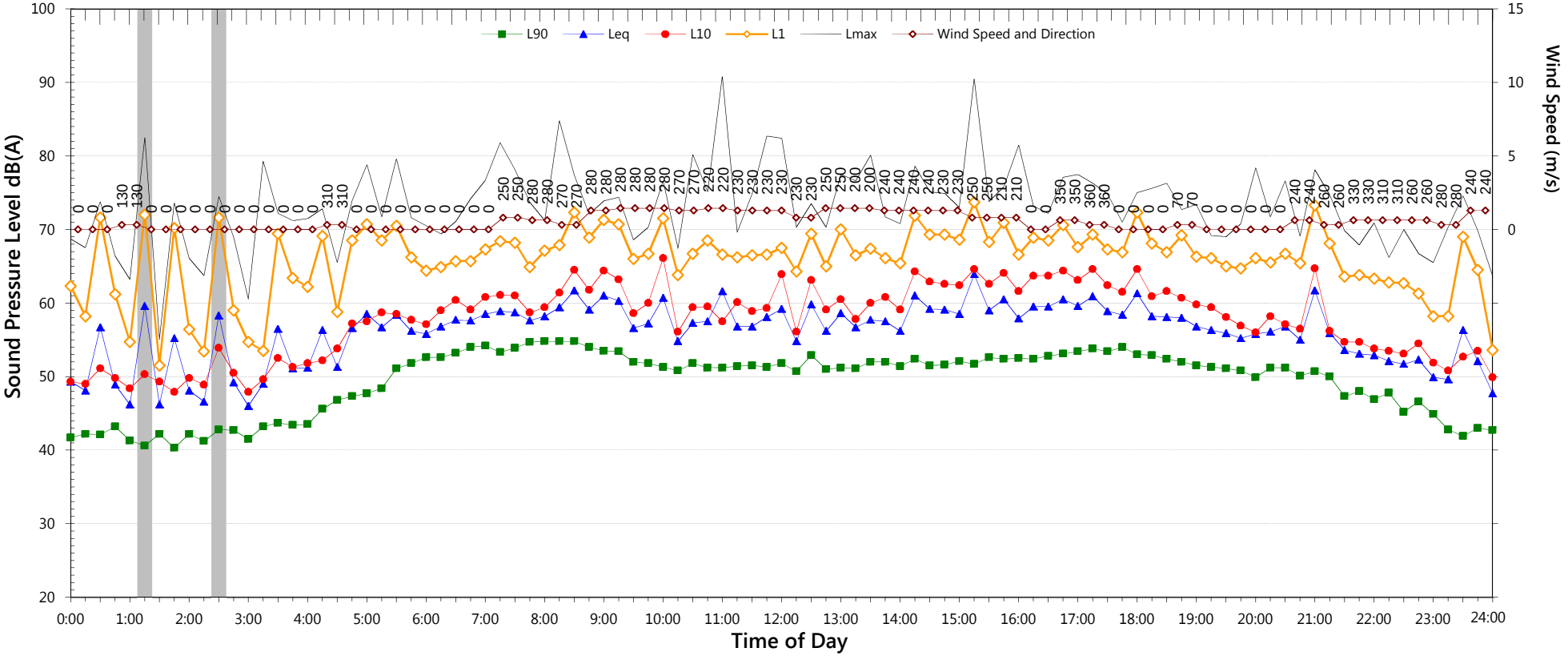
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.5	57.4
$L_{eq\ 1hr}$ upper 10 percentile	62.8	60.2
$L_{eq\ 1hr}$ lower 10 percentile	57.4	50.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.9	to	80.1
Lmax - Leq (Range)	19.0	to	26.4

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Tuesday, 6 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	51.2	47.3	39.9
Leq	59.2	56.8	54.2

NOTES:

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

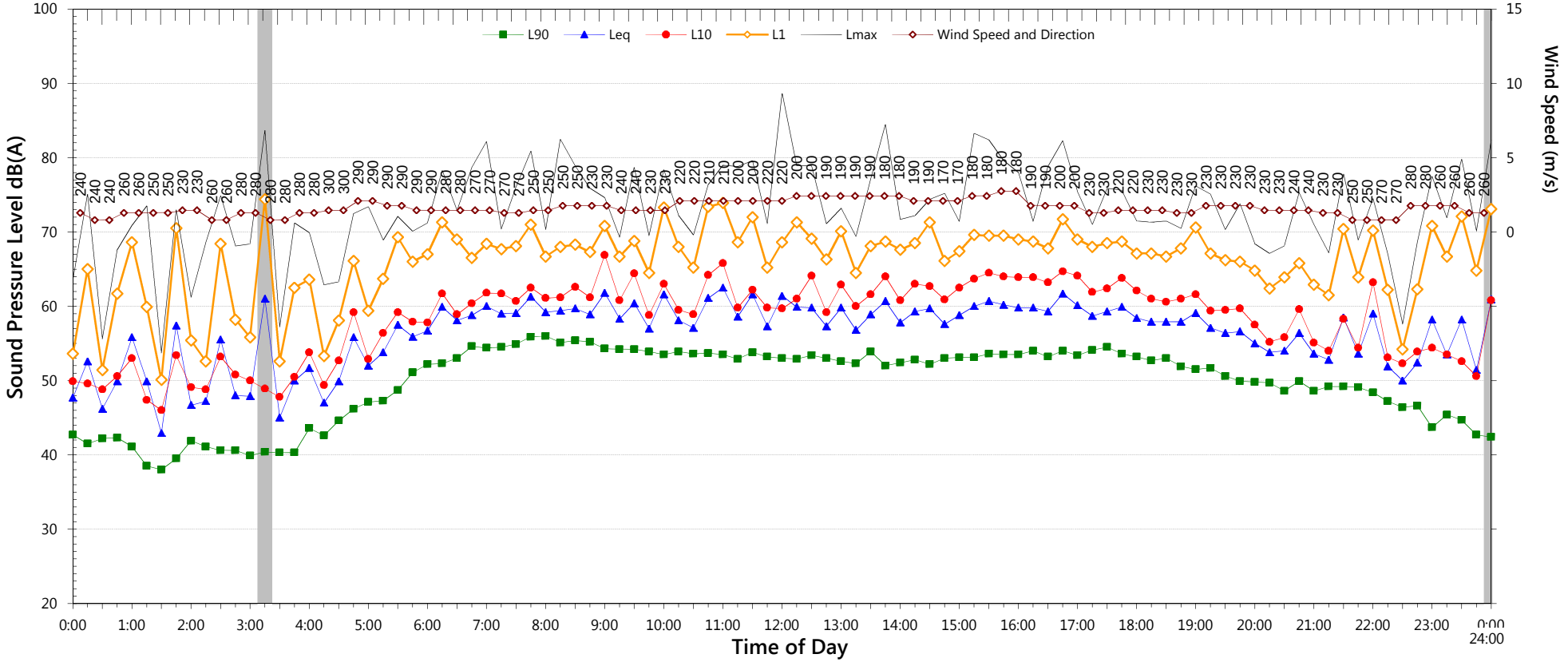
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.2	56.7
$L_{eq\ 1hr}$ upper 10 percentile	63.2	61.8
$L_{eq\ 1hr}$ lower 10 percentile	57.5	52.2

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.0	to	82.2
Lmax - Leq (Range)	15.9	to	23.7

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Wednesday, 7 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	52.6	48.6	40.5
Leq	59.7	56.7	54.8

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)

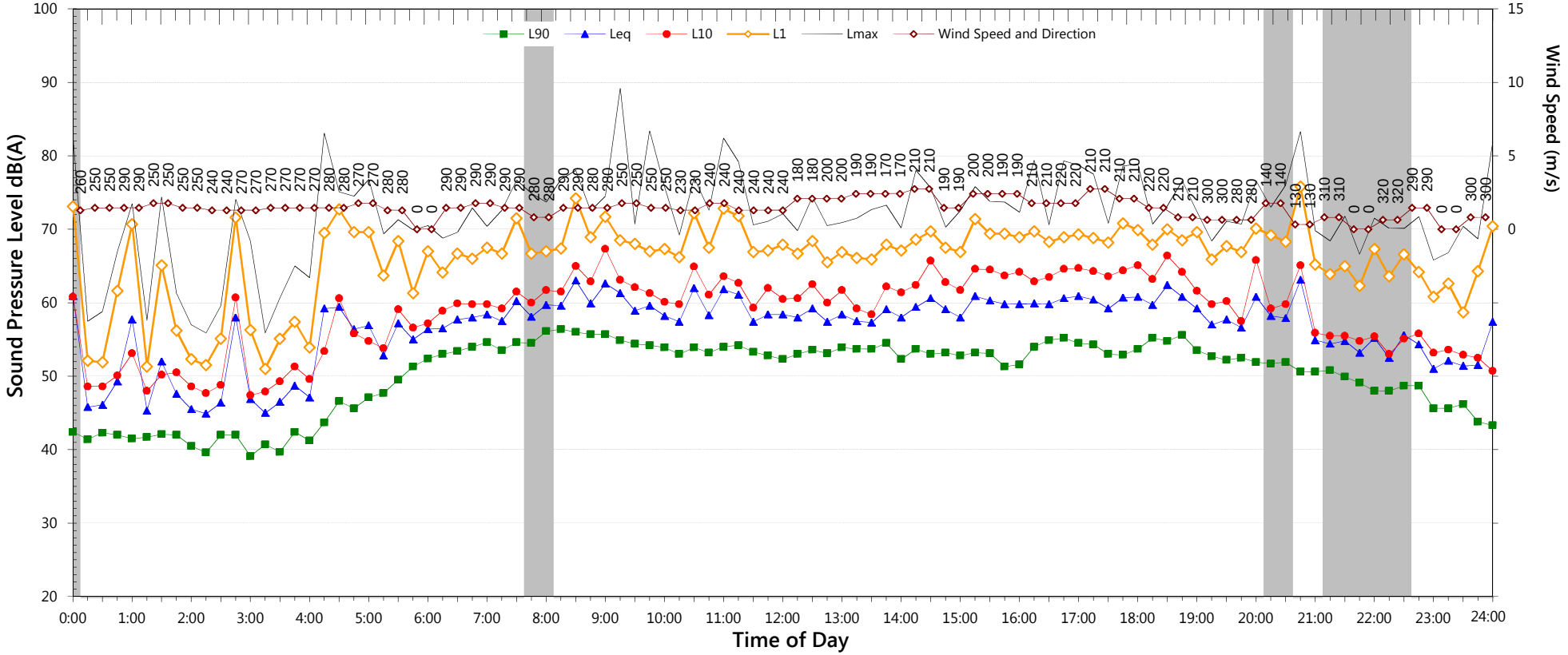
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.6	57.3
$L_{eq\ 1hr}$ upper 10 percentile	62.8	60.7
$L_{eq\ 1hr}$ lower 10 percentile	58.1	49.5

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.0	to	83.1
Lmax - Leq (Range)	15.2	to	25.9

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Thursday, 8 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	52.8	-	-
Leq	59.8	-	-

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)

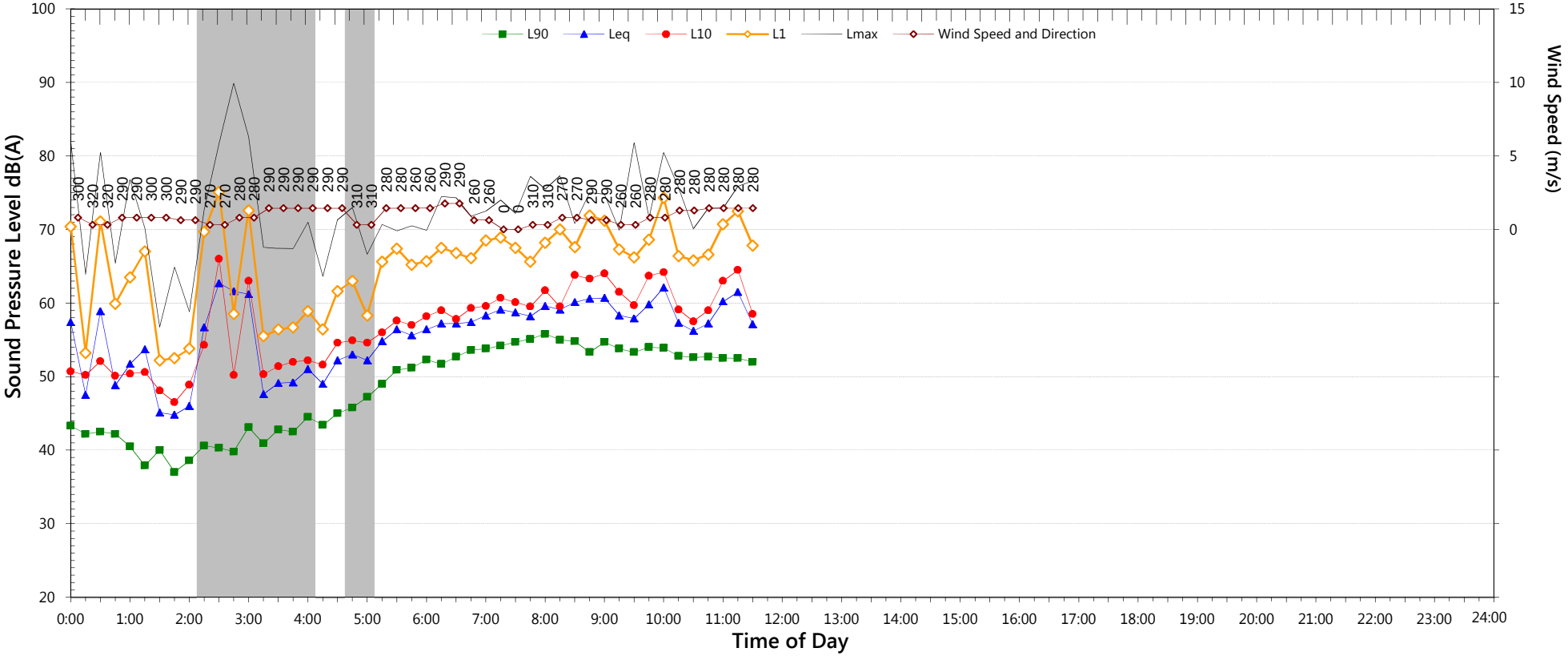
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	62.3	57.0
$L_{eq\ 1hr}$ upper 10 percentile	63.7	60.0
$L_{eq\ 1hr}$ lower 10 percentile	60.6	51.8

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.2	to	81.9
Lmax - Leq (Range)	17.0	to	28.0

Unattended Noise Monitoring Results

M1 - 19 Howarth St, Wyong

Friday, 9 May 2014



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

NOTES:

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

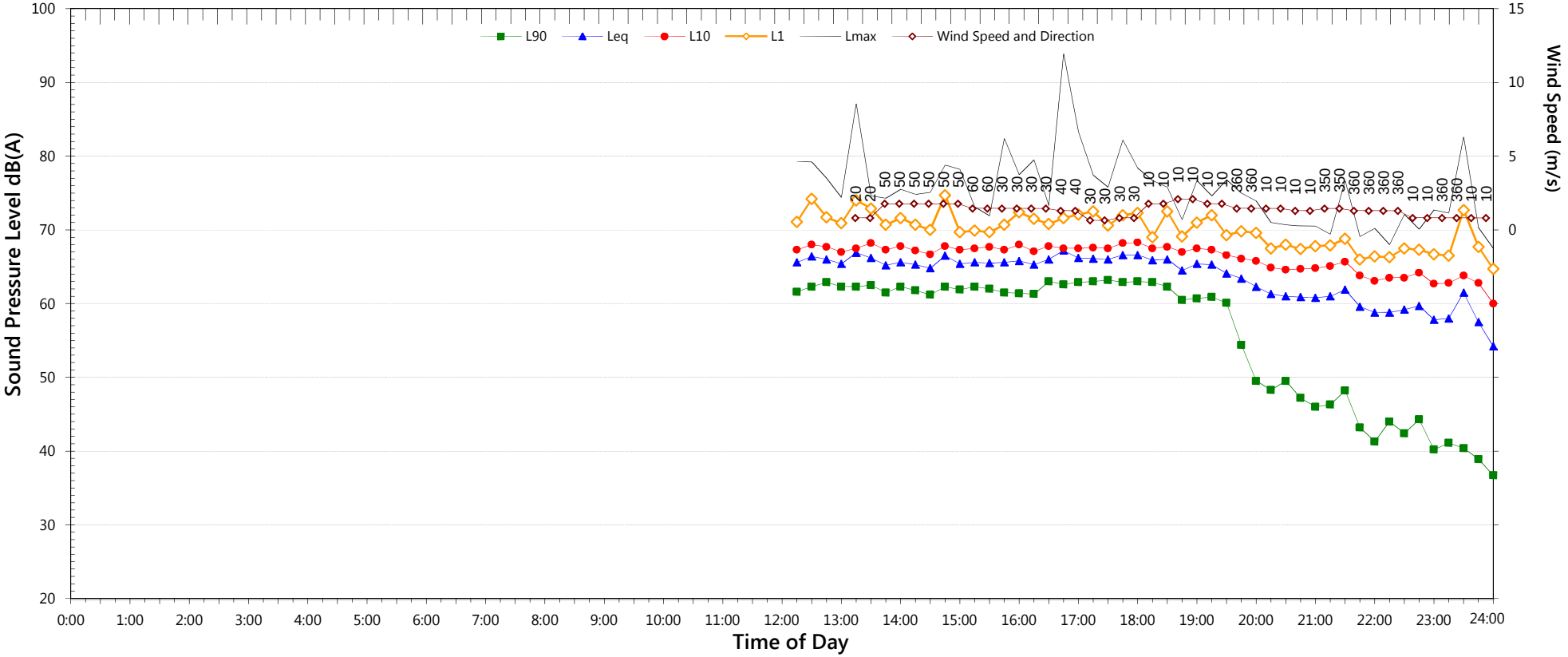
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	61.9	-
$L_{eq\ 1hr}$ upper 10 percentile	62.7	-
$L_{eq\ 1hr}$ lower 10 percentile	60.5	-

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

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Tuesday, 29 April 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	43.2	-
Leq (see note 3)	-	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)

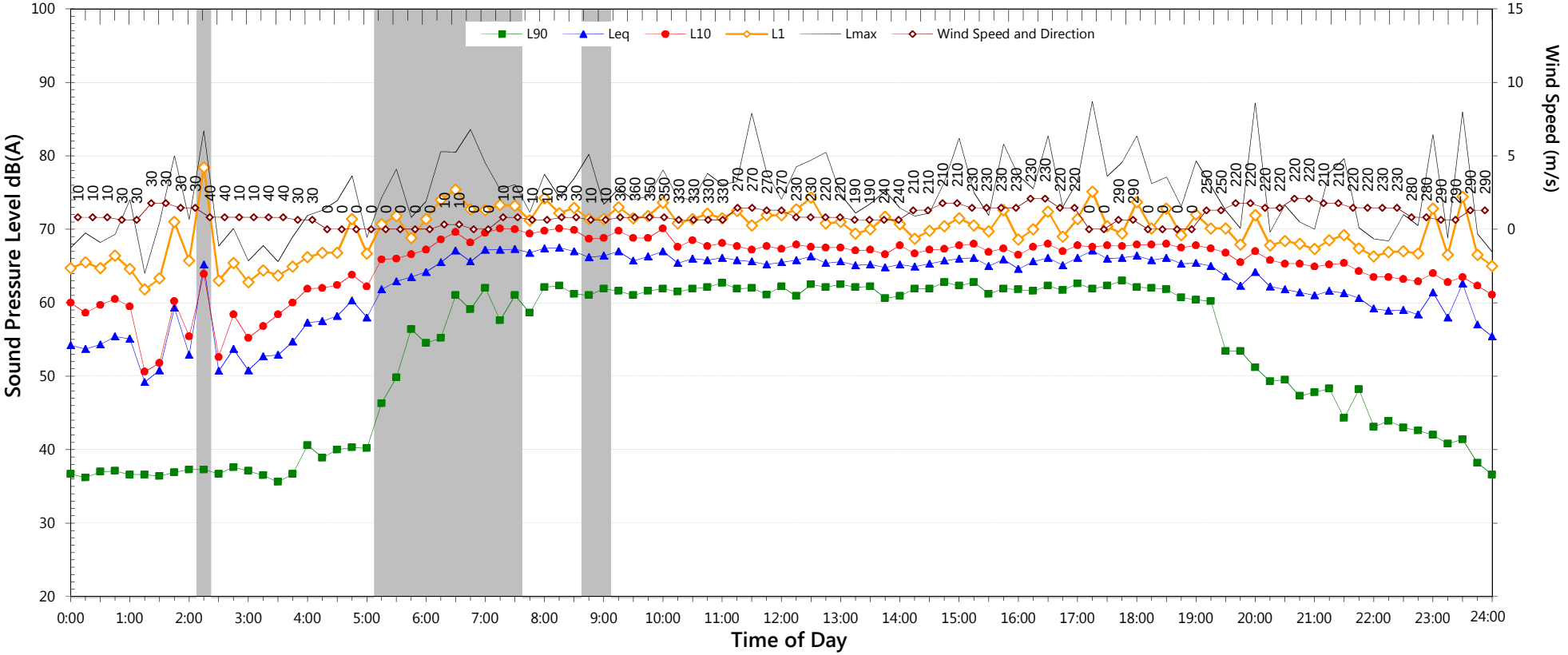
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.0	56.8
$L_{eq\ 1hr}$ upper 10 percentile	66.3	58.9
$L_{eq\ 1hr}$ lower 10 percentile	60.5	52.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.1	to	82.6
Lmax - Leq (Range)	17.1	to	25.1

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Wednesday, 30 April 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	61.0	44.3	35.3
Leq (see note 3)	63.4	60.9	57.7

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.
3. Graphed data measured 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)

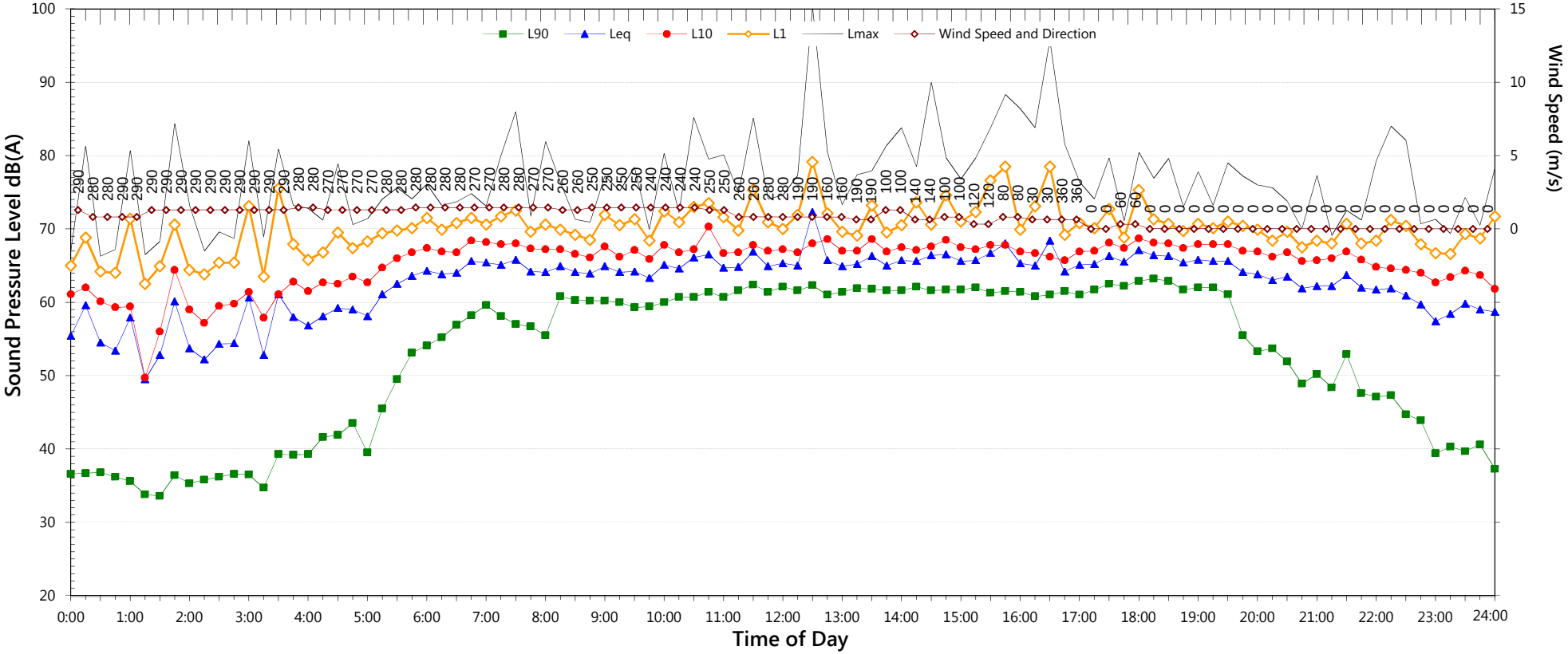
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.4	60.2
$L_{eq\ 1hr}$ upper 10 percentile	67.2	64.8
$L_{eq\ 1hr}$ lower 10 percentile	61.2	55.8

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	78.9	to	86.0
Lmax - Leq (Range)	20.3	to	28.6

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Thursday, 1 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	59.3	47.6	35.0
Leq (see note 3)	63.4	61.8	58.2

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)

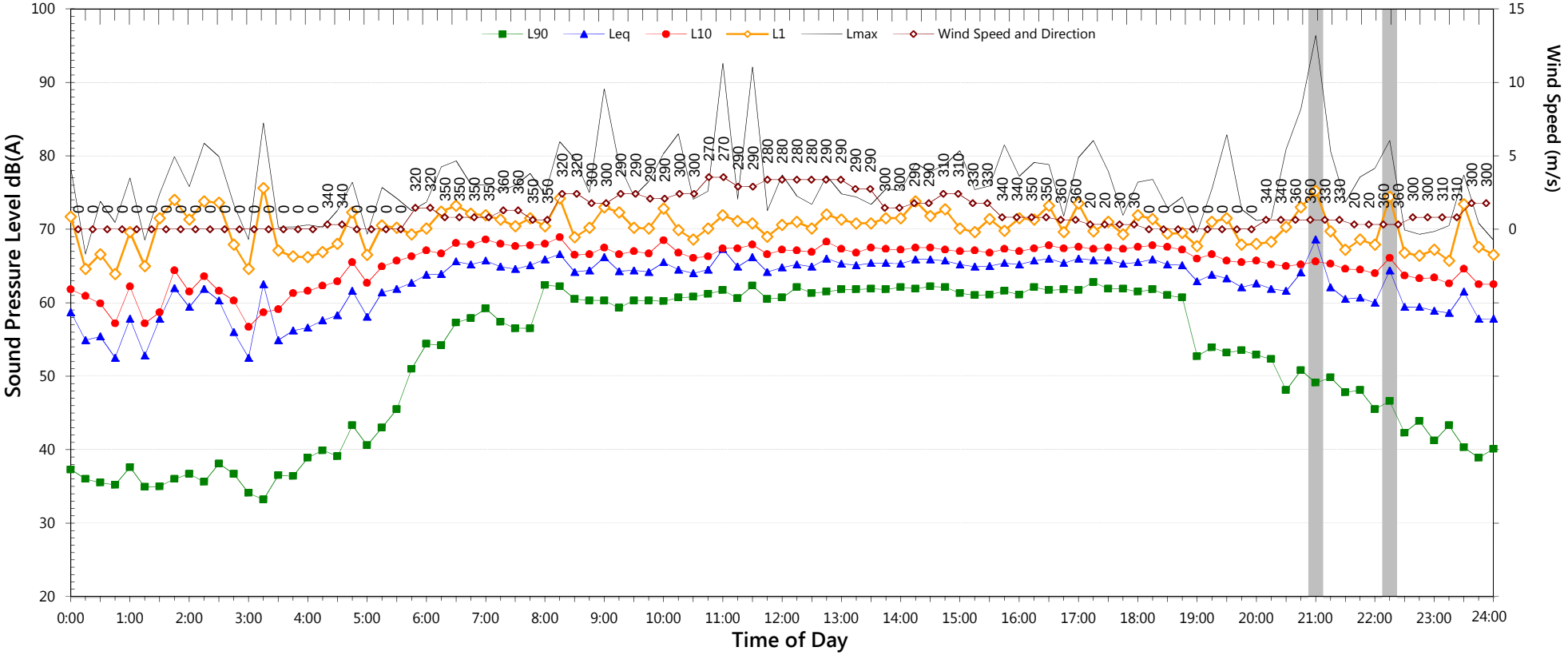
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.5	60.7
$L_{eq\ 1hr}$ upper 10 percentile	67.5	65.2
$L_{eq\ 1hr}$ lower 10 percentile	62.6	55.6

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	76.4	to	84.5
Lmax - Leq (Range)	17.2	to	25.8

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Friday, 2 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	60.2	47.8	32.6
Leq (see note 3)	62.8	60.6	56.5

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)

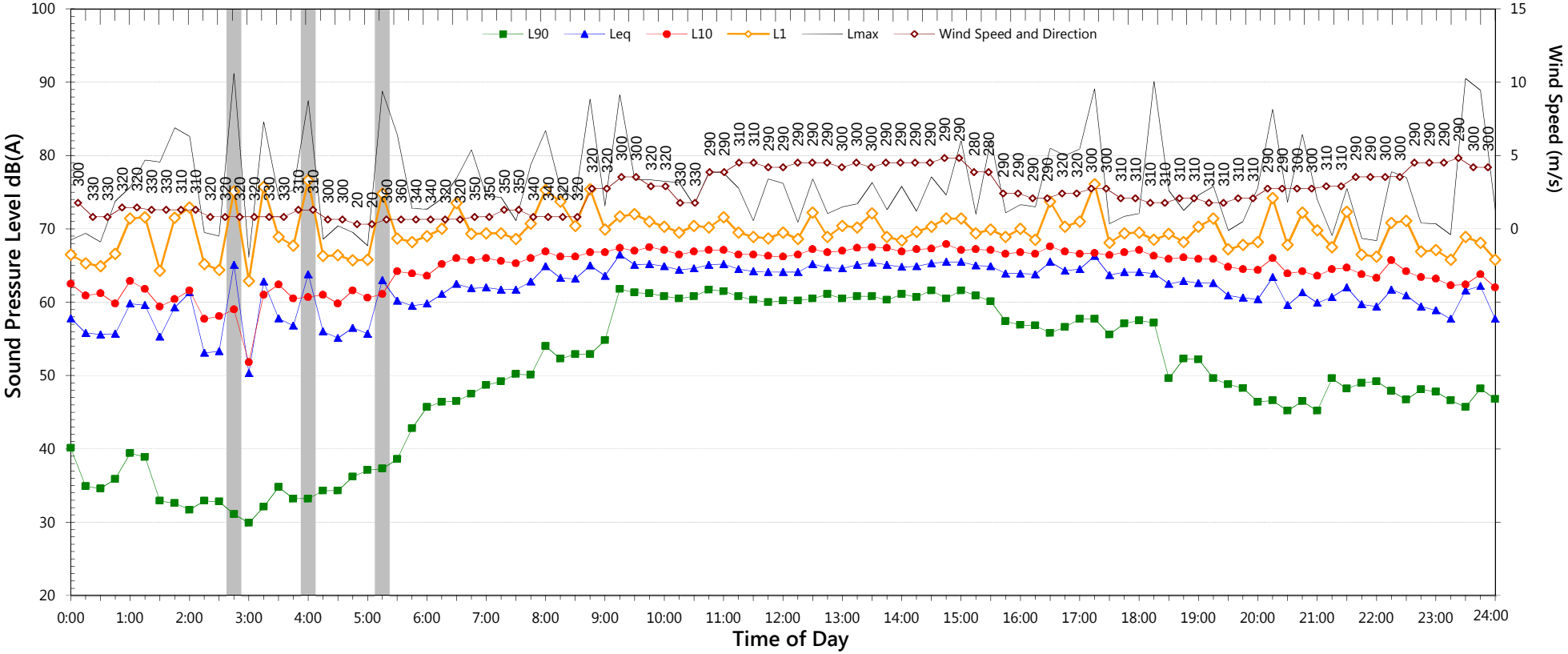
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.9	59.0
$L_{eq\ 1hr}$ upper 10 percentile	65.7	61.9
$L_{eq\ 1hr}$ lower 10 percentile	61.9	52.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	69.5	to	84.6
Lmax - Leq (Range)	17.1	to	24.6

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Saturday, 3 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	52.9	45.2	42.1
Leq (see note 3)	62.1	59.1	57.0

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured 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)

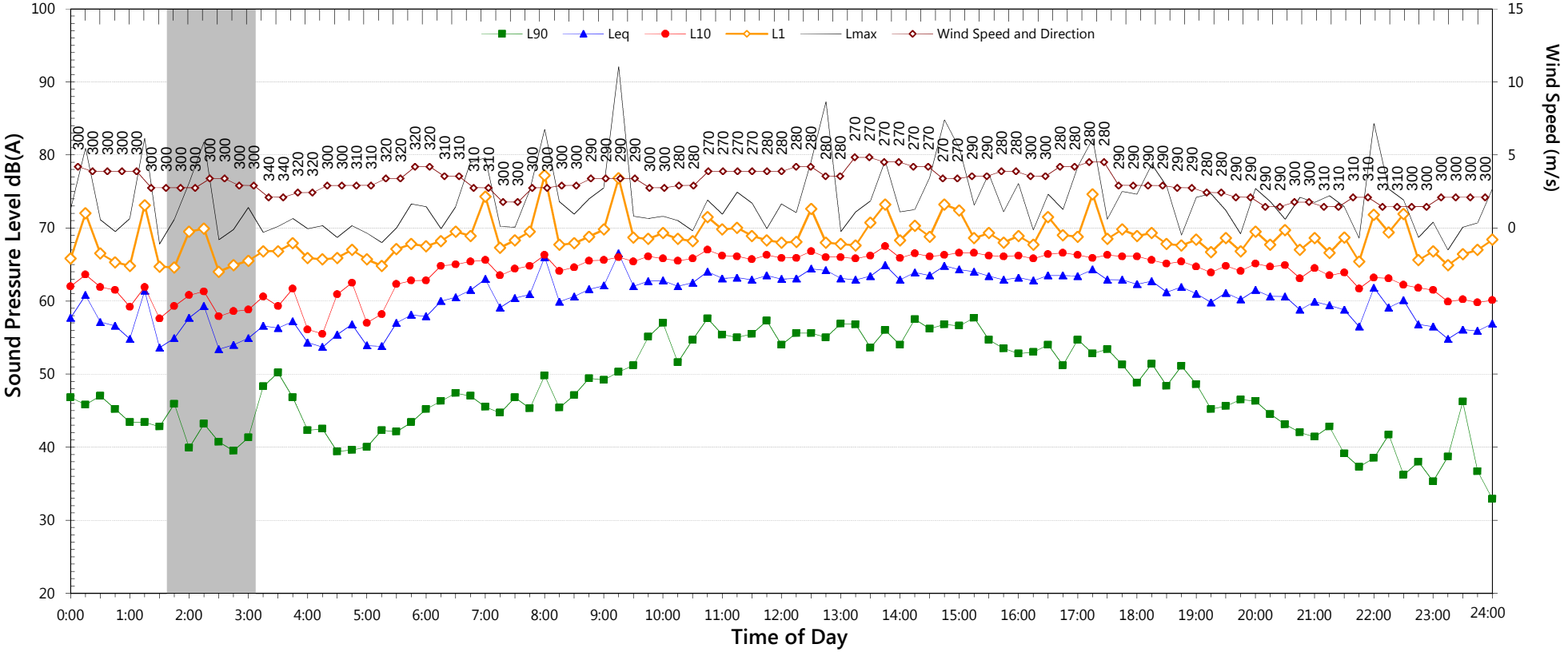
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.0	59.5
$L_{eq\ 1hr}$ upper 10 percentile	65.4	61.4
$L_{eq\ 1hr}$ lower 10 percentile	60.9	55.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.3	to	90.5
Lmax - Leq (Range)	15.1	to	30.2

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Sunday, 4 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	49.3	38.5	33.3
Leq (see note 3)	60.8	58.1	57.6

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 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)

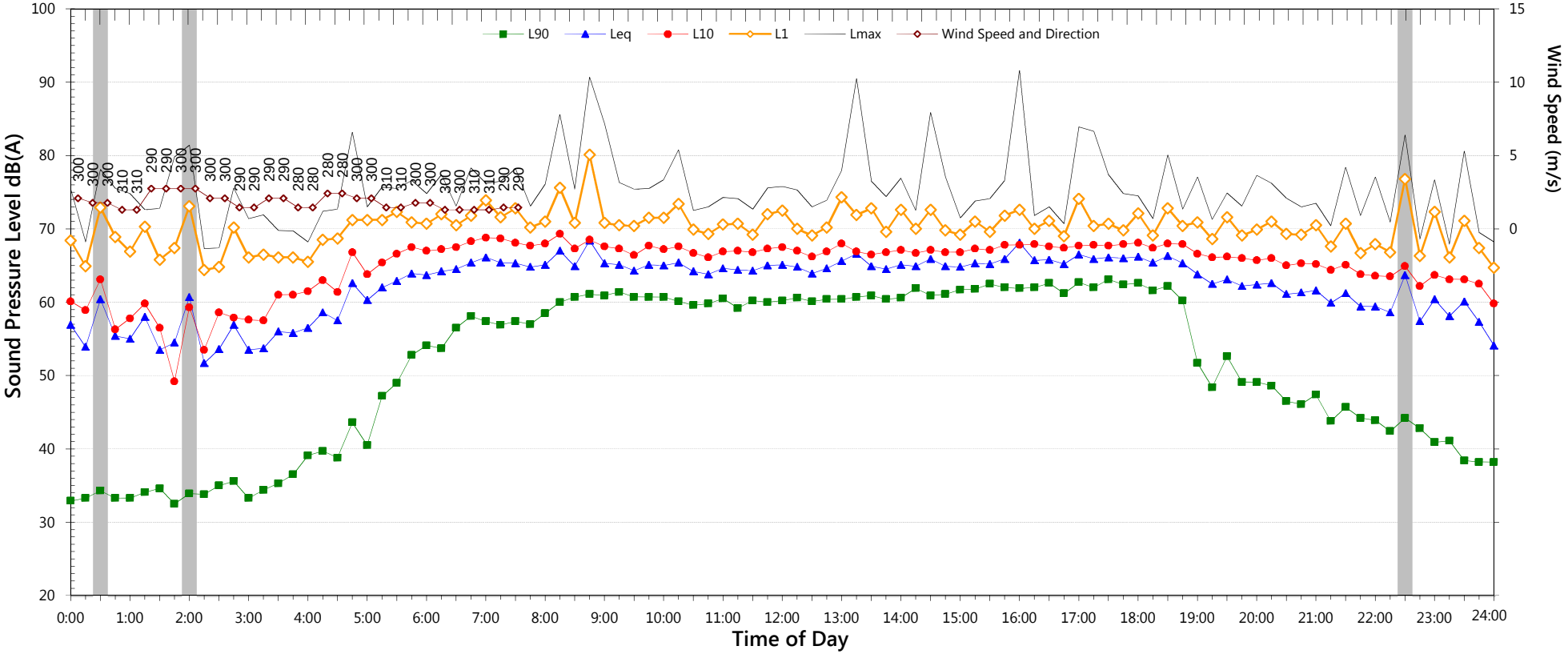
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	62.7	60.1
$L_{eq\ 1hr}$ upper 10 percentile	64.0	65.1
$L_{eq\ 1hr}$ lower 10 percentile	59.8	54.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	71.9	to	83.2
Lmax - Leq (Range)	16.3	to	24.0

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Monday, 5 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	59.2	43.9	35.3
Leq (see note 3)	62.9	60.3	57.8

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "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)

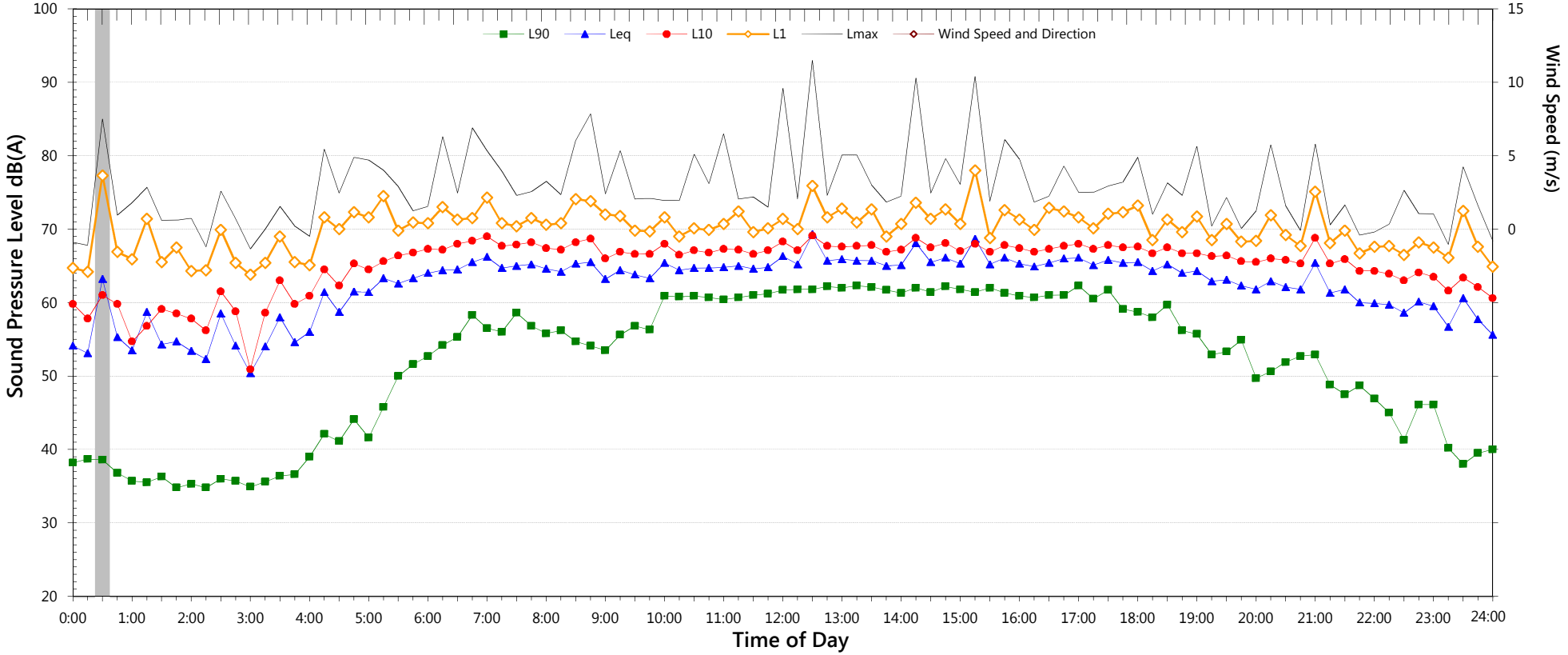
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.9	60.3
$L_{eq\ 1hr}$ upper 10 percentile	66.5	65.2
$L_{eq\ 1hr}$ lower 10 percentile	60.9	54.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	73.1	to	83.8
Lmax - Leq (Range)	17.2	to	22.7

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Tuesday, 6 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	55.8	47.5	37.2
Leq (see note 3)	63.0	60.5	58.0

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured 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)

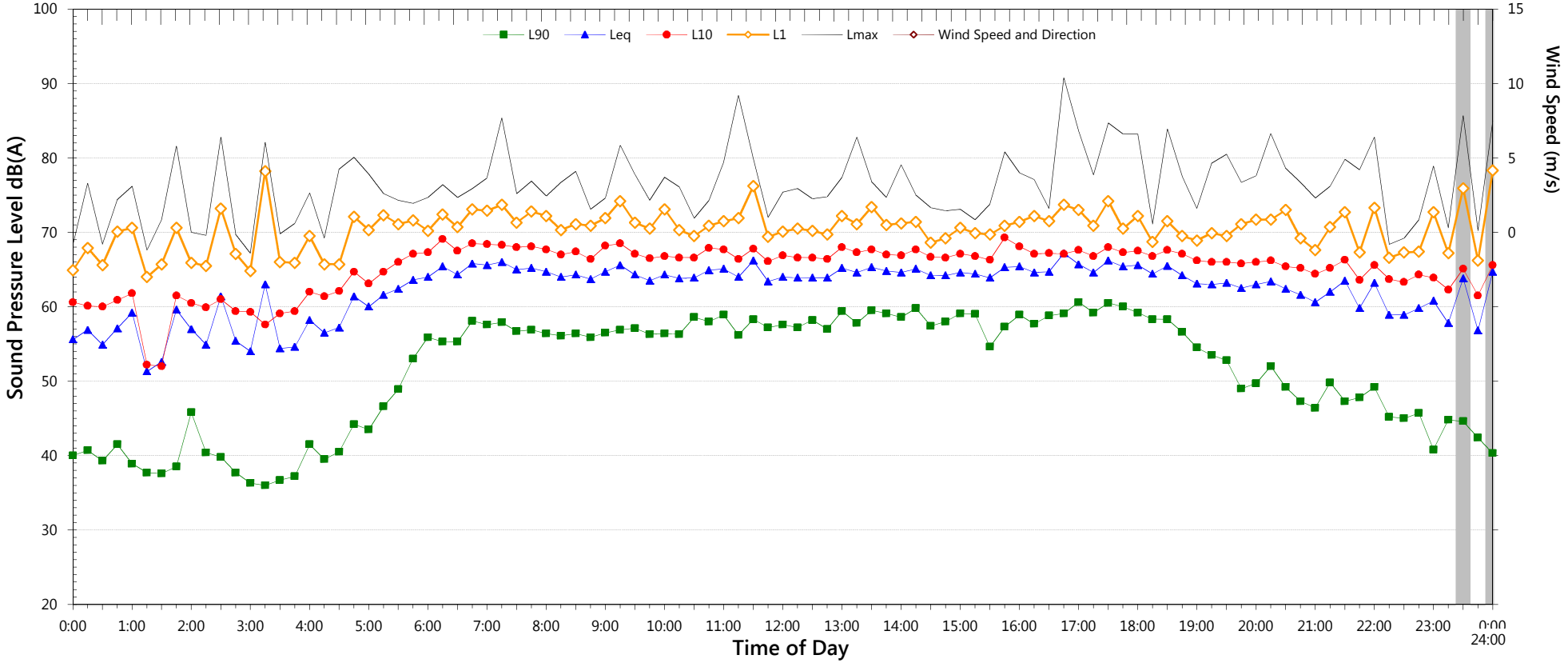
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.0	60.5
$L_{eq\ 1hr}$ upper 10 percentile	66.7	65.3
$L_{eq\ 1hr}$ lower 10 percentile	61.8	56.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	75.3	to	82.8
Lmax - Leq (Range)	15.8	to	25.2

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Wednesday, 7 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	56.3	47.3	35.8
Leq (see note 3)	62.3	60.5	58.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured 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)

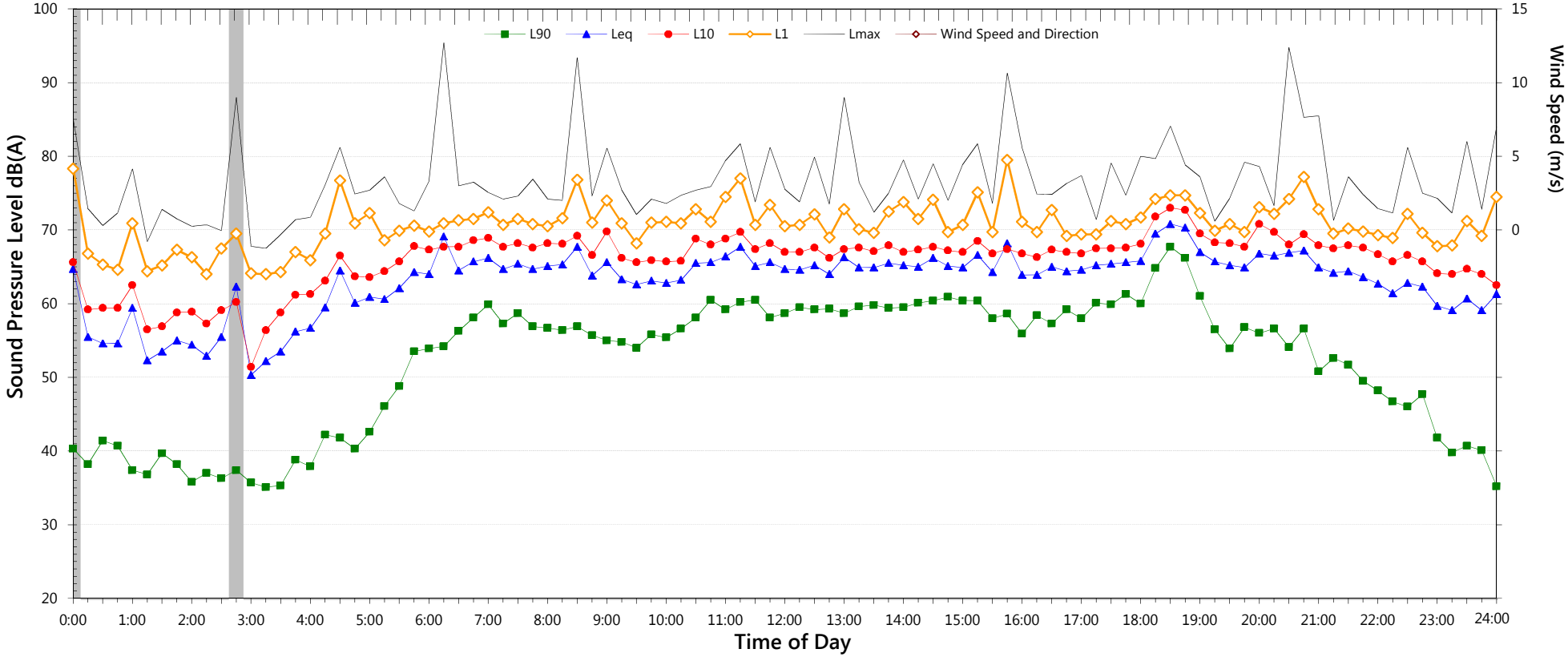
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.4	61.1
$L_{eq\ 1hr}$ upper 10 percentile	65.6	66.7
$L_{eq\ 1hr}$ lower 10 percentile	62.2	53.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	70.7	to	95.4
Lmax - Leq (Range)	16.7	to	28.7

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Thursday, 8 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	55.7	49.5	35.0
Leq (see note 3)	62.7	64.4	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)

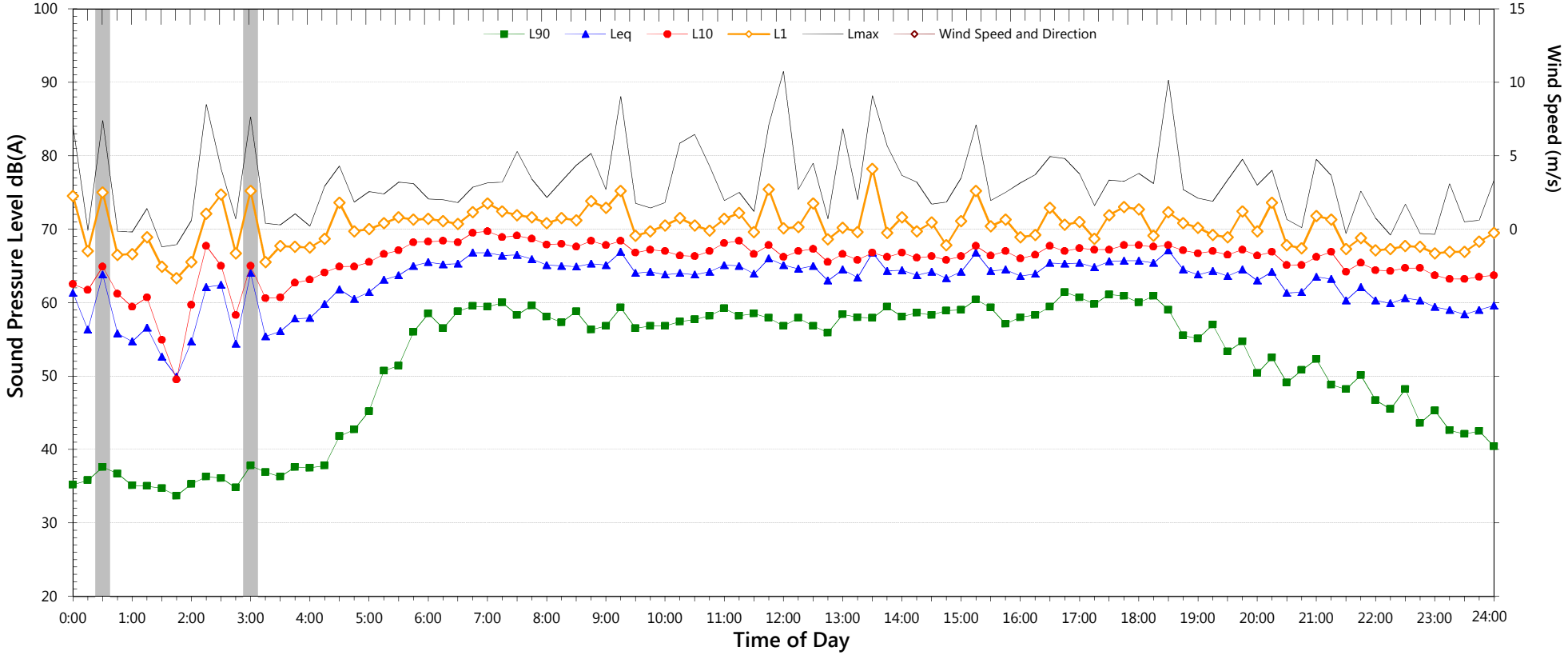
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.7	61.7
$L_{eq\ 1hr}$ upper 10 percentile	68.3	66.1
$L_{eq\ 1hr}$ lower 10 percentile	63.4	54.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	72.1	to	87.0
Lmax - Leq (Range)	15.2	to	26.2

Unattended Noise Monitoring Results

M2 - 3/142 Pacific Highway, Wyong

Friday, 9 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	56.8	48.2	36.7
Leq (see note 3)	62.4	61.1	57.7

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured 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)

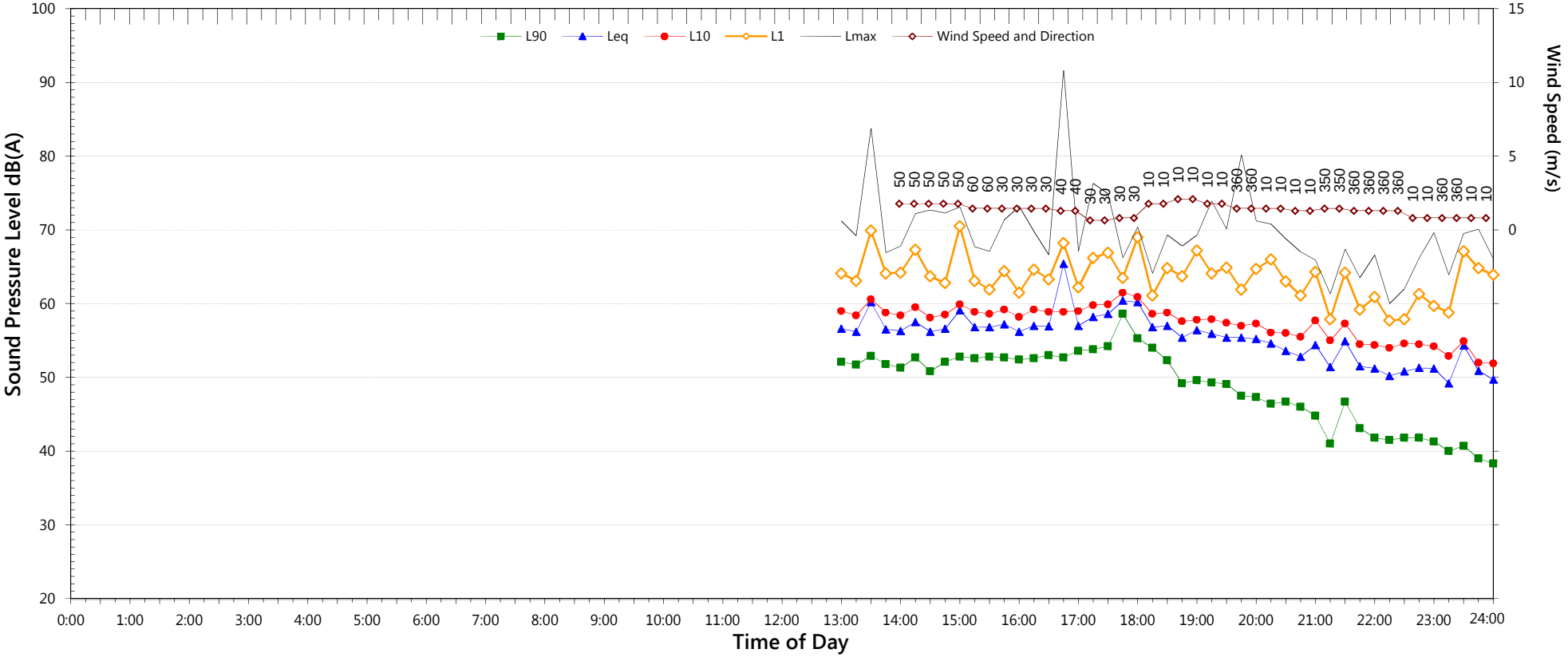
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.6	60.2
$L_{eq\ 1hr}$ upper 10 percentile	65.7	63.7
$L_{eq\ 1hr}$ lower 10 percentile	62.3	58.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	76.3	to	85.9
Lmax - Leq (Range)	17.0	to	27.0

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Tuesday, 29 April 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	41.8	-
Leq	-	54.8	-

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)

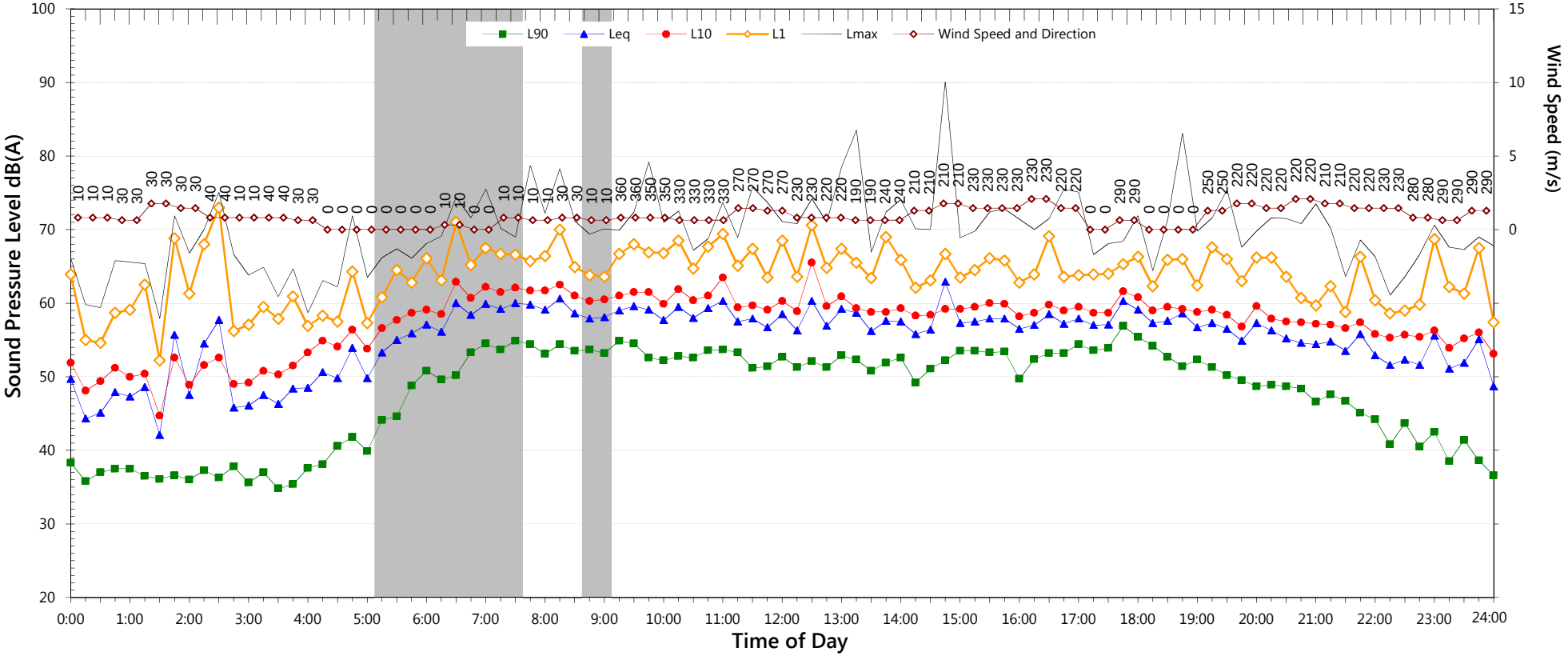
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.9	53.5
$L_{eq\ 1hr}$ upper 10 percentile	63.4	56.3
$L_{eq\ 1hr}$ lower 10 percentile	55.1	48.9

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.8	to	75.1
Lmax - Leq (Range)	17.1	to	21.3

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Wednesday, 30 April 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	51.2	45.1	35.3
Leq	58.5	56.1	53.7

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)

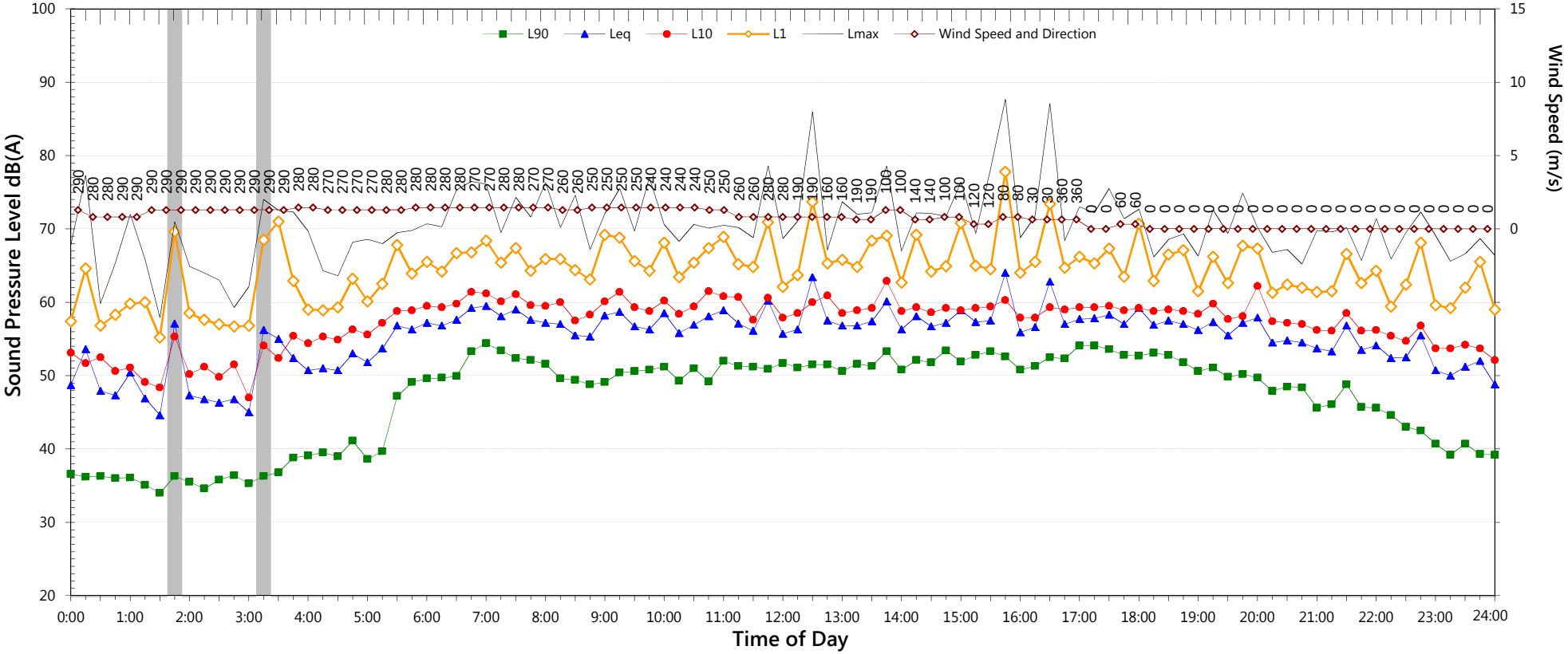
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.5	56.2
$L_{eq\ 1hr}$ upper 10 percentile	62.1	60.9
$L_{eq\ 1hr}$ lower 10 percentile	57.3	48.8

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.8	to	77.3
Lmax - Leq (Range)	16.7	to	26.7

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Thursday, 1 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	49.4	45.6	35.7
Leq	58.3	55.9	53.5

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)

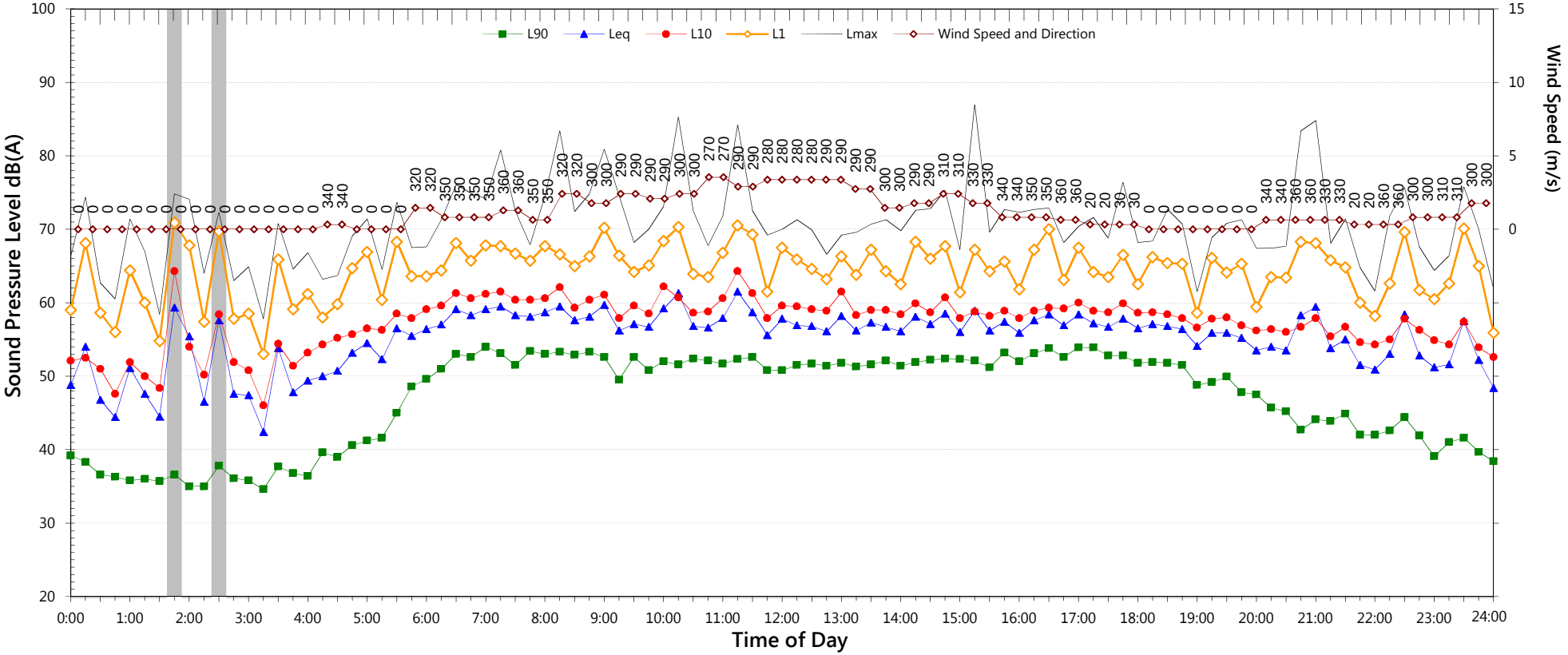
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.3	56.0
$L_{eq\ 1hr}$ upper 10 percentile	62.3	61.0
$L_{eq\ 1hr}$ lower 10 percentile	57.0	49.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.7	to	76.1
Lmax - Leq (Range)	17.6	to	23.8

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Friday, 2 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	51.2	42.0	-
Leq	57.9	55.6	-

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)

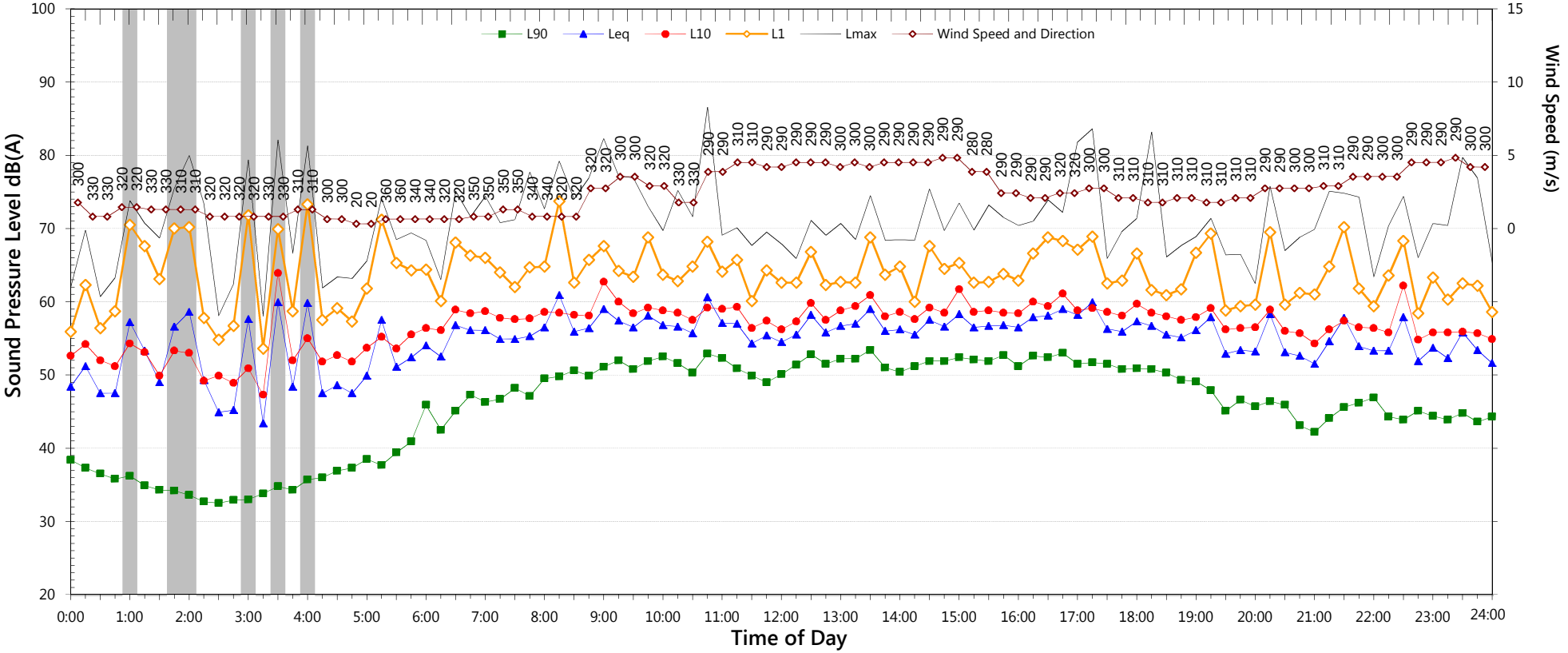
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.9	55.4
$L_{eq\ 1hr}$ upper 10 percentile	61.4	58.2
$L_{eq\ 1hr}$ lower 10 percentile	56.8	49.1

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.6	to	75.8
Lmax - Leq (Range)	17.1	to	26.4

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Saturday, 3 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	49.5	43.1	39.7
Leq	57.2	55.2	53.9

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)

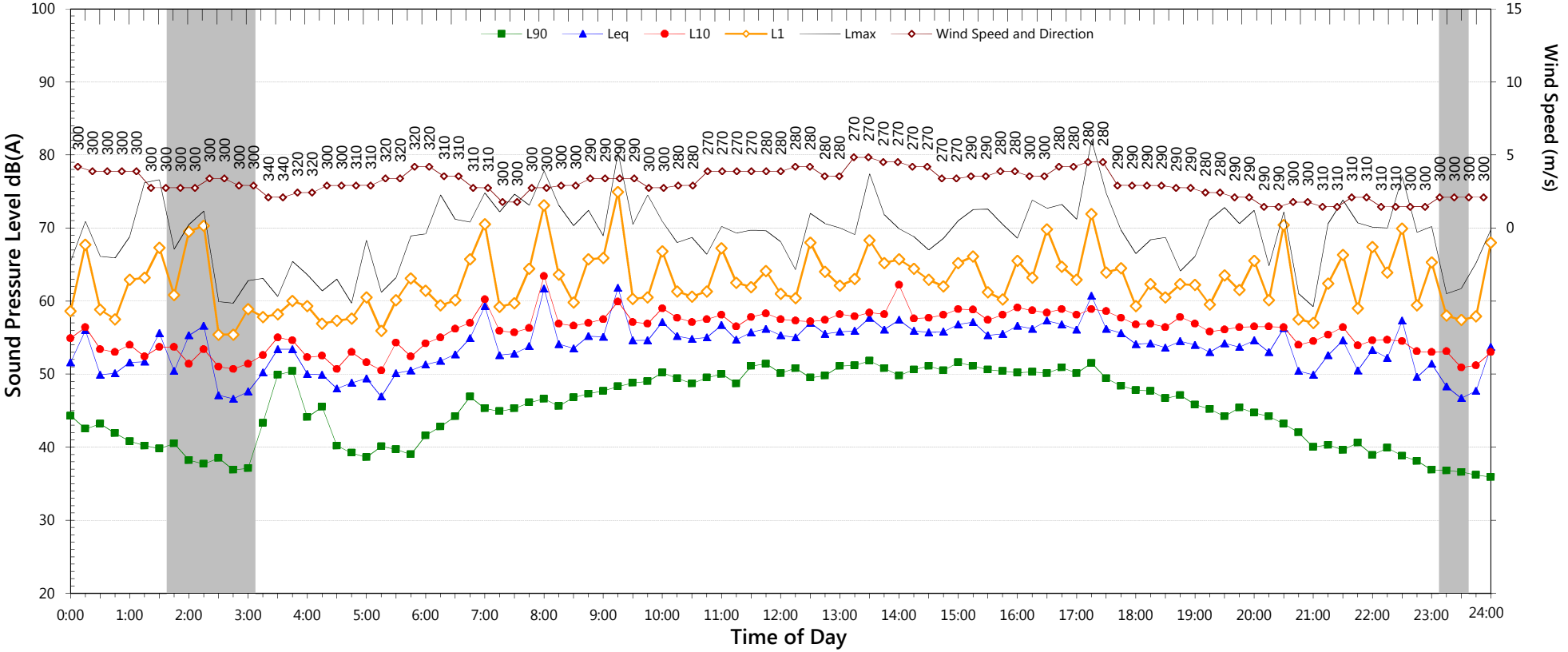
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.3	56.4
$L_{eq\ 1hr}$ upper 10 percentile	60.9	58.2
$L_{eq\ 1hr}$ lower 10 percentile	57.3	51.6

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.3	to	79.7
Lmax - Leq (Range)	18.2	to	26.1

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Sunday, 4 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	47.8	39.6	-
Leq	56.4	53.6	-

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)

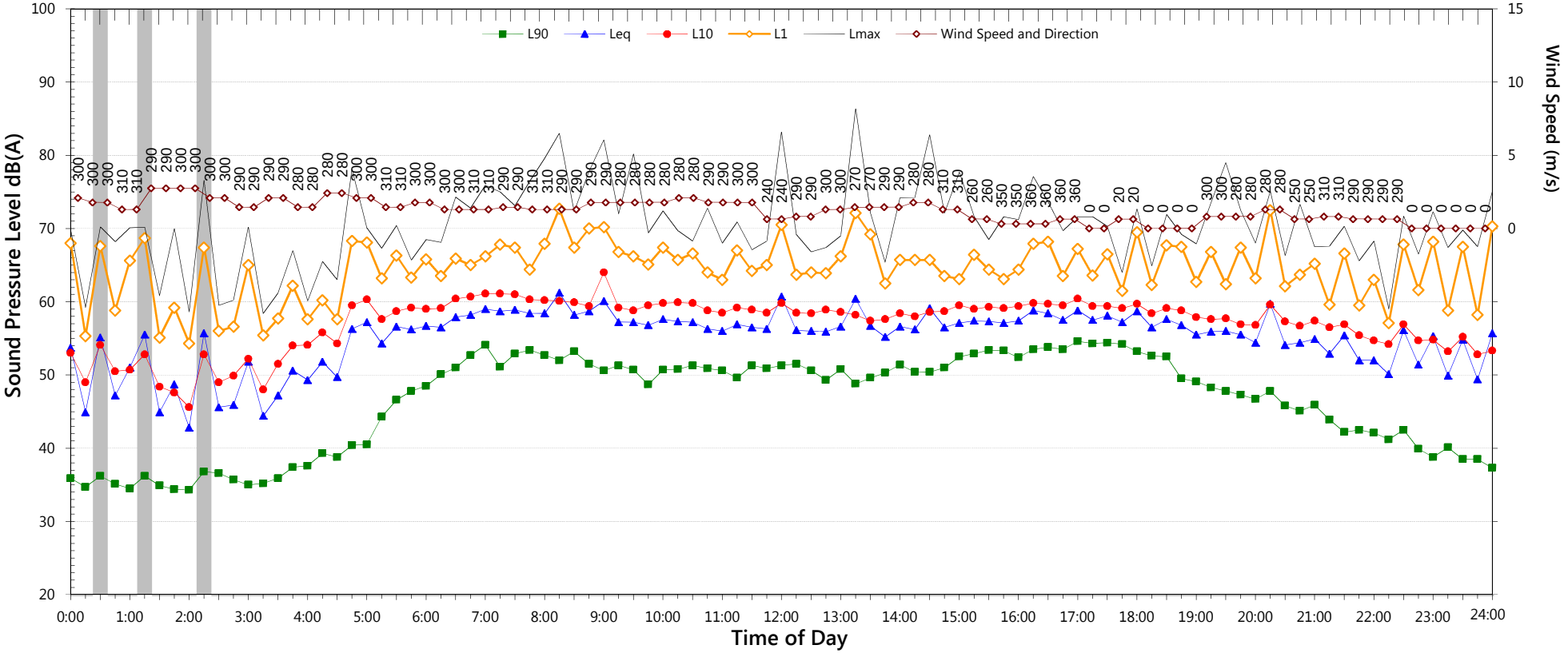
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	58.4	56.3
$L_{eq\ 1hr}$ upper 10 percentile	60.3	60.5
$L_{eq\ 1hr}$ lower 10 percentile	55.6	48.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	67.0	to	78.1
Lmax - Leq (Range)	17.9	to	23.8

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Monday, 5 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	49.6	42.2	36.0
Leq	57.8	55.7	54.5

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)

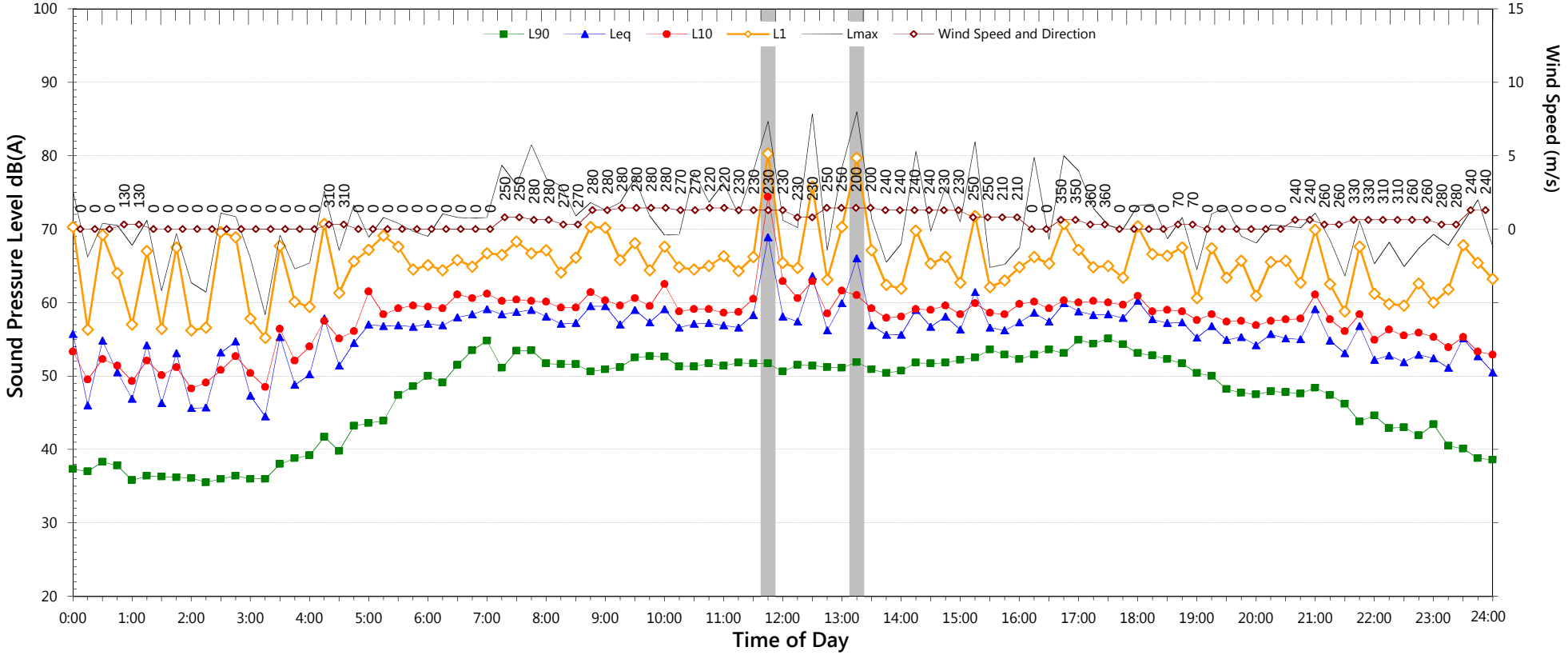
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.9	57.0
$L_{eq\ 1hr}$ upper 10 percentile	61.7	60.7
$L_{eq\ 1hr}$ lower 10 percentile	57.0	53.5

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	69.2	to	75.2
Lmax - Leq (Range)	17.8	to	21.8

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Tuesday, 6 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.9	44.6	36.4
Leq	58.3	56.0	53.7

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)

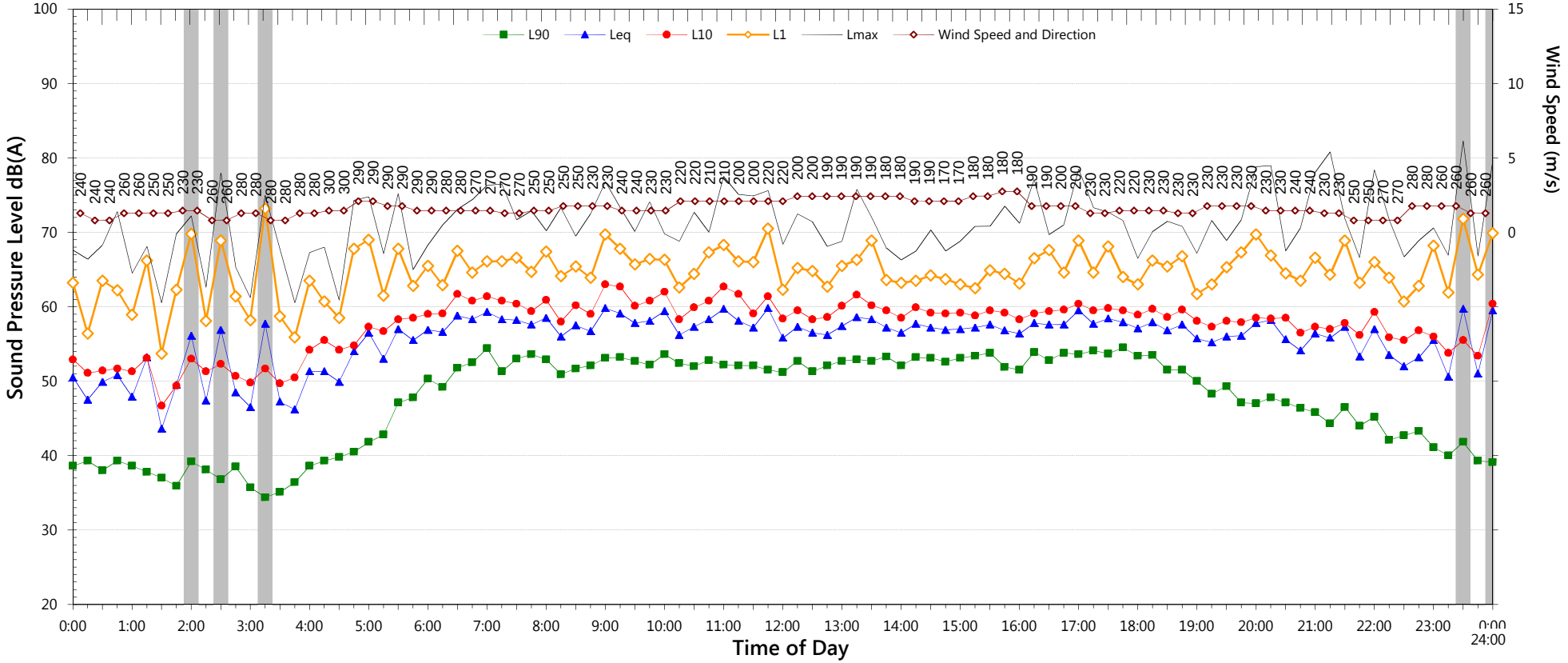
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.3	56.2
$L_{eq\ 1hr}$ upper 10 percentile	62.1	60.9
$L_{eq\ 1hr}$ lower 10 percentile	57.5	50.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.3	to	76.3
Lmax - Leq (Range)	16.8	to	23.6

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Wednesday, 7 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	51.5	44.3	-
Leq	57.8	56.5	-

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)

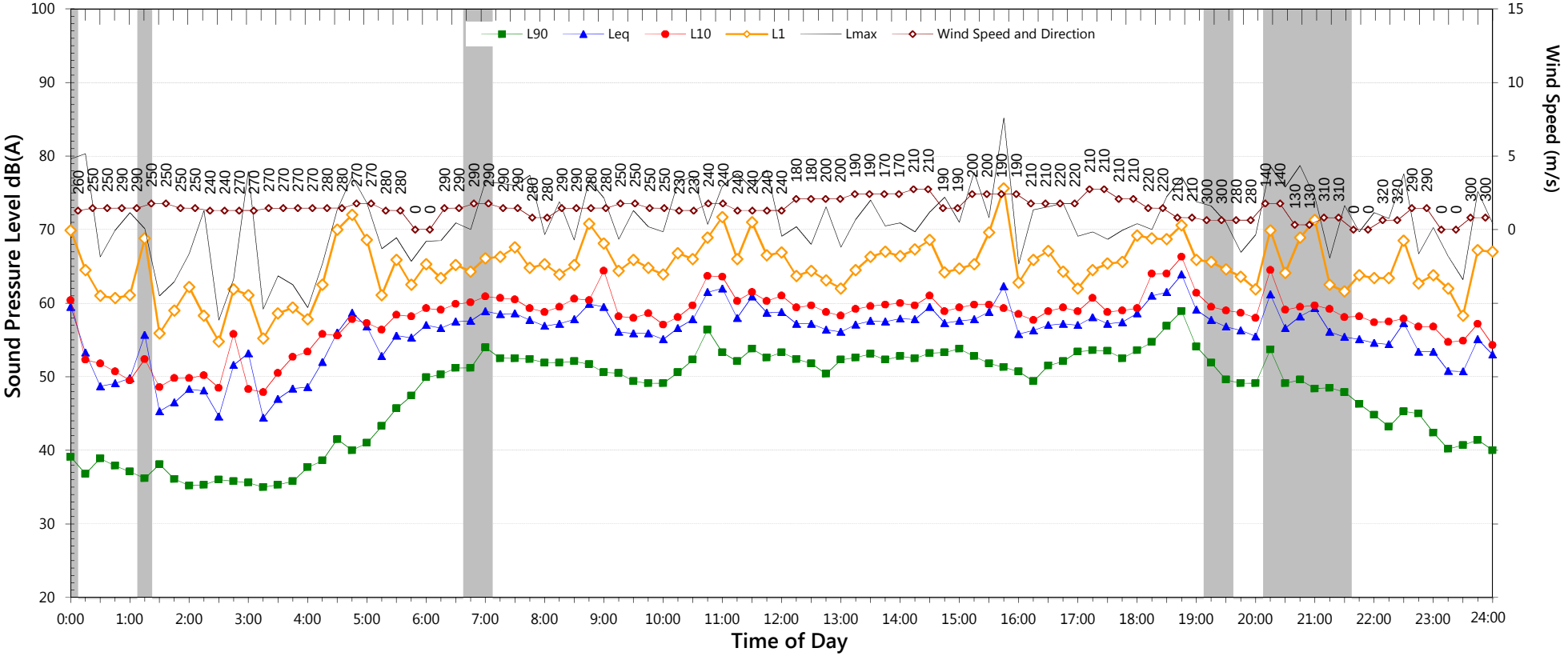
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.0	55.8
$L_{eq\ 1hr}$ upper 10 percentile	60.9	59.6
$L_{eq\ 1hr}$ lower 10 percentile	58.7	49.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	66.7	to	80.3
Lmax - Leq (Range)	16.1	to	29.6

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Thursday, 8 May 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	50.4	-	-
Leq	58.2	-	-

NOTES:

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

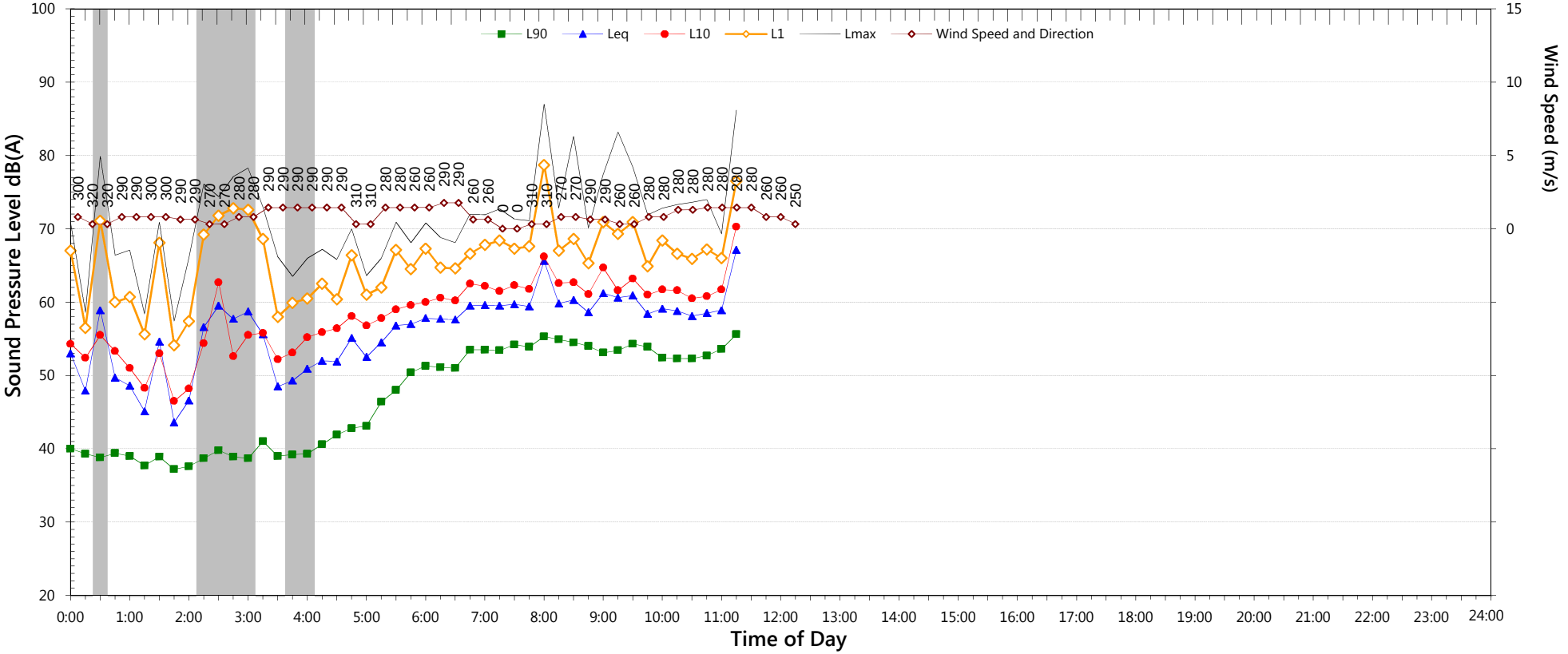
NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	60.9	57.3
$L_{eq\ 1hr}$ upper 10 percentile	63.6	61.2
$L_{eq\ 1hr}$ lower 10 percentile	57.7	51.3

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	67.1	to	77.6
Lmax - Leq (Range)	16.9	to	22.7

Unattended Noise Monitoring Results

M3 - 14/1A Cutler Drive, Wyong

Friday, 9 May 2014



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

NOTES:

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

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	63.7	-
$L_{eq\ 1hr}$ upper 10 percentile	69.6	-
$L_{eq\ 1hr}$ lower 10 percentile	61.1	-

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