Noise and Vibration

Assessment report

Summary

Renzo Tonin & Associates was engaged to undertake an assessment of noise and vibration for the proposed Claymore Urban Renewal project.

Objectives

The objective of this noise and vibration report is to present the methods by which potential noise and vibration issues from and onto the development can be addressed. This report addresses the noise and vibration issues specifically in regard to the following;

- Road traffic noise onto existing and future development within the Claymore site;
- Operational noise from any noise generating development; and
- Management of construction noise and vibration.

Methods and findings

Road traffic noise was assessed through a combination of noise measurement and predictive modelling. The assessment revealed that road traffic noise will be addressed through a combination of external noise mitigation treatment such as barriers and earth mounds, along with provision of appropriate building envelope treatment so as to comply with the internal noise level criteria set out within the State Environmental Planning Policy (Infrastructure) 2007.

Operational noise would be generated primarily from any mechanical equipment that may be required for any development within the precinct. Other than mechanical equipment, operational noise would be limited to the use of the retail centre and community facilities at the corner of Badgally Road and Glenroy Road. Assessment of noise emission from sources such as mechanical services equipment, loading docks and general activity, should assessed to the existing and future residential development against relevant policies and guidelines. This assessment would be required at the specific development application stage.

Construction noise and vibration has been addressed through the measurement of existing ambient noise levels to establish noise goals in accordance with relevant policy guidelines. Whilst specific assessment of construction noise and vibration has not been provided at this concept stage, sensitive sites and activities have been identified. Suitable management procedures and principles have been provided for further development in the individual development application and design development stages, at which time further detail would be available.

Conclusions

With regard to road traffic noise, the assessment concludes that road traffic noise levels can be satisfied through a combination of external mitigation and building envelope treatment. Further detailed design of any external mitigation measures such as barriers and earth mounds should be investigated at the relevant development application stages. With respect to the Hume Highway interface, consultation with the RTA will be required to determine options for any noise mitigation treatment within the road corridor.

Noise generating development has been addressed through the measurement of existing ambient noise levels so as to allow noise goals to be established in accordance with relevant policy guidelines. Whilst specific detail of any noise generating development is not known at this stage, noise management principles and guidelines have been provided within the report.

Construction noise should be assessed and management plans developed for the specific development application stages. Construction noise and vibration management plans should give consideration to project sequencing, equipment use, construction processes, hours of operation and consultation.

ESD principles demonstrated in the project
The primary opportunities for ESD principles in acoustic mitigation are as follows;

- Provision of adequate external noise mitigation so that windows may be open for natural ventilation;
- Ensure external noise mitigation does not adversely affect solar access;
- Minimise undue building envelope controls that require additional building materials beyond standard building constructions.

With respect to Badgally Road, there is opportunity to provide sufficient external noise mitigation to protect ground level locations and eliminate requirements for alternative ventilation.

By fortune of the predominant road traffic noise sources being to the south and west, external noise mitigation should not unduly impact on solar access to residential premises.

It is recommended that external noise mitigation treatment be balanced with building envelope design to minimise undue construction requirements.

Recommendations

With regard to road traffic noise it is recommended that barrier fences along the Badgally Road frontage be provided to reduce ground level external noise level to compliant levels. Further detailed modelling is required during the specific development application stages to determine appropriate building envelope design requirements for residual impacts at second storey locations.

For the Hume Highway interface, results revealed that unreasonable mitigation would be required to meet the ECRTN. However as the ISEPP 2007 was largely satisfied without the need for alternative ventilation or building envelope treatment no further external mitigation was considered, with exception of Stage 2 on the southern side of Dobell.

Nonetheless, for Stages 7, 8 and 9, as redevelopment is not proposed until after completion of the F5 widening it is recommended that post construction measurements are undertaken to validate the noise model and re-evaluate the noise impacts.

With respect to Stage 2 works, in particular the lots proposed on the southern side of Dobell Road, additional external noise mitigation is recommended to provide reasonable external noise amenity and reduce building envelope constructions. Restriction of development to single storey could also be given after assessment of the required building envelope treatment. From the analysis, noise barrier construction in the order of 4-5m high was deemed to provide reasonable reduction in external traffic levels at ground level. The physical height of noise wall rather than earth mound could be balanced through excavation of the existing ground level.

Further plans and strategies required

Appropriate strategies for the determining the extent of any external noise mitigation treatment compared with any residual building envelope construction needs to be determined, in particular for Stage 2 works on the southern side of Dobell Road.

In addition the strategies for individual lot development should be determined so that appropriate detail assessment may be undertaken at the development application stage. Specifically this should address the needs of any individual lot developers such that detailed acoustic assessment is not required for individual building constructions.

Contents

1. Objectives of assessment

At a glance

The objective of the noise and vibration report is to outline the potential impacts and or constraints relating to road traffic noise onto the future residential premises, operational noise from any relevant development and construction noise and vibration impacts. The report aims to identify sensitive areas of development and the methods by which potential impacts can be managed and addressed.

Renzo Tonin & Associates was engaged to undertake an assessment of potential noise and vibration impacts in relation to the proposed Claymore Urban Renewal project, primarily to respond to the following the Director Generals requirements.

- *3. Environmental and Residential Amenity*

  Impacts of the proposal on solar access, acoustic privacy, visual privacy, view loss and wind impacts (within the site and on surrounding development); and

  Details of the measures to be implemented to achieve a high level of environmental amenity.

- *17. Noise and Vibration*

  Provide a quantitative assessment of the potential demolition, construction, operation and traffic noise and vibration impacts of the project, in accordance with the NSW Interim Construction Noise Guidelines and NSW Industrial Noise Policy and relevant guidelines. The assessment shall have regard to the impact from both the Hume Highway and Badgally Road on the Concept Plan and include details of any required acoustic attenuation methods.

Road Traffic Noise

The development interface with both Badgally Road and the Hume Highway are of primary importance for road traffic noise exposure at future residential development. Consideration has been given to the proposed lot layouts, dwelling orientations, setbacks to the roadways and topographical features in order to assess the options available for road traffic noise mitigation.

Operational Noise

At a concept planning stage there is insufficient information to carry out detailed assessment of any noise generating development that may be part of the project. Nonetheless, the guidelines and policies relevant to the assessment of operational noise have been discussed and planning principles provided so as to minimise potential conflict arising at land-use interfaces.

Construction Noise

Whilst a quantitative assessment is requested in the Director General's requirements, this report does not detail construction noise and vibration impacts due to the information available of proposed schedules and activities. Nonetheless, construction noise and vibration management will need to give regard to the staged development program and thus impacts on existing and future residential premises in the area. Heritage sites are particularly sensitive to vibration impacts and therefore any development in proximity to such sites needs to be identified. The guidelines and policies relevant to the assessment of construction noise and vibration have been discussed and management measures provided so as to minimise potential impact.

Acoustic Privacy

In the context of a residential subdivision, acoustic privacy generally relates to the effective separation between individual dwellings. This issue is best addressed at the detailed development stage of individual lots and dwellings and therefore has not been covered in this concept plan report.

2. Site analysis

At a glance

Site investigations for the noise and vibration assessment primarily involved measurement of existing noise levels at various receiver locations across the site. The measurement results were used to validate noise modelling for Badgally Road traffic and provide guidance for operational and construction noise goals. With regard to the road traffic noise from the Hume Highway, current construction works precluded acquisition of relevant noise data. Assessment of Hume Highway road traffic noise has been based upon the noise modelling undertaken for the NSW Roads & Traffic Authority.

Existing Acoustic Environment

Existing noise data is useful for setting benchmark noise levels in an area, and where already affected by traffic noise, it can be used to validate noise prediction models. Background noise levels are also used to establish noise goals for operational and construction noise assessment.

Appendix B of the NSW Industrial Noise Policy (INP) presents two methods of determining the background noise levels of an area being '*B1 – Long-term background noise method*' and '*B2 – Short-term background noise method*'.

Long-term Noise Monitoring
For this project existing noise levels were measured at the following three locations using long-term, unattended monitoring methods (see Appendix 3 for detailed method). The monitoring locations are also shown in Appendix 2.

Location ID	Description
Location L1	2 Carter Place, Claymore The logger was located approximately 2m above the local ground level, on the front porch of the premise. The logger location was selected to capture general ambient noise, and to be representative of premises in the northern portion of Claymore and Eaglevale. As the location was not on a main road, the ambient noise levels are considered to be at the lower range of noise levels for the area.
Location L2	11 Dobell Road, Claymore – Guardian Angel Childcare Centre The logger was located in line with the southern facade of the building behind an open metal fence, 1.5m above the ground in the free field. It is noted that the Child Care Centre was in operation 7am – 5pm Monday to Friday, however the main play area of the centre is located on the northern side of the building, acoustically shielded from the monitoring location.

Location ID	Description
Location L3	11 Waler Place, Blairmont The noise logger was located 1.5m above the local ground level, in the rear yard of the property, 1m from the rear facade facing Badgally Road. A standard timber paling fence is located along the rear boundary of the property. The top of fence was generally below the elevation of Badgally Road and the microphone position and therefore considered to provide minimal acoustic shielding. The logger location was primarily selected to capture Badgally Road traffic noise.

Monitoring at was conducted between Tuesday 12th April and Wednesday 20th April 2011. Whilst monitoring was undertaken during school holidays it is expected that background noise levels would be conservatively low, and with regard to Badgally Road traffic, measurements were for the purpose of model validation only, with assessment based on future traffic flows. Therefore measurement during school holidays is considered not to have adversely affected the objectives of the study.

The following table presents the noise monitoring results for the long-term noise monitoring locations.

Long-term Noise Monitoring Results

Location	Background L_{A90} Noise Levels			Ambient L_{Aeq} Noise Levels		
	Day	Evening	Night	Day	Evening	Night
L1 – 2 Carter Pl	40	37	36	49	44	43
	38*	33*	28*	-	-	-
L2 – 11 Dobell Rd	42	40	34	52	49	47
L3 – 11 Waler Pl	42	39	34	55	52	47

Notes: * - Minimum background L90 levels also presented for reference as long term results appear to be affected by extraneous noise, potentially mechanical equipment.

Short-term Noise Monitoring

Short-term noise measurement along Badgally Road with simultaneous manned traffic counting was also undertaken to assist in validation of noise modelling. The measurement location was 3.7m from the nearest carriage way in the ‘free field’, opposite the long-term noise monitoring location at Location L3.

Short-term Noise Monitoring Results

Location	L_{Aeq}	L_{A90}	Traffic Counts (HV%)
S1 – Badgally Rd, 3.7m from Carriageway	67	55	189 (1%)

Notes: HV% - Heavy Vehicle Percentage

Hume Highway F5 Road Traffic Noise

The Hume Highway is in the process of being upgraded to 3-lanes each way. At the time of site investigations, traffic along the Hume Highway was restricted two-lanes each way and speed of 80km/h. Future sign post speed is to be 110km/h. In addition, it is understood that a 5m high earth mound is to be constructed along the interface with the Claymore Precinct for road traffic noise mitigation as part of the upgrade works. The earth mound is to be formed within the road corridor with the height being referenced to the current road level.

As a result of the current road works, future conditions will vary significantly from the conditions present at time of our site investigations. Therefore, assessment of future road traffic noise impacts has relied upon the noise model prepared for the NSW RTA as part of the Hume Highway widening works. An assessment based on the NSW RTA noise modelling, but including the proposed Claymore Development works, has been presented in this report.

3. Regulatory context

At a glance

Potential impact from noise and vibration is assessed in accordance with non-mandatory guidelines published by relevant NSW Departments such as the NSW Environmental Criteria for Road Traffic Noise, NSW Interim Construction Guideline, NSW Industrial Noise Policy. This is with the exception of the State Environmental Planning Policy (Infrastructure) 2007 which sets out noise criteria for residential development adjacent roads having Annual Average Daily Traffic (AADT) greater than 40,000. For the Claymore Development, this is relevant due to the interface with the Hume Highway F5.

Road Traffic Noise

There are a number of policies, guidelines and Australian Standards which relate to the assessment of road traffic noise upon new residential developments in NSW. These are as follows;

- State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) came into force in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. The aim of the policy includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure development. In regard to development near busy roads, the ISEPP strictly applies to development adjacent roads with Annual Average Daily Traffic (AADT) volumes greater than or equal to 40,000.
- Development Near Rail Corridors and Busy Roads - Interim Guideline (the ISEPP Guideline) was released by the NSW Department of Planning in December 2008. The guideline is referenced by the ISEPP under clauses 85, 86, 87, 102 and 103 where development is proposed in, or adjacent to, specific roads and railway corridors. The guideline also recommends that it be used as best practice approach for development along roads having volumes between 20,000 and 40,000 AADT.
- NSW Environmental Criteria for Road Traffic Noise (ECRTN) 1999 - The ECRTN is a non-mandatory guideline for the assessment of road traffic noise. The ECRTN is referenced in the ISEPP Guideline. Of notable difference to the ISEPP is that the ECRTN assesses road traffic impact at external areas of residential premises.
- Australian Standard 3671-1989 - Sets out a procedure for the assessment of road traffic noise and defers to Australian Standard 2107-2000 (see below) for recommended internal noise levels.
- Australian Standard 2107-2000 - Provides recommended internal L_{Aeq} noise levels for the assessment of steady state noise sources for which road traffic is considered. The standard presents recommended noise levels in terms of satisfactory and maximum goals for a range of development types and specific occupancies.

The Director General's Requirements (DGR) refers to the State Environmental Planning Policy (Infrastructure) 2007 under Key Issue 1. DGR Key Issue 17 'Noise and Vibration' does not stipulate specific criteria or policy in regard to road traffic noise but makes an open reference to 'relevant guidelines'. As Key Issue 17 makes reference to other NSW guidelines, it is considered that the NSW ECRTN should be considered in addition to the State Environmental Planning Policy (Infrastructure) 2007. It is importance to restate that the SEPP is a statutory requirement whilst the ECRTN is non-mandatory.

Site Specific Road Traffic Noise Criteria

Given consideration of the relevant policy documents above the following assessment procedure and guidelines are most relevant to the Claymore development;

- Development impacted by the Hume Highway (having AADT greater than 40,000) must comply with the ISEPP requirements;
- Consideration shall also be given to the NSW ECRTN, and all feasible and reasonable mitigation measures should be incorporated into development interfacing with Badgally Road and the Hume Highway so as to meet the external noise criteria. Emphasise on achieving satisfactory external noise levels in areas of principle private open space shall be given.
- Where external road traffic noise levels cannot be reasonably mitigated to meet the NSW ECRTN, assessment shall be made against the external equivalent goals for the ISEPP (assuming naturally ventilated building). Any residual noise impacts should be addressed through appropriate design of the building envelope in accordance with either the ISEPP or AS2107-2000 as relevant.

The most relevant noise criteria for new residential development within the Claymore Renewal site are set out in the table below.

Road Traffic Noise Criteria for New Residential Development

Type of Road	Criteria	Room	Location	$L_{Aeq, 15hr}$ Day 7am – 10pm	$L_{Aeq\ 9hr}$ Night 10pm – 7am
Arterial	ISEPP	Living Rooms*	Internal, windows closed	40	40
			External – facade, natural Ventilation	62.5#	60.5^
		Bedrooms*	Internal, windows closed	-	35
			External – facade, Natural Ventilation	-	57.5#
	ECRTN	Habitable Rooms	External, facade	55	50

Note:

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

ISEPP Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open mechanical ventilation is required. External goals have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA 2011 requirements.

^ The equivalent night time goal has been calculated based on a 2dB(A) difference between the daytime and night road traffic noise levels measured for the RTA study.

Under the ECRTN the noise criteria for new residential development impacted by arterial road traffic is more stringent than that of a redeveloped arterial road or that determined using the ISEPP internal goals. It is noted that the works being undertaken by the RTA would allow higher noise exposure at existing residential premises to that recommended for any new residential premises being built in the area.

Operational Noise

In accordance with the Director General's Requirements, operational noise would generally be assessed in accordance with the NSW Industrial Noise Policy (INP). Whilst the NSW INP is largely for the assessment of industrial sites, it can be used to assess noise impacts from other noise generating development. The NSW INP sets appropriate noise criteria to protect noise amenity of areas. The basis for its policy relies on two components – firstly, controlling intrusive noise impacts in the short term for residences and secondly, maintaining noise level amenity for particular land uses.

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

The second component, 'noise amenity', ensures that industrial noise levels do not increase without limit. If a number of industrial noise sources were permitted to increase the background noise level by 5dB(A) in turn, there would be a point where the cumulative noise level is unacceptable. A limit on the ultimate acceptable noise level is therefore introduced as a way of ensuring that cumulative noise impact from industrial growth is curtailed. This limit is referred to as the amenity goal. The appropriate limit in any circumstance relates to the land use category, for example, there are different limits for rural, suburban and urban areas.

Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface - for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55

Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
School classrooms - internal	All	Noisiest 1 hr period when in use	35	40
Hospital ward - internal - external	All	Noisiest 1 hr period	 35 50	 40 55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75
Note:	Daytime 7:00am to 6:00pm or 8:00am to 6:00pm Sundays and Public Holidays; Evening 6:00pm to 10:00pm; Night-time 10:00pm to 7:00am or 10:00pm to 8.00am Sundays and Public Holidays.			

Construction Noise

In accordance with the Director General's Requirements, construction noise should be assessed in accordance with the NSW Interim Construction Noise Guideline. The key components of the NSW *Interim Construction Noise Guideline* (ICNG) that can be incorporated into assessments include:

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

2. Application of feasible and reasonable noise mitigation measures
As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints. Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects, including the cost of the measure.

3. Quantitative and qualitative assessment

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment.

A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

A qualitative assessment is recommended for small projects with a short-term duration where works are not likely to affect an individual or sensitive land use for more than three weeks in total. It focuses on minimising noise disturbance through the implementation of feasible and reasonable work practices, and community notification.

Given the significant scale of the construction works proposed for this Project, a quantitative assessment should be carried out at the relevant detailed planning stages.

4. Management Levels

Residences

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

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

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm 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.

* 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 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Sensitive Land Use

The table below (reproduced from Table 2 of the ICNG) sets out the noise management levels for various sensitive land use developments.

Land use	Management level, $L_{Aeq\ (15\ min)}$ – applies when land use is being utilised
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.

Construction Vibration

Disturbance to Buildings Occupants

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

Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the technical guideline defines each type of vibration as follows:

Continuous vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).

Impulsive vibration is 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.

Intermittent vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.

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

'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

Preferred and maximum values for continuous and impulsive vibration acceleration (m/s^2, 1-80Hz) are defined in Table 2.2 of the guideline and are reproduced below.

Preferred and Maximum Weighted rms Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 1-80Hz

Location	Assessment Period	Preferred Values, m/s^2		Maximum Values, m/s^2	
		z axis	x & y axis	z axis	x & y axis
Continuous Vibration					
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					
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

Notes 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

Intermittent vibration is to be assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline. Preferred and maximum VDV values ($m/s^{1.75}$) are defined in Table 2.4 of the guideline and are reproduced below.

Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime [1]		Night-time [1]	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

Structural Damage to Buildings

Currently there exists no Australian Standard for assessment of structural building damage caused by vibrational energy. Therefore, reference is made to both the British and German standards below which are relevant to the assessment of structural damage.

British Standard

British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The levels from the standard are given below in the table below.

BS 7385 Structural Damage Criteria

Location	Peak component particle velocity, mm/s		
	4Hz to 15Hz	15Hz to 40Hz	40Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50		
Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration limits set for minimal risk of ‘cosmetic’ damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Group 2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Group 1; constant across all frequencies). ‘Minor’ damage is considered possible at vibration magnitudes which are twice those given and ‘major’ damage to a building structure may occur at levels greater than four times those values.

These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered ‘safe limits’ up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

German Standard

The German standard DIN 4150 - Part 3 - "Structural vibration in buildings - Effects on Structures”, also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

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 (e.g. 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 the table below and are generally recognised to be conservative.

DIN 4150-3 Structural Damage Criteria

Type of Structure	Vibration Velocity, mm/s			
	At Foundation at Frequency of			Plane of Floor Uppermost Storey
	< 10Hz	10Hz - 50Hz	50Hz - 100Hz	All Frequencies
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15

4. Methods and results

At a glance

The primary results of the study relate to road traffic noise as operational and construction noise is to be addressed during detailed planning stages of individual development or stages.

In respect to the Hume Highway F5, the base RTA noise model reveals that much of the site will be exposed to noise levels above the ECTRN external noise criteria. However by assessment against ISEPP internal goals, the majority of the site reveals compliance with no need for building upgrades or alternative ventilation. With the exception of development within Stage 2, on the southern side of Dobell Road, it has been deemed unreasonable to provide any further external barrier type noise mitigation beyond the RTA's noise mound. Any residual noise impacts at residential receiver locations can be mitigated to meet the relevant internal noise criteria.

With regard to Badgally Road, modelling revealed that road traffic noise levels at the nearest residential facades would exceed the ECRTN external noise criteria. Noise mitigation so as to meet either external and/or internal noise levels should be considered for development fronting Badgally Road.

Road Traffic Noise

Road traffic noise impacts from Badgally Road and the Hume Highway have been assessed through a combination of noise measurement and predictive modelling. A detailed methodology is presented in Appendix 5. Preliminary noise modelling was used to guide development of the concept plan, in terms of suitable lot layouts, resulting building orientations, external mitigation measures and minimising the extent of building envelope treatment.

Hume Highway F5

Noise modelling based on the future widened Hume Highway revealed areas of the Claymore site that exceed the external ECRTN noise criteria for new residential development. With the exception of development within Stage 2, on the southern side of Dobell Road, it has been deemed unreasonable to provide any further external barrier type noise mitigation beyond the RTA's noise mound. Any residual noise impacts at residential receiver locations can be mitigated to meet the relevant internal noise criteria.

The primary external noise mitigation for the Claymore site is to be provided as part of the Hume Highway widening works. Whilst yet to be constructed, a 5m earth mound above the road level, is to be formed within the road corridor. As identified in the RTA's 'F5 Freeway (Hume Highway) upgrade – Noise fact sheet' dated February 2010, the earth mound is to extend from a location approximately 200m north of the Glenroy Homestead and connect with an existing noise wall located north of Fullwood Reserve.

Results of the noise modelling have been discussed below by Stage as the relationship between the Claymore site and the F5 varies along the interface.

Stage 2

The Stage 2 works proposed on the southern side of Dobell Road and adjacent Glenroy Homestead is elevated above the Hume Highway. As no barrier type mitigation is proposed as part of the Hume Highway works in this area additional noise mitigation in the form of earth mounds, noise walls, or combination of these measures are recommended so as to improve external amenity for residential premises and reduce the extent of building envelope treatment. It is noted that if dwelling are not constructed on the southern side of Dobell Road within Stage 2, additional noise wall/mound treatment is not required for lots on the northern side of Dobell Road.

With regard to the southern area of Stage, consideration to lowering the local ground height was given in the analysis. The findings revealed that there were no acoustic benefits to lowering the local ground height, but it could allow earth mounds rather than noise walls to be used for noise mitigation. Further detailed analysis of these options should be undertaken at the specific development application stage. The following findings therefore relate to the existing ground topography.

F5 – Claymore Stage 2 Year 2021 $L_{Aeq\ 9\ hour}$ Road Traffic Noise Levels

Noise Wall Scenario	Ground Floor, dB(A)	First Floor, dB(A)
No Noise Wall	62	65
3m Wall	56	61
4m	55	58
5m	54	57
8m	50	52
Criteria		
ECRTN	50	
ISEPP External Living*	60.5	
ISEPP External Bedroom*	57.5	

Notes:
Residential Facade approximately 50m from edge of nearside carriageway
Noise Wall approximately 25m from nearside carriageway
* As set out in Section 3, p.12

Analysis reveals that a wall height in the order of 8m would be required to meet the ECRTN at ground level. However based on the ISEPP goals, lower wall heights would be more cost effective as compliant buildings not requiring mechanical ventilation could still be provided with lower wall heights.

The actual external noise level and reduction provided by the barrier/mound would be dependent upon the actual location of the wall and its height relative the receiver location. Detailed assessment is therefore required once a suitable location and form is determined. With regard to the ISEPP criteria, any residual noise impact not addressed through the provision of external mitigation would require building envelope treatment so as to meet the ISEPP internal noise goals.

Stages 7, 8 and 9

The residential dwellings within Stage 7 and 8 are generally lower or level with the F5. The 5m mound to be provided during the widening works is to be most effective for these Stages. The noise modelling results presented in Appendix 6 reveals noise levels to exceed the ECRTN

but generally comply with the ISEPP goals at all but 3 lots (excluding Stage 2 lots). The affected lots would require windows to be closed and provided with alternative ventilation. Due to the minimal number of lots affected it is not considered reasonable to provide additional external mitigation.

Badgally Road

Modelling for future road traffic noise along Badgally Road was undertaken for the indicative residential lot layout between Dobell Road and Glenroy Road. It is considered that similar outcomes could be expected for development to the north of Glenroy Road, if low densities development is provided. However, where higher density, multi-level development is proposed, noise treatment is likely to be restricted to building envelope treatment. The table below provide a summary of the noise modelling results considering various boundary wall heights.

Badgally Road Year 2026 $L_{Aeq\ 15hour}$ Road Traffic Noise Levels

Location	Noise Modelling Scenario – Facade Noise Level, dB(A)				ECRTN Criteria
	No Wall	1.8m Wall	2.4m Wall	2.8m Wall	
Ground Floor	62.0	58.4	56.2	54.9	55
First Floor	64.5	64.5	64.3	63.1	55

Notes: Residential Facade approximately 20m from edge of nearside carriageway

Boundary Fence approximately 12m from nearside carriageway

The results reveal that a solid wall in the order of 2.8m high would be required to reduce external road traffic noise to compliant levels in the rear yard of residential properties. Residual impact is still predicted at second storey level. On this basis the any second storey would require building envelope treatment to ensure reasonable internal acoustic amenity. The building envelope construction is general restricted to the windows and doors, but can require upgrade of typical lightweight cladding constructions. Further discussion of results is set out in Section 5 ‘Assessment’.

Operational Noise

As the development is predominately residential in nature, operational noise would be predominately that of any mechanical services equipment associated with ventilation. This may include air-conditioning and integrated supply and exhaust ventilation for any higher density multiunit development. Noise emission from such equipment is addressed at the detailed development stages of the relevant development and is not discussed further in this report.

The only other noise generating development identified in the area is that of a retail centre with potential community facilities at the corner of Badgally Road and Glenroy Road. Assessment of noise emission from sources such as mechanical services equipment, loading docks and general activity, should assessed to the existing and future residential development. This assessment is a detailed issue that can only be addressed at the time of the specific development proposal. Nonetheless, the siting of potential noise generating activity along the busy roads should reduce potential impact due to the higher background noise levels compared with the central location within the Renewal Area.

No further discussion regarding operational noise mitigation or management is presented in this report.

Construction Noise and Vibration Mitigation Measures

Construction Noise and Vibration Management Plans (CNVMP) should be prepared for significant development that has the potential to impact existing receiver locations, in particular heritage items. Reports should detail the methods that will be implemented to manage noise and vibration impacts for the duration of the construction stage of the project to satisfy the 'Interim Construction Noise Guideline' (DECCW, 2009) and 'Assessing Vibration; a technical guideline' (DECCW, 2006). For reference the table below outlines a number of techniques and options for controlling construction noise and vibration.

Construction Noise and Vibration Management Options

Source Controls	
Time constraints	Limit work to daylight hours. Consider implementing respite periods with low noise/vibration-producing construction activities.
Scheduling	Perform noisy work during less sensitive time periods. Schedule high noise/ vibration impact activities such as rock breaking, rock hammering and sheet piling to ensure that sensitive receivers have satisfactory respite periods. Consult with affected educational institutions and ensure that noise-generating construction works in the vicinity of the institutions are not timetabled during examination periods, unless other arrangements acceptable to the affected institutions are made at no cost to the affected institutions. Scheduling deliveries during the recommended standard hours only, unless restricted by police or other authorities.
Equipment restrictions	Select low-noise plant and equipment. Ensure equipment has quality mufflers installed.
Emission restrictions	Establish stringent noise emission limits for specified plant and equipment. Implement noise monitoring audit program to ensure equipment remains within specified limits. Evaluation and review of performance procedures (eg noise, vibration and blast monitoring for checking work practices and equipment).
Substitute methods	Use quieter and less vibration emitting construction methods where possible. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration reduction benefits.
Limit equipment on site	Only have necessary equipment on site.
Limit activity duration	Where possible, concentrate noisy activities at one location

	and move to another as quickly as possible. Any equipment not in use for extended periods during construction work should be switched off.
Equipment Location	Noisy plant and equipment should be located as far as possible from noise sensitive areas, optimising attenuation effects from topography, natural and purpose built barriers and materials stockpiles.
Site access	Locating the site entries, site offices and parking areas as far as possible from the residences. Vehicle movements outside construction hours, including loading and unloading operations, should be minimised and avoided where possible.
Reduced equipment power	Use only necessary size and power.
Quieter work practices	For example, implement worksite induction training, educating staff on noise sensitive issues and quiet work practices, particularly during out-of-hours work.
Reversing alarms	Consider alternatives, such as manually adjustable or ambient noise sensitive types (“smart” reversing alarms) and closed circuit TV systems. Install broadband instead of tonal reverse alarms on mobile plant to minimise potential noise impacts Arranging the work sites to minimise the use of alarms on mobile plant Alternative site management strategies can be developed, in accordance with the *Occupational Health and Safety Plan*, with the concurrence of the Occupational Health and Safety Officer.
Path Controls	
Noise barriers	Consider installing temporary construction noise barriers. Install any permanent noise barriers/ mounds required to minimise road traffic noise as early as possible in the construction process. Locate equipment to take advantage of the noise barriers provided by existing site features and structures, such as embankments and storage sheds.
Project Planning	Construction should be programmed so that noise barriers or mounding required to control noise are built as soon as possible.
Enclosures	Install noise-control kits for noisy mobile equipment and shrouds around stationary plant, as necessary.
Increased distance	Locate noisy plant as far away from noise-sensitive receptors as possible.
Site access	Select and locate site access roads as far away as possible from noise-sensitive areas.
Receptor Controls	
Architectural treatment	Upgrade the glazing or window shutters of affected bedrooms.

Structural surveys and vibration monitoring	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
Temporary relocation	In extreme cases.
Consultation	Community consultation, information, participation and complaint responses are essential aspects of all construction noise management programs. They typically involve: Procedures for notifying potentially affected receivers of forthcoming works that are likely to cause noise and vibration impacts. A community information program before construction and/or high risk activities are commenced. This usually involves a leaflet distribution and direct discussions and negotiations with affected residents, explaining the type, time and duration of expected noise emissions. Ongoing consultation with the community, distribution of newsletters, mail-outs and advertising in local newspapers regularly, notifying of the nature of noisy work, expected duration, mitigation and management processes in place to reduce and manage noise and vibration impacts. Engaging, informing and discussing performance with the community. The involvement of affected residents in the development of acceptable noise management strategies. A nominated community liaison officer with a contact telephone number. A 24 hour toll-free information and complaints hotline. Timely responses to complaints, providing information on planned actions and progress towards the resolution of concerns.

5. Assessment

At a glance

The extent of acoustic assessment was contained to road traffic noise onto the future residential premises within the Claymore Renewal project. As required by the DGR's assessment addressed both Badgally Road and the Hume Highway F5.

With regard to Badgally Road acoustic impacts can be readily addressed through boundary wall construction and building envelope treatment.

With regard to the Hume Highway F5, the 5m noise mound to be constructed as part of the F5 upgrade works was deemed to be sufficient for the majority of the precinct, with the exception of lots on the southern side of Dobell Rd in Stage 2 and three lots within Stage 8. With regard to Stage 2 lots, a combination of noise wall/mound and treatment of the individual building envelopes is likely to be required to satisfy the ISEPP 2007.

Hume Highway F5 Traffic Noise

The results based on the RTA 5m mound revealed exceedance of the ECRTN however complied with the ISEPP at all but three lots in Stage 8 and the lots on the southern side of Dobell Rd in Stage 2. Due to the minimal residual impact of lots in Stage 8 it was not considered reasonable to provide additional external mitigation measures.

The affected lots in Stage 8 would require windows to be closed and provided with mechanical or alternative ventilation. Standard building constructions are likely to suffice however it is recommended that acoustic seals be fitted to windows. Detailed assessment could be undertaken at the specific development application stage.

With regard to Stage 2 works on the southern side of Dobell Road, where no mitigation is proposed as part of the F5 works, noise walls/mounds in the order of 4-5m high are recommended to provide reasonable external amenity to external areas of the proposed residential lots.

Badgally Road Traffic Noise

The results revealed that for the proposed Badgally Road/Residential Interface, boundary fences to a height of 2.8m would result in compliant external noise levels in the rear yards of those properties. This barrier treatment would therefore negate any additional building envelope design to ground floor levels of residential premises. It is noted that the barrier would need to be of sufficient mass (generally above 15kg/m^2) to limit the effect of direct noise transmission through the barrier.

If residential premises are to be two storeys, the upper levels would be exposed to external levels above the ECRTN criteria. Barrier treatment to reduce second storey levels to compliant levels would need to be in the order of 5m high. As this outcome is not considered desirable for the Badgally Road frontage or the amenity of rear yards, building envelope treatment would be recommended to ensure reasonable internal amenity.

The required building envelope treatment is dependent upon the size and configuration of the dwellings, along with the size of any window and door openings. Further detailed advice, as to the type of building envelope treatment could be provided at the relevant Development Application (DA) stage. It is noted that when windows and doors are required to be closed so as to meet the ISEPP internal criteria, mechanical or alternative ventilation may be required.

Specification of Building Envelope Design

The way in which the acoustic requirements of the building envelopes are specified can vary dependent upon whether the lots are to be developed by individual owners or a single developer. So as to limit the cost of additional acoustic assessment being undertaken by an individual lot developer, it is recommended that appropriate information is provided in the DA assessment to allow those individuals to build from the recommendations provided. This however is in the interest of reducing the burden on the individual rather than any prescribed requirement. The information provided in this regard would be more generic but need to provide reasonable flexibility for the owner, in particular through the benefits of reducing windows sizes or appropriately location sensitive rooms.

When multiple lots are to be developed by a single entity, it may be cost effective to undertake detailed acoustic assessment of the final dwelling designs so that the acoustic requirements can be optimised across the larger number of dwellings.

In any respect, assessment of the building envelope requirements should be undertaken at the development application stage so that the extent of any external barrier type attenuation can be determined and approved by the relevant authorities.

6. References

1. British Standards Institution 1992, *BS6472 - Evaluation of human exposure to vibration in buildings (1-80Hz)*

2. British Standards Institution 1993, *BS7385 - Part 2 Evaluation and measurement of vibration in buildings*,

3. Department of Planning NSW 2008, *Development near rail corridors and busy roads – interim guideline*

4. Department of Environment and Climate Change NSW 2009, *Interim Construction Noise Guideline,* Department of Environment and Climate Change NSW, Sydney South, Australia

5. Environment Protection Authority NSW 1999, *Environmental Criteria for Road Traffic Noise*, Environment Protection Authority, Chatswood, Australia

6. Environment Protection Authority NSW 2000, *Industrial Noise Policy*, Environment Protection Authority, Sydney South, Australia

7. German Standard 1999, DIN 4150 – Part 3, *Structural vibration in buildings - Effects on Structures*

8. NSW Government 2007, *State Environmental Planning Policy (Infrastructure) 2007*

9. Renzo Tonin & Associates 2008, *TD437-02F06 (rev 1) Noise Assessment*, Renzo Tonin & Associates

10. Standards Australia 2000, Australian Standard 2021-2000 *Acoustics – Aircraft noise intrusion - building siting and construction,* Standards Australia International Ltd Sydney Australia

11. Standards Australia 1981, Australian Standard 2436-1989 *Guide to Noise Control on Construction Maintenance and Demolition Sites,* Standards Australia International Ltd Sydney Australia

12. Standards Australia 1989, Australian Standard 1055-1989 *Acoustics – Description and measurement of environmental noise, part 1 General Procedures,* Standards Australia International Ltd Sydney Australia

13. Standards Australia 2000, Australian Standard 2021-2000 *Acoustics – Aircraft noise intrusion - building siting and construction,* Standards Australia International Ltd Sydney Australia

Appendix 1: Glossary

Term	Meaning
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 **L_{90}** 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 Martin Place 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.
Ecologically Sustainable Development	Ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making. It can be achieved by implementing the following principles and programs: ▪ the precautionary principle ▪ inter-generational equity ▪ conservation of biological diversity and ecological integrity ▪ improved valuation, pricing and incentive mechanisms.
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.
HV%	Heavy Vehicles Percentage – the percentage of heavy vehicles in respect to the total traffic volume
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.
NSW INP	New South Wales Industrial Noise Policy document 1997
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 L_{90} 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 2: Measurement Locations

- Long-term Monitoring Location
- Short-term Monitoring Location
- Badgally Rd Traffic Counting

Appendix 3: Long-term Noise Monitoring Methodology

Noise Monitoring Equipment

Long term noise monitoring was conducted using RTA Technology noise loggers. The noise monitoring equipment complies with AS IEC 61672.1 2004 “Electroacoustics - Sound Level Meters” and are designated as Type 1 instrument.

A noise monitor consists of a sound level meter and a computer housed in a weather resistant enclosure. Ambient noise levels were recorded at a rate of 10 samples per second. Every 15 minutes, the data is processed statistically and stored in memory. The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 calibrator. No significant drift in calibration was observed.

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 at 1.5m above ground level. The correction factor applied to the data was taken from *Australian Standard AS1170.2 1989 Section 4.2.5.1*.

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. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels at the noise monitoring location in Appendix D illustrate these concepts.

Noise levels are commonly measured in units of A-weighted decibels or dB(A). The "A-weighting" refers to a standardised amplitude versus frequency curve used to "weight" sound measurements to represent the response of the human ear. The human ear is less sensitive to low pitch sound than it is to high pitch sound. Overall A-weighted measurements quantify sound with a single number to represent how people subjectively hear different frequencies at different levels.

Background noise is the term used to describe the noise measured in the absence of the noise under investigation. 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 time period. This is represented as the L90 noise level.

Appendix 4: Long-term Noise Monitoring Results

RENZO TONIN & ASSOCIATES
inspired to achieve

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noise logger results

Location L1 - 2 Carter Place, Claymore

BACKGROUND & AMBIENT NOISE MONITORING RESULTS
NSW DECCW's 'INDUSTRIAL NOISE POLICY', 2000

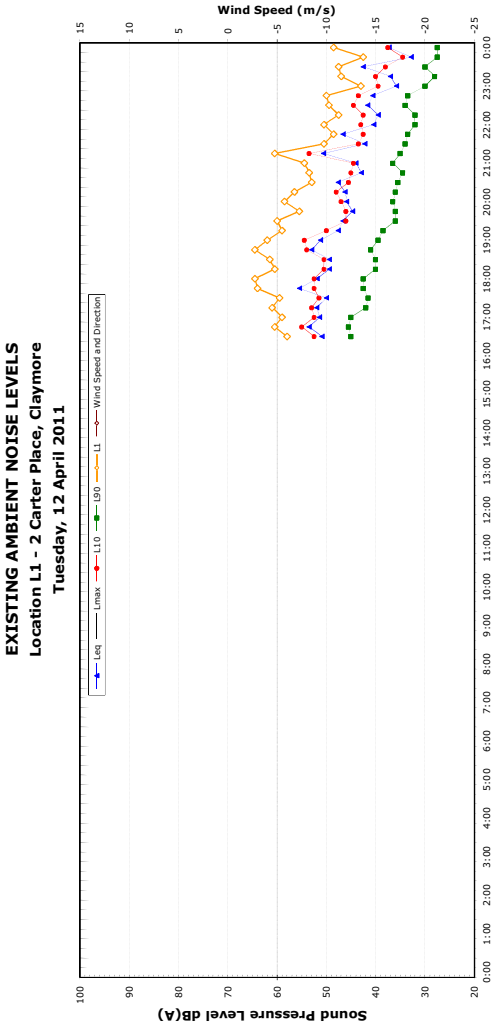
	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
Day	Day	Evening	Night	Day	Evening	Night
Tuesday-12-April-2011	-	34	28	-	45	45
Wednesday-13-April-2011	38	33	30	51	45	42
Thursday-14-April-2011	41	40	37	48	44	43
Friday-15-April-2011	40	37	36	51	43	41
Saturday-16-April-2011	43	38	37	48	43	40
Sunday-17-April-2011	41	36	34	51	43	42
Monday-18-April-2011	39	38	38	47	42	43
Tuesday-19-April-2011	38	40	38	49	45	43
Wednesday-20-April-2011	38	-	-	50	-	-
Representative Level	**40**	**37**	**36**	**49**	**44**	**43**

Notes:
1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Partial day's monitoring
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq

TRAFFIC NOISE MONITORING RESULTS
NSW DECCW 'ENVIRONMENTAL CRITERIA FOR ROAD TRAFFIC NOISE', 1999

	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Day	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Tuesday-12-April-2011	50	48	53	46	57	34
Wednesday-13-April-2011	52	44	57	46	51	37
Thursday-14-April-2011	50	46	53	44	51	41
Friday-15-April-2011	52	43	59	43	46	39
Saturday-16-April-2011	50	42	52	44	46	39
Sunday-17-April-2011	52	45	57	43	51	39
Monday-18-April-2011	49	45	52	42	50	41
Tuesday-19-April-2011	50	45	54	46	52	41
Wednesday-20-April-2011	52	-	58	48	-	-
Representative Weekday	**51**	**45**	**56**	**45**	**52**	**39**
Representative Weekend	**51**	**44**	**55**	**43**	**49**	**39**
Representative Week	**51**	**45**	**56**	**45**	**52**	**39**

TF298-01S02 (rev0) 2 Carter Place, Claymore.xls
Template QTT-01 (rev 67) Logger Graphs



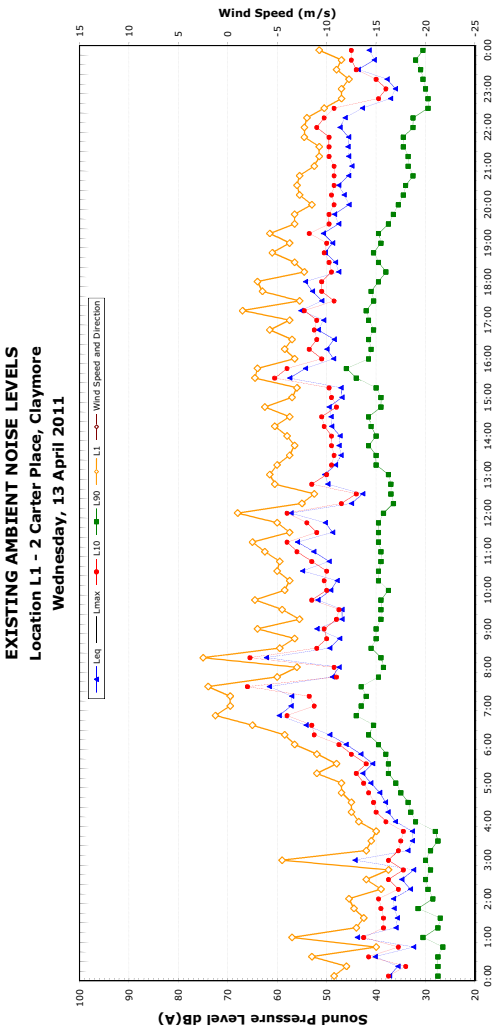
NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	33.5	27.5
Leq (see note 3)	-	45.5	45.1

NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	49.9	47.6
$L_{eq\ 15hr}$ upper 10 percentile	52.8	56.5
$L_{eq\ 15hr}$ lower 10 percentile	45.6	34.0

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

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)*

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs
TF298-01S02 (rev0) 2 Carter Place, Claymore.xls



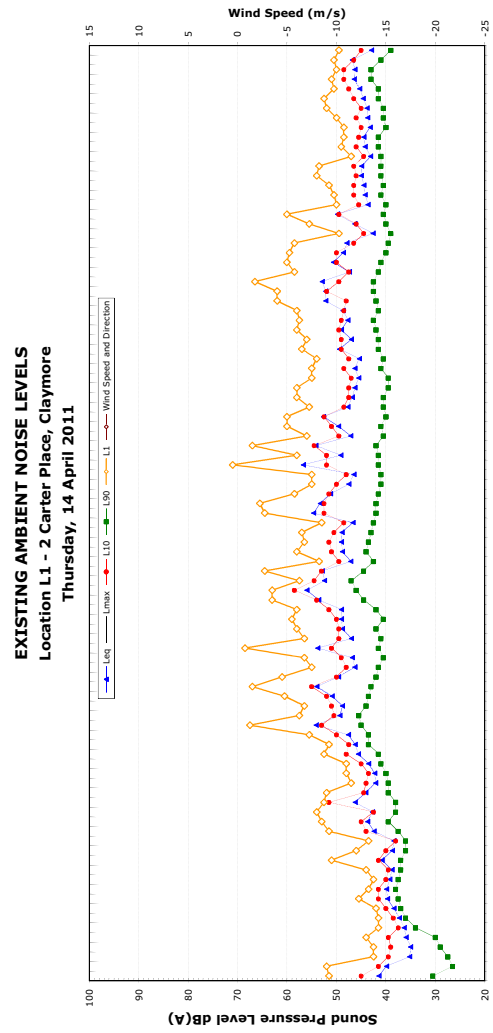
NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	37.5	32.5	29.5
Leq (see note 3)	50.7	45.1	41.8

NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52.3	44.3
$L_{eq\ 15hr}$ upper 10 percentile	57.0	50.8
$L_{eq\ 15hr}$ lower 10 percentile	46.2	37.0

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

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)*

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs
TF298-01S02 (rev0) 2 Carter Place, Claymore.xls



NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	40.5	39.5	37.0
Leq (see note 3)	48.4	43.9	43.3

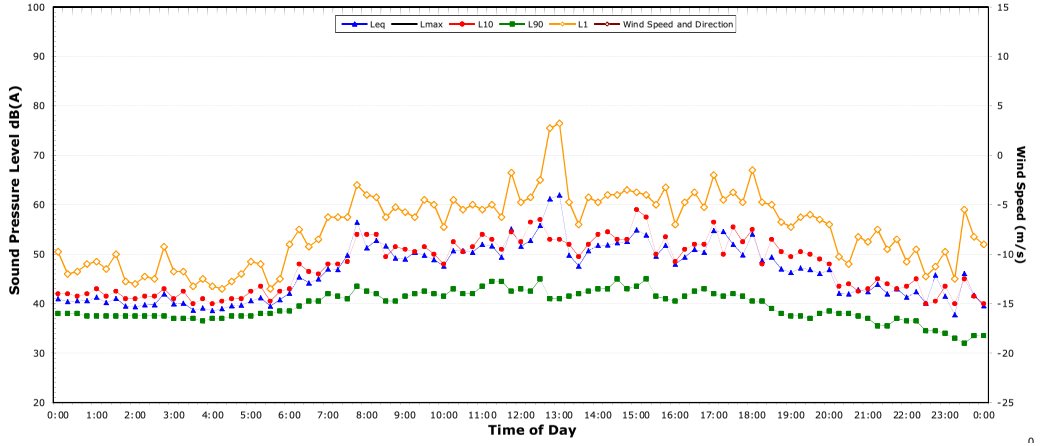
NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	50.1	45.8
$L_{eq\ 15hr}$ upper 10 percentile	53.1	51.0
$L_{eq\ 15hr}$ lower 10 percentile	44.2	40.6

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

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)*

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs
TF298-01S02 (rev0) 2 Carter Place, Claymore.xls

EXISTING AMBIENT NOISE LEVELS
Location L1 - 2 Carter Place, Claymore
Sunday, 17 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	41.0	35.5	33.5
Leq (see note 3)	50.8	43.1	42.1

NOTES:

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

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured 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)

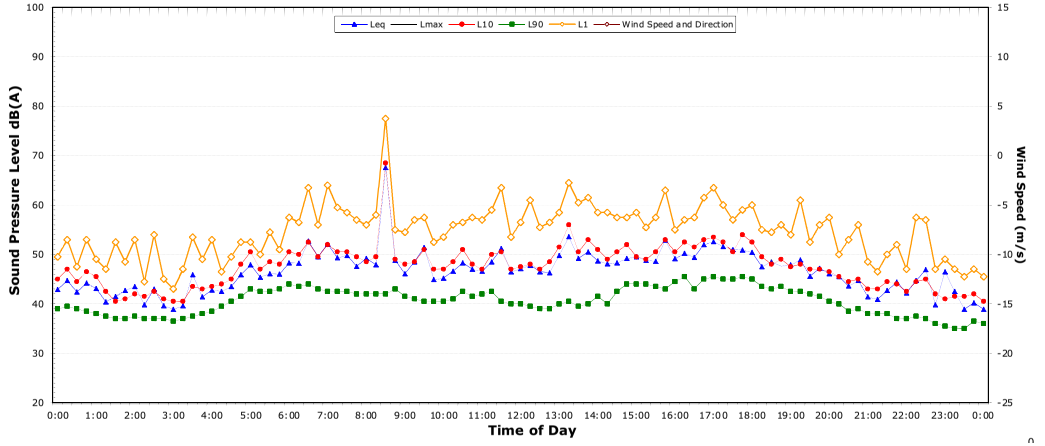
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9hr}$	52.2	44.6
$L_{eq\ 1hr}$ upper 10 percentile	57.3	51.2
$L_{eq\ 1hr}$ lower 10 percentile	42.5	38.6

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

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02 (rev0) 2 Carter Place, Claymore.xls

EXISTING AMBIENT NOISE LEVELS
Location L1 - 2 Carter Place, Claymore
Friday, 15 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	40.0	37.0	35.5
Leq (see note 3)	50.9	43.5	40.8

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)

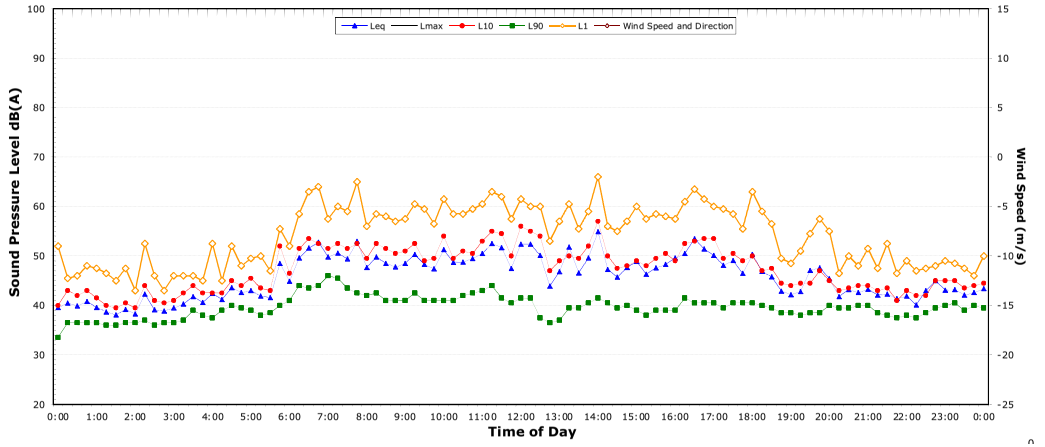
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9hr}$	52.3	43.3
$L_{eq\ 1hr}$ upper 10 percentile	59.1	46.1
$L_{eq\ 1hr}$ lower 10 percentile	43.4	39.1

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

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02 (rev0) 2 Carter Place, Claymore.xls

EXISTING AMBIENT NOISE LEVELS
Location L1 - 2 Carter Place, Claymore
Monday, 18 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	39.0	38.0	37.5
Leq (see note 3)	47.4	41.7	42.8

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)

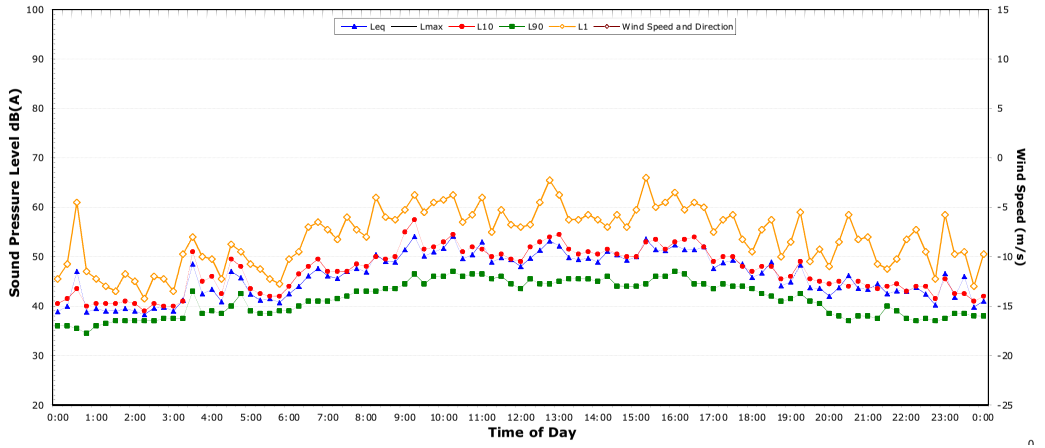
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9hr}$	49.0	45.3
$L_{eq\ 1hr}$ upper 10 percentile	51.7	50.0
$L_{eq\ 1hr}$ lower 10 percentile	42.4	41.1

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

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02 (rev0) 2 Carter Place, Claymore.xls

EXISTING AMBIENT NOISE LEVELS
Location L1 - 2 Carter Place, Claymore
Saturday, 16 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	43.0	37.5	37.0
Leq (see note 3)	48.1	42.5	39.5

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)

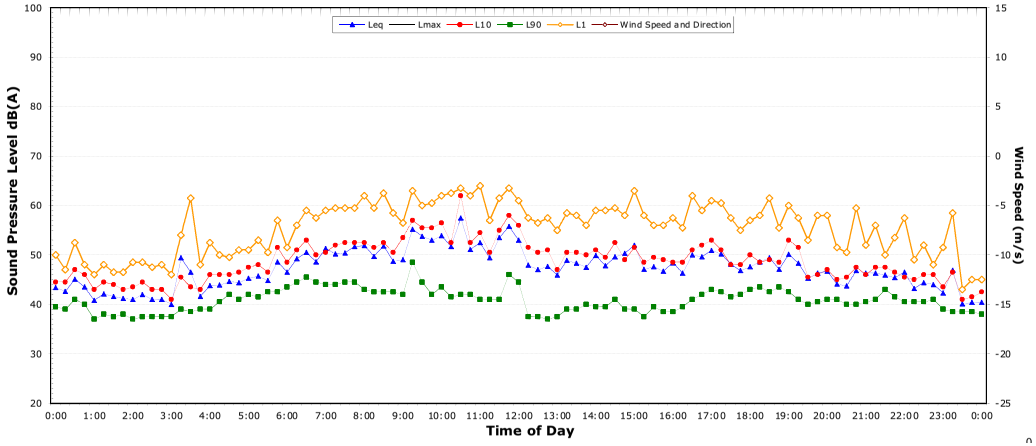
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9hr}$	49.7	42.0
$L_{eq\ 1hr}$ upper 10 percentile	52.2	45.5
$L_{eq\ 1hr}$ lower 10 percentile	43.9	39.2

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

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02 (rev0) 2 Carter Place, Claymore.xls

EXISTING AMBIENT NOISE LEVELS
Location L1 - 2 Carter Place, Claymore
Tuesday, 19 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	37.5	40.0	38.0
Leq (see note 3)	48.6	44.5	42.9

NOTES:

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

2. "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)

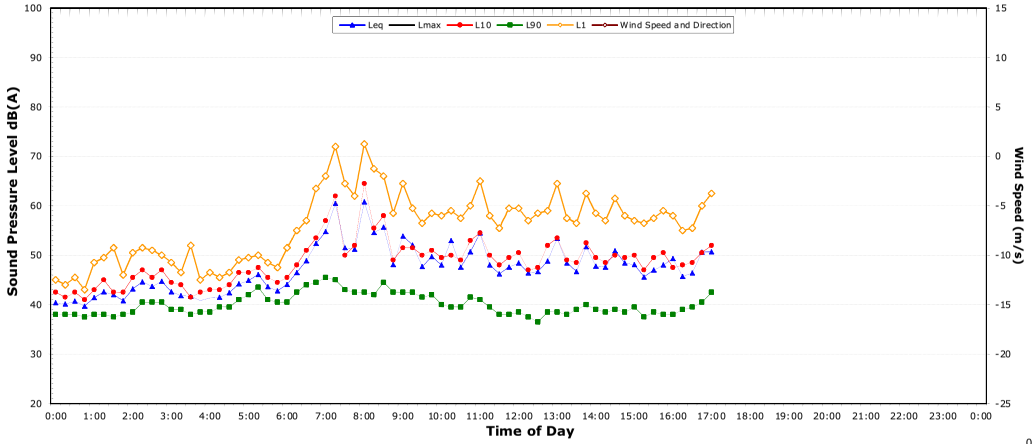
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	50.3	45.4
$L_{eq\ 1hr}$ upper 10 percentile	54.1	51.7
$L_{eq\ 1hr}$ lower 10 percentile	45.7	40.5

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

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02 (rev0) 2 Carter Place, Claymore.xls

EXISTING AMBIENT NOISE LEVELS
Location L1 - 2 Carter Place, Claymore
Wednesday, 20 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	38.0	-	-
Leq (see note 3)	49.5	-	-

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 ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52.0	-
$L_{eq\ 1hr}$ upper 10 percentile	58.1	-
$L_{eq\ 1hr}$ lower 10 percentile	47.6	-

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

Data File: 20110412 RTA0402.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02 (rev0) 2 Carter Place, Claymore.xls

RENZO TONIN & ASSOCIATES
inspired to achieve

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

noise logger results

Location L2 - 11 Dobell Road

BACKGROUND & AMBIENT NOISE MONITORING RESULTS
NSW DECCW's 'INDUSTRIAL NOISE POLICY', 2000

	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
Day	Day	Evening	Night	Day	Evening	Night
Wednesday-13-April-2011	-	38	34	-	48	48
Thursday-14-April-2011	44	42	35	53	50	47
Friday-15-April-2011	43	40	34	52	49	46
Saturday-16-April-2011	-	39	33	-	49	45
Sunday-17-April-2011	42	39	33	52	47	46
Monday-18-April-2011	41	44	36	51	50	47
Tuesday-19-April-2011	42	44	39	52	50	48
Wednesday-20-April-2011	43	-	-	53	-	-
Representative Level	**42**	**40**	**34**	**52**	**49**	**47**

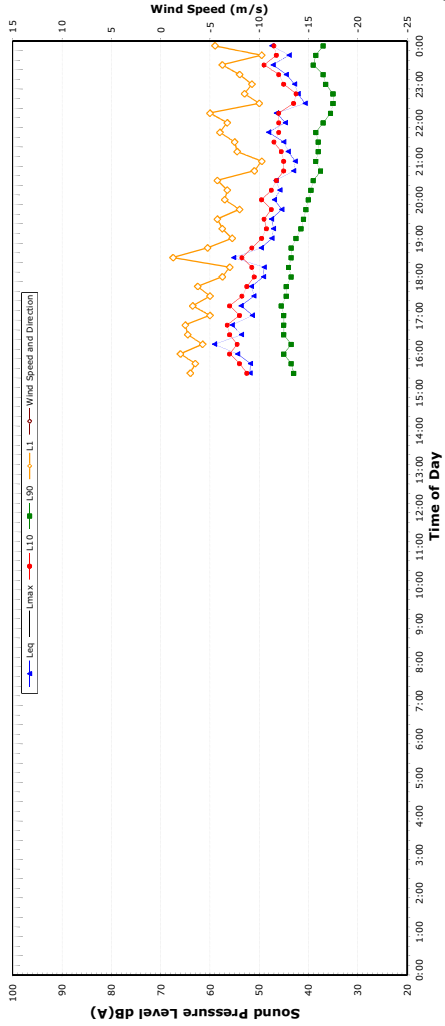
Notes:
1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Partial day's monitoring
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq

TRAFFIC NOISE MONITORING RESULTS
NSW DECCW 'ENVIRONMENTAL CRITERIA FOR ROAD TRAFFIC NOISE', 1999

	L_{Aeq} Noise Levels			$L_{Aeq\ 1hr}$ Noise Levels		
Day	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Wednesday-13-April-2011	54	51	58	47	58	42
Thursday-14-April-2011	55	49	57	50	53	43
Friday-15-April-2011	54	48	57	49	55	43
Saturday-16-April-2011	56	47	63	50	54	42
Sunday-17-April-2011	54	49	57	48	55	41
Monday-18-April-2011	53	49	56	50	55	44
Tuesday-19-April-2011	54	50	56	51	56	45
Wednesday-20-April-2011	56	-	58	52	-	-
Representative Weekday	**54**	**50**	**57**	**50**	**56**	**44**
Representative Weekend	**55**	**48**	**61**	**49**	**55**	**42**
Representative Week	**54**	**49**	**58**	**50**	**55**	**43**

25 YEARS 2005 ACOUSTIC ENGINEERING EXCELLENCE

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Wednesday, 13 April 2011



NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	37.5	33.5
Leq (see note 3)	-	48.1	48.3

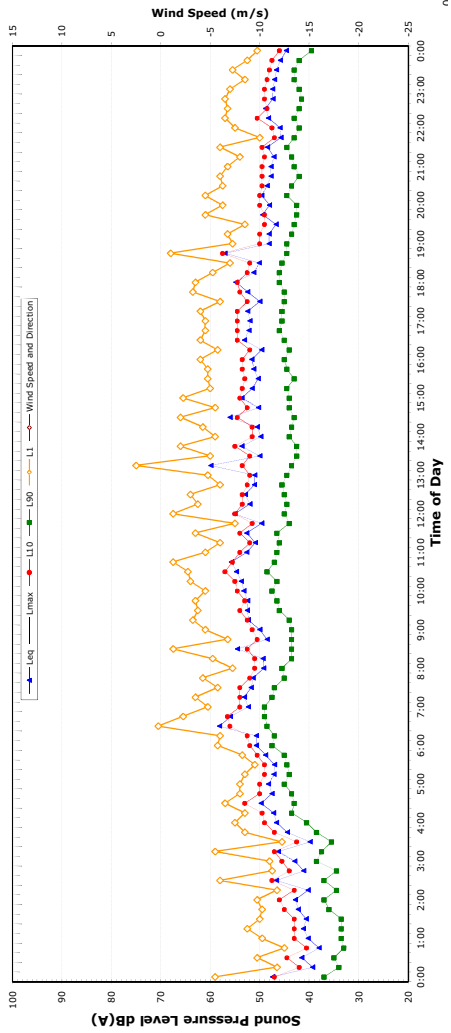
NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53.9	50.8
$L_{eq\ 15\ hr}$ upper 10 percentile	58.3	57.7
$L_{eq\ 1\ hr}$ lower 10 percentile	47.4	42.4

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

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)*

Data File: 20110412 RTA0414.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Thursday, 14 April 2011



NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	43.5	42.0	35.0
Leq (see note 3)	52.8	49.8	46.6

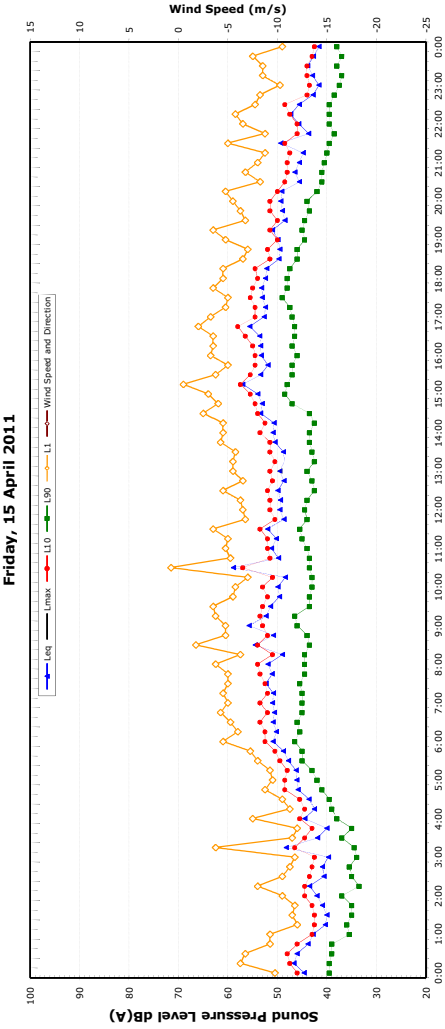
NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	54.7	49.1
$L_{eq\ 15\ hr}$ upper 10 percentile	57.4	53.2
$L_{eq\ 1\ hr}$ lower 10 percentile	50.1	43.4

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

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)*

Data File: 20110412 RTA0414.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Friday, 15 April 2011



NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	43.0	39.5	34.0
Leq (see note 3)	52.5	48.7	45.8

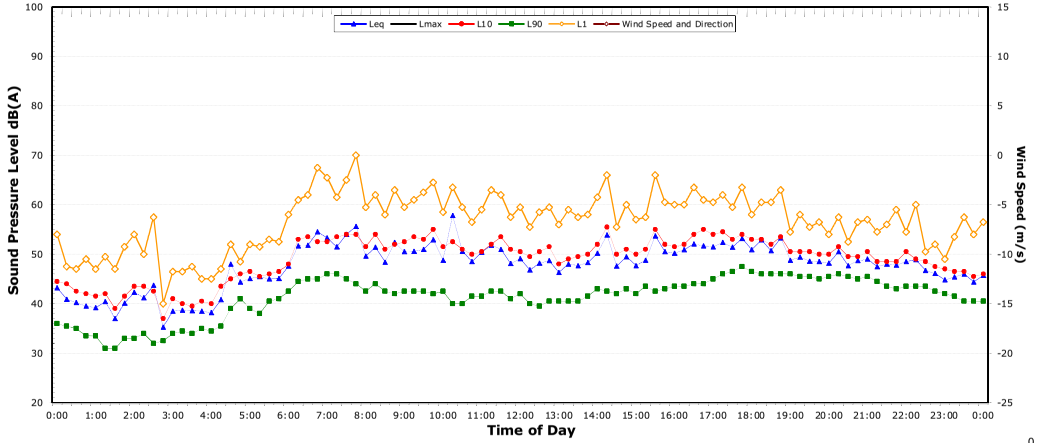
NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	54.2	48.3
$L_{eq\ 15\ hr}$ upper 10 percentile	56.8	55.4
$L_{eq\ 1\ hr}$ lower 10 percentile	49.2	43.3

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

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)*

Data File: 20110412 RTA0414.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Monday, 18 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	40.5	43.5	36.0
Leq (see note 3)	51.3	49.6	46.7

NOTES:

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

2. "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

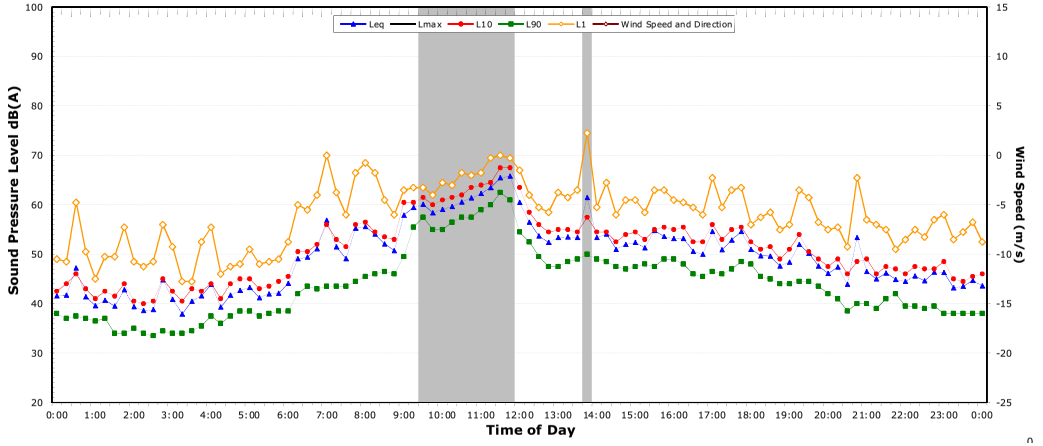
4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53.4	49.2
$L_{eq\ 1hr}$ upper 10 percentile	55.9	54.8
$L_{eq\ 1hr}$ lower 10 percentile	50.3	43.5

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

Data File: 20110412 RTA0414.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Saturday, 16 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	39.0	33.0
Leq (see note 3)	-	48.6	44.6

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

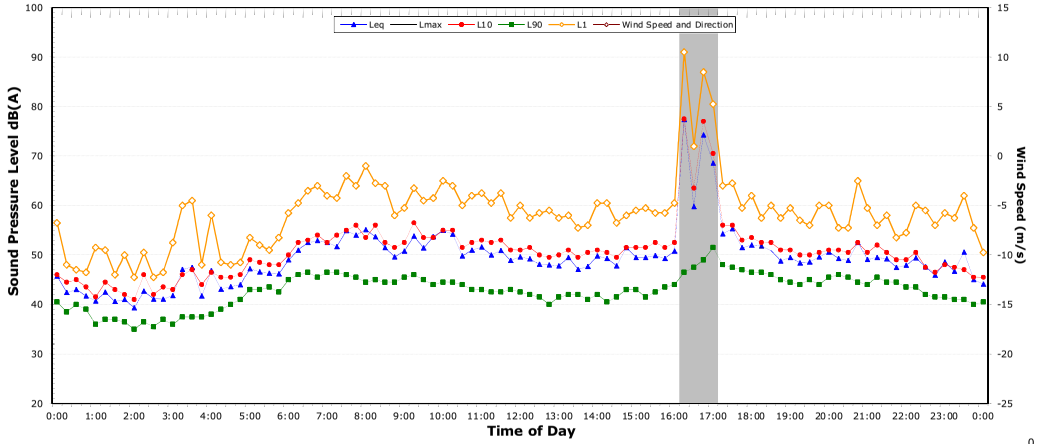
4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	55.6	47.1
$L_{eq\ 1hr}$ upper 10 percentile	62.6	53.5
$L_{eq\ 1hr}$ lower 10 percentile	49.6	42.1

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

Data File: 20110412 RTA0414.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Tuesday, 19 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	41.5	44.0	38.5
Leq (see note 3)	51.6	49.7	47.5

NOTES:

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

2. "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

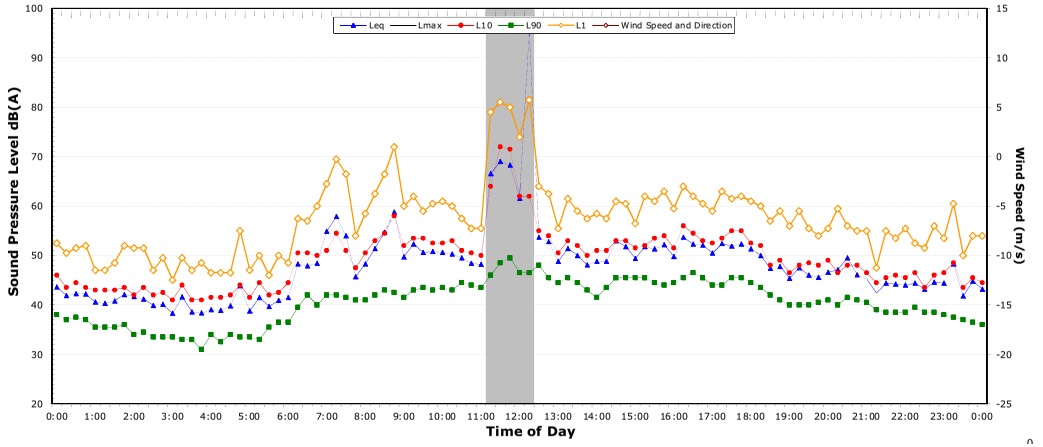
4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53.7	50.0
$L_{eq\ 1hr}$ upper 10 percentile	56.4	56.0
$L_{eq\ 1hr}$ lower 10 percentile	50.9	45.0

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

Data File: 20110412 RTA0414.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Sunday, 17 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	41.5	38.5	32.5
Leq (see note 3)	52.1	46.6	46.2

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

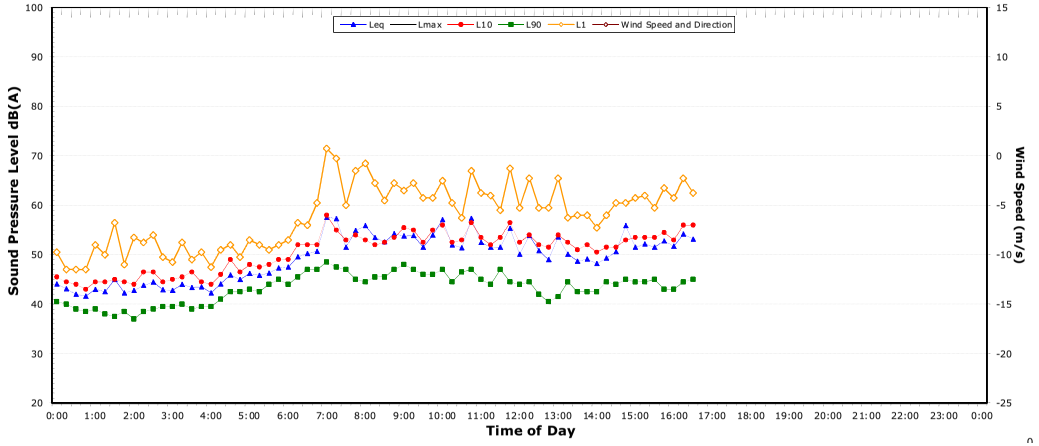
4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53.6	48.7
$L_{eq\ 1hr}$ upper 10 percentile	57.1	55.5
$L_{eq\ 1hr}$ lower 10 percentile	47.6	41.0

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

Data File: 20110412 RTA0414.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L2 - 11 Dobell Road
Wednesday, 20 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	42.5	-	-
Leq (see note 3)	53.3	-	-

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 ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	55.8	-
$L_{eq\ 1hr}$ upper 10 percentile	57.9	-
$L_{eq\ 1\ hr}$ lower 10 percentile	51.6	-

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

Data File: 20110412 RTA0414.xls

Template QTT-01 (rev 67) Logger Graphs

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inspired to achieve

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email: sydney@renzotonin.com.au
website: www.renzotonin.com.au

noise logger results

Location L3 - 11 Waler Place, Blairmount

BACKGROUND & AMBIENT NOISE MONITORING RESULTS
NSW DECCW's 'INDUSTRIAL NOISE POLICY', 2000

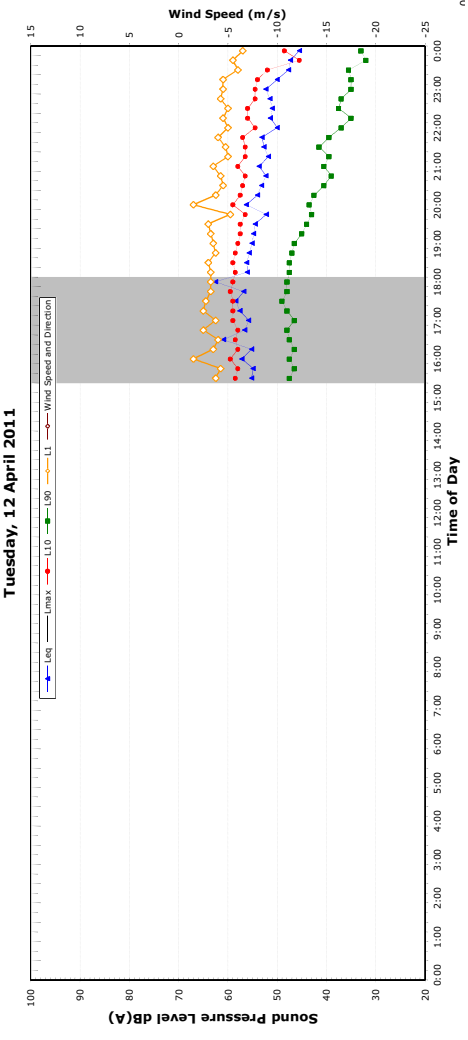
	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
Day	Day	Evening	Night	Day	Evening	Night
Tuesday-12-April-2011	-	39	32	-	52	47
Wednesday-13-April-2011	40	36	34	55	51	48
Thursday-14-April-2011	44	43	35	56	53	48
Friday-15-April-2011	42	39	33	54	51	47
Saturday-16-April-2011	44	38	33	54	50	47
Sunday-17-April-2011	38	38	34	55	50	47
Monday-18-April-2011	41	42	37	57	52	47
Tuesday-19-April-2011	41	44	38	56	53	48
Wednesday-20-April-2011	42	39	34	57	52	47
Thursday-21-April-2011	44	-	-	53	-	-
Representative Level	**42**	**39**	**34**	**55**	**52**	**47**

Notes:
1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Partial day's monitoring
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq

TRAFFIC NOISE MONITORING RESULTS
NSW DECCW 'ENVIRONMENTAL CRITERIA FOR ROAD TRAFFIC NOISE', 1999

	L_{Aeq} Noise Levels			$L_{Aeq\ 1hr}$ Noise Levels		
Day	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Tuesday-12-April-2011	54	50	56	52	55	43
Wednesday-13-April-2011	57	51	63	52	56	43
Thursday-14-April-2011	58	50	62	54	54	43
Friday-15-April-2011	56	49	58	52	53	43
Saturday-16-April-2011	56	50	58	51	55	42
Sunday-17-April-2011	56	49	61	50	55	39
Monday-18-April-2011	58	50	62	53	55	42
Tuesday-19-April-2011	58	51	61	53	55	42
Wednesday-20-April-2011	58	50	62	52	56	43
Thursday-21-April-2011	55	-	56	55	-	-
Representative Weekday	**57**	**50**	**61**	**53**	**55**	**43**
Representative Weekend	**56**	**50**	**60**	**51**	**55**	**41**
Representative Week	**57**	**50**	**61**	**53**	**55**	**42**

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls
Template QTT-01 (rev 67) Logger Graphs



EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Tuesday, 12 April 2011

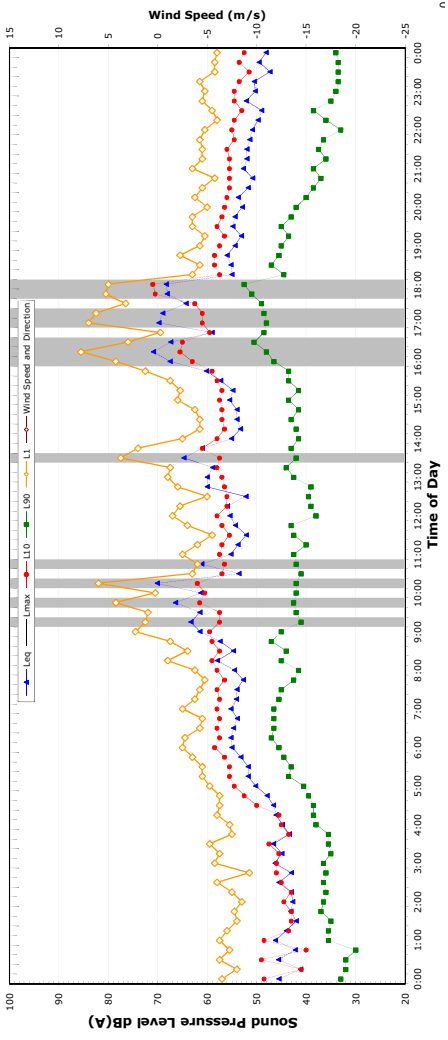
NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	39.0	32.0
Leq (see note 3)	-	51.7	47.4

NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9hr}$	54.2	49.9
$L_{eq\ 15hr}$ upper 10 percentile	55.8	54.8
$L_{eq\ 1hr}$ lower 10 percentile	52.1	43.0

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

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)*

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs



EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Wednesday, 13 April 2011

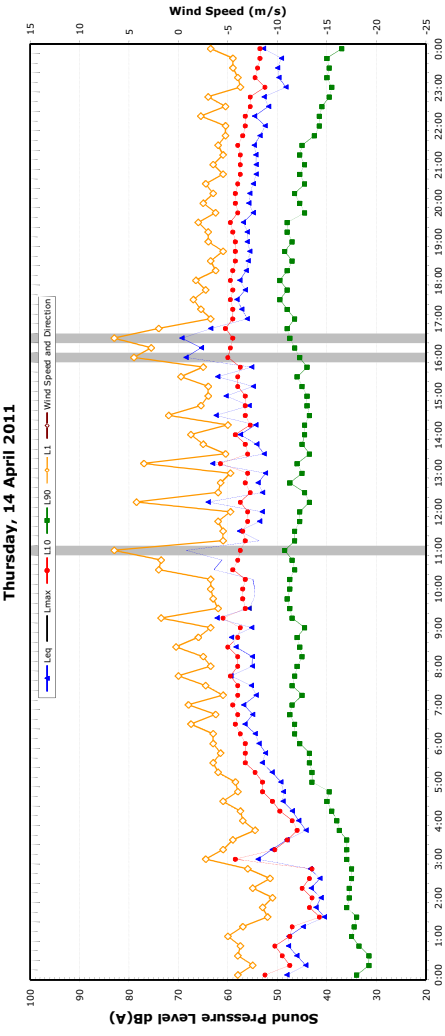
NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	39.5	36.0	33.5
Leq (see note 3)	55.4	51.0	48.1

NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9hr}$	56.8	50.6
$L_{eq\ 15hr}$ upper 10 percentile	63.1	55.8
$L_{eq\ 1hr}$ lower 10 percentile	52.0	42.5

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

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)*

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs



EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Thursday, 14 April 2011

NSW Industrial Noise Policy (Free Field)	Day	Evening	Night[2]
Descriptor	7am-6pm	6pm-10pm	10pm-7am
L_{90}	44.0	42.5	35.0
Leq (see note 3)	56.4	52.7	47.7

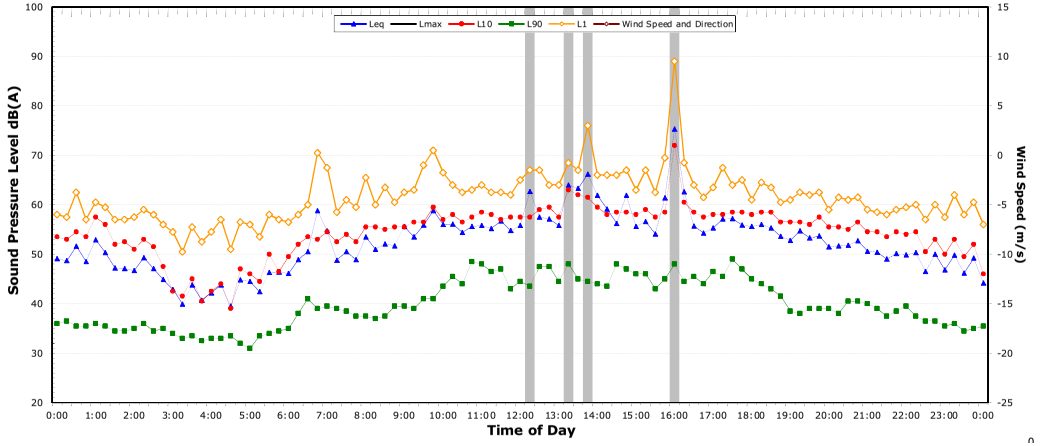
NSW ECRTN Policy (1m from facade) (see note3)	Day	Night[2]
Descriptor	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9hr}$	58.1	50.2
$L_{eq\ 15hr}$ upper 10 percentile	62.1	54.4
$L_{eq\ 1hr}$ lower 10 percentile	54.4	43.0

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

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)*

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Sunday, 17 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	38.0	38.0	33.5
Leq (see note 3)	54.7	50.3	46.7

NOTES:

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

2. "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)

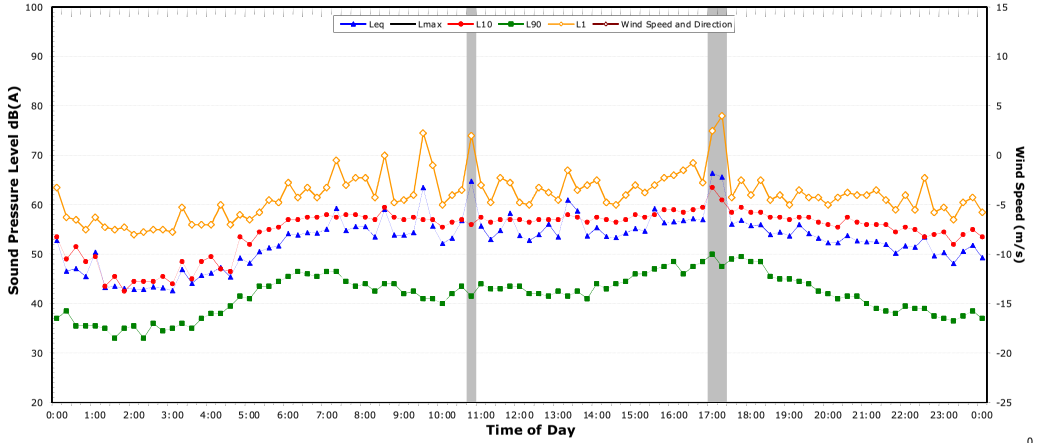
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9\ hr}$	56.3	49.2
$L_{eq\ 1hr}$ upper 10 percentile	61.2	55.5
$L_{eq\ 1hr}$ lower 10 percentile	50.4	38.7

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

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls

EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Friday, 15 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	41.5	38.5	32.5
Leq (see note 3)	54.0	51.0	46.6

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)

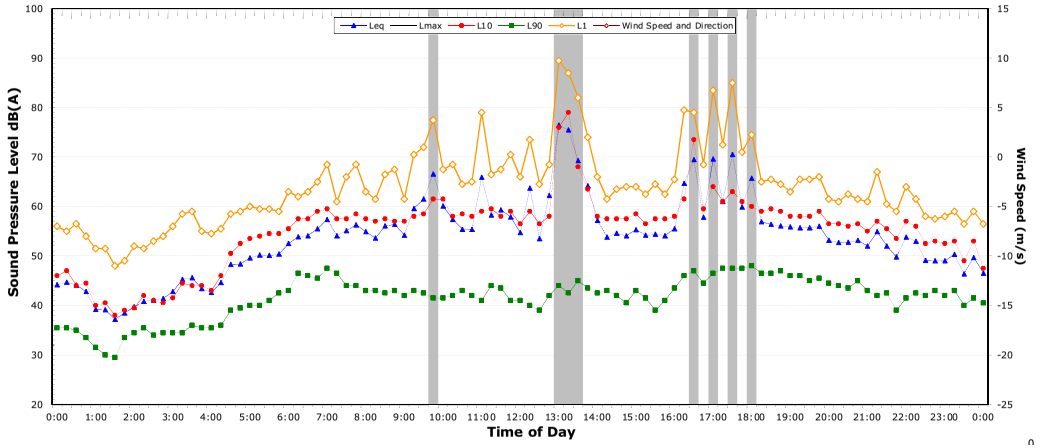
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am- 10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9\ hr}$	55.9	49.1
$L_{eq\ 1hr}$ upper 10 percentile	58.5	52.7
$L_{eq\ 1hr}$ lower 10 percentile	52.3	42.6

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

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls

EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Monday, 18 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	40.5	41.5	37.0
Leq (see note 3)	56.6	52.1	47.5

NOTES:

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

2. "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)

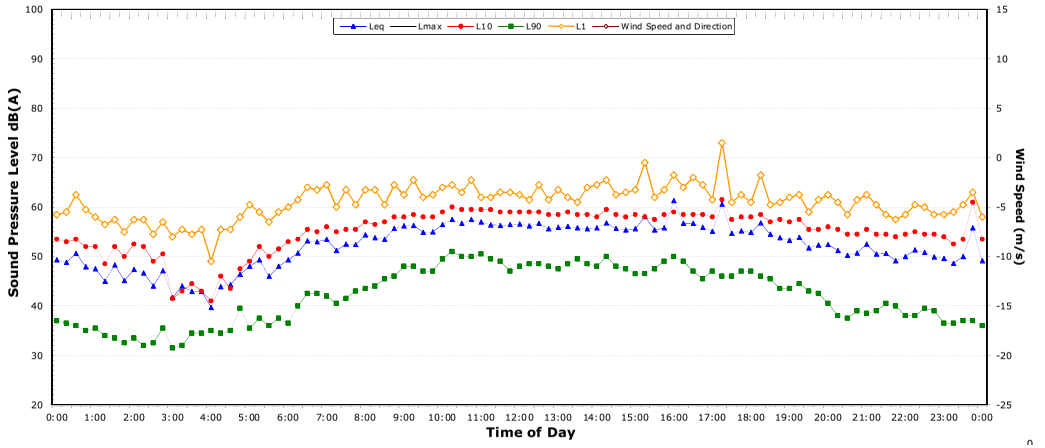
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9\ hr}$	58.1	50.0
$L_{eq\ 1hr}$ upper 10 percentile	62.2	55.1
$L_{eq\ 1hr}$ lower 10 percentile	52.9	42.3

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

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls

EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Saturday, 16 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	44.0	38.0	33.0
Leq (see note 3)	53.7	50.1	47.4

NOTES:

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

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured 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)

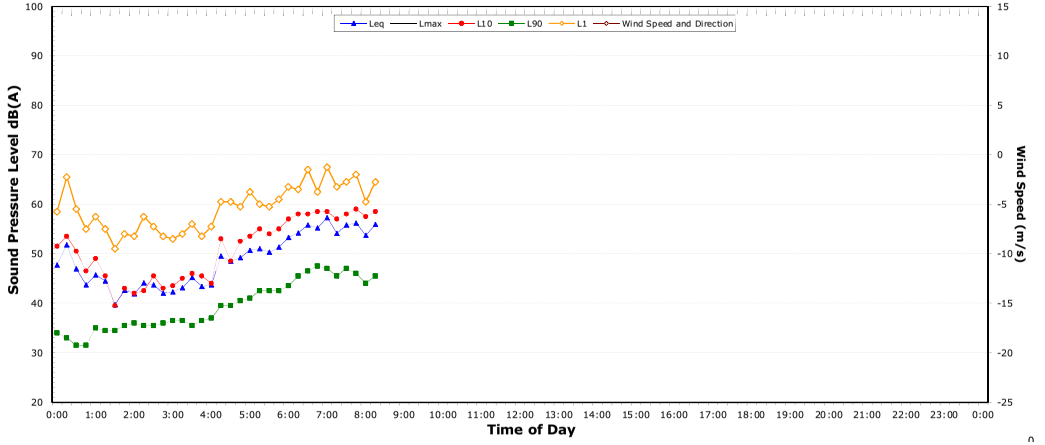
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15hr}$ and $L_{eq\ 9\ hr}$	55.5	49.9
$L_{eq\ 1hr}$ upper 10 percentile	57.8	54.9
$L_{eq\ 1hr}$ lower 10 percentile	50.7	41.9

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

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls

EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Thursday, 21 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	44.0	-	-
Leq (see note 3)	52.8	-	-

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)

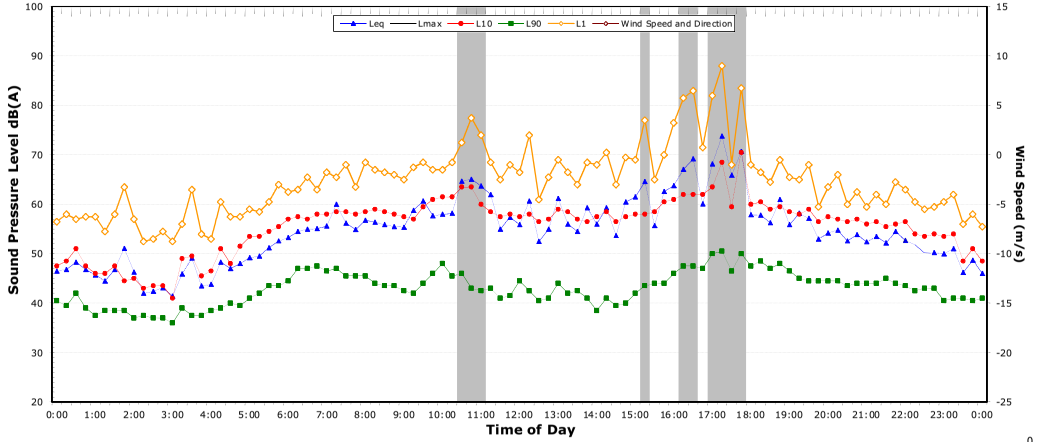
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	55.3	-
$L_{eq\ 1hr}$ upper 10 percentile	55.9	-
$L_{eq\ 1hr}$ lower 10 percentile	55.1	-

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

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls

EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Tuesday, 19 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	40.5	43.5	38.0
Leq (see note 3)	56.2	53.3	48.3

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 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)

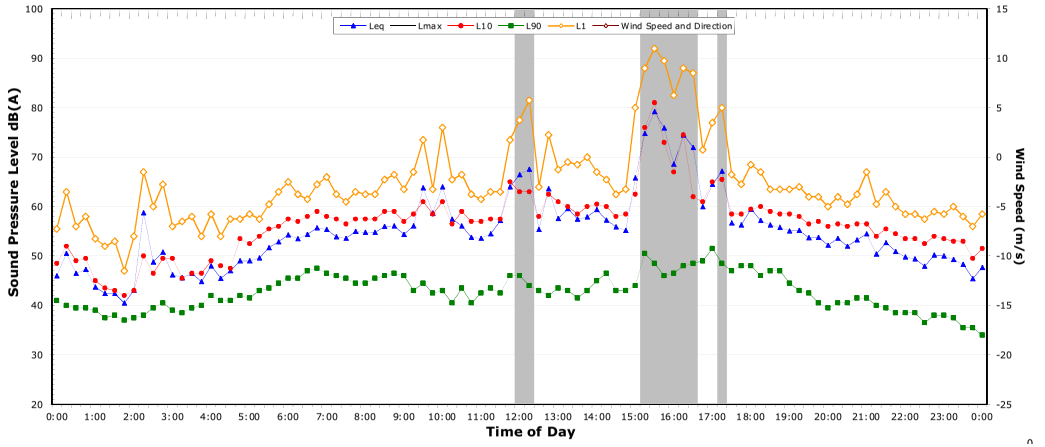
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	58.0	50.8
$L_{eq\ 1hr}$ upper 10 percentile	61.1	54.8
$L_{eq\ 1\ hr}$ lower 10 percentile	53.4	42.2

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

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls

EXISTING AMBIENT NOISE LEVELS
Location L3 - 11 Waler Place, Blairmount
Wednesday, 20 April 2011



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	42.0	38.5	34.0
Leq (see note 3)	56.8	51.5	47.5

NOTES:

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

2. "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 ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	58.3	50.0
$L_{eq\ 1hr}$ upper 10 percentile	62.4	55.8
$L_{eq\ 1\ hr}$ lower 10 percentile	52.2	42.5

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

Data File: 20110412 RTA0404.xls
Template QTT-01 (rev 67) Logger Graphs

TF298-01S02(rev0) 11 Waler Pl, Blairmount.xls

Appendix 5: Road Noise Assessment Methodology

Hume Highway F5

Road traffic noise emission form the Hume Highway F5 has been based upon the noise model prepared for the RTA's widening works for the Year 2021. Permission from the RTA was granted to utilise the noise model for the Claymore site investigations.

The details of the noise modelling were set out in the following;

- Renzo Tonin & Associates Report TD437-02F06 (rev 1) Noise Assessment, dated 19th June 2008
- RTA's 'F5 Freeway (Hume Highway) upgrade – Noise fact sheet' dated February 2010

Of particular note is that the noise modelling was based on the night time period only as it was established to be the most critical assessment period. In regard to noise mitigation measures, a 5m high earth mound or wall is proposed along the Claymore site interface, within the road corridor. No mitigation was proposed in proximity to Glenroy Homestead.

The base noise model has been used for modelling of the F5. Modifications to the model have been made in order to assess mitigation options such as the extension or increase in height of the proposed noise wall/mound.

Badgally Road

Road traffic noise from Badgally Road onto future residential premises within the Claymore Renewal site has been assessed as follows;

- Measurement of existing road traffic noise levels with concurrent traffic counting;
- Use existing traffic noise levels and traffic volumes to validate a noise model;
- Adjust traffic flows for future traffic volumes predicted for Badgally Road;
- Use model to predict traffic noise levels at future residential receivers based upon proposed interface between residential premises and Badgally Road.
- Use model to assess potential noise mitigation measures such as noise barriers.

The relevant information utilised for the assessment is set out below.

Existing Road Traffic Noise Levels - Long-term Monitoring Results

Location	Day $L_{Aeq\ 15\ hour}$	Night $L_{Aeq\ 9\ hour}$
L3 – 11 Waler Pl	57	50

Existing Average Traffic Volumes, Composition and Speed

Badgally Rd Claymore	Period	Total (HV%)	85% Speed	AM Peak Hr (HV%)	PM Peak Hr (HV%)
North Bound	Day	3283 (1.6%)	66.3	123 (3.3%)	395 (0.8%)
	Night	338 (2.4%)	68.1	-	-
South Bound	Day	3785 (2.3%)	65.1	370 (1.6%)	282 (2.1%)
	Night	396 (3.5%)	66.2	-	-
Total	Day	7068 (2.0%)	65.7	493 (2.0%)	677 (1.3%)
	Night	734 (3.0%)	67.1	-	-

Notes: Traffic counts undertaken concurrently with long-term noise level measurements. Carried out to the north of Blairmount School

Peak hour totals are not provided as southbound and northbound peaks occur at different times

.

Future Traffic Levels

Future traffic volumes along Badgally Road for the year 2026 have been sourced from the Oran Park and Turner Road Precinct traffic modelling. The traffic modelling provides AM and PM peak hour volumes only. The AM and PM peaks have been compared to the peak hour volumes presented above to determine the future growth.

Badgally Rd Claymore	Period	Volume	Growth from 2011	Average Growth Two-Way
North Bound	AM	237	193%	193%
	PM	767	194%	
South Bound	AM	878	237%	188%
	PM	390	138%	
Total	AM	1115	226%	199%
	PM	1157	171%	

Source: Maunsell/AECOM 2007, Oran Park and Turner Road Precinct Plan Transport Assessment, 29 August 2007

Noise Prediction Method

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 Environment Protection Authority. The model predicts noise levels for steady flowing traffic and a modified method has been developed which enables an accurate prediction of noise from high truck exhausts to be taken into account.

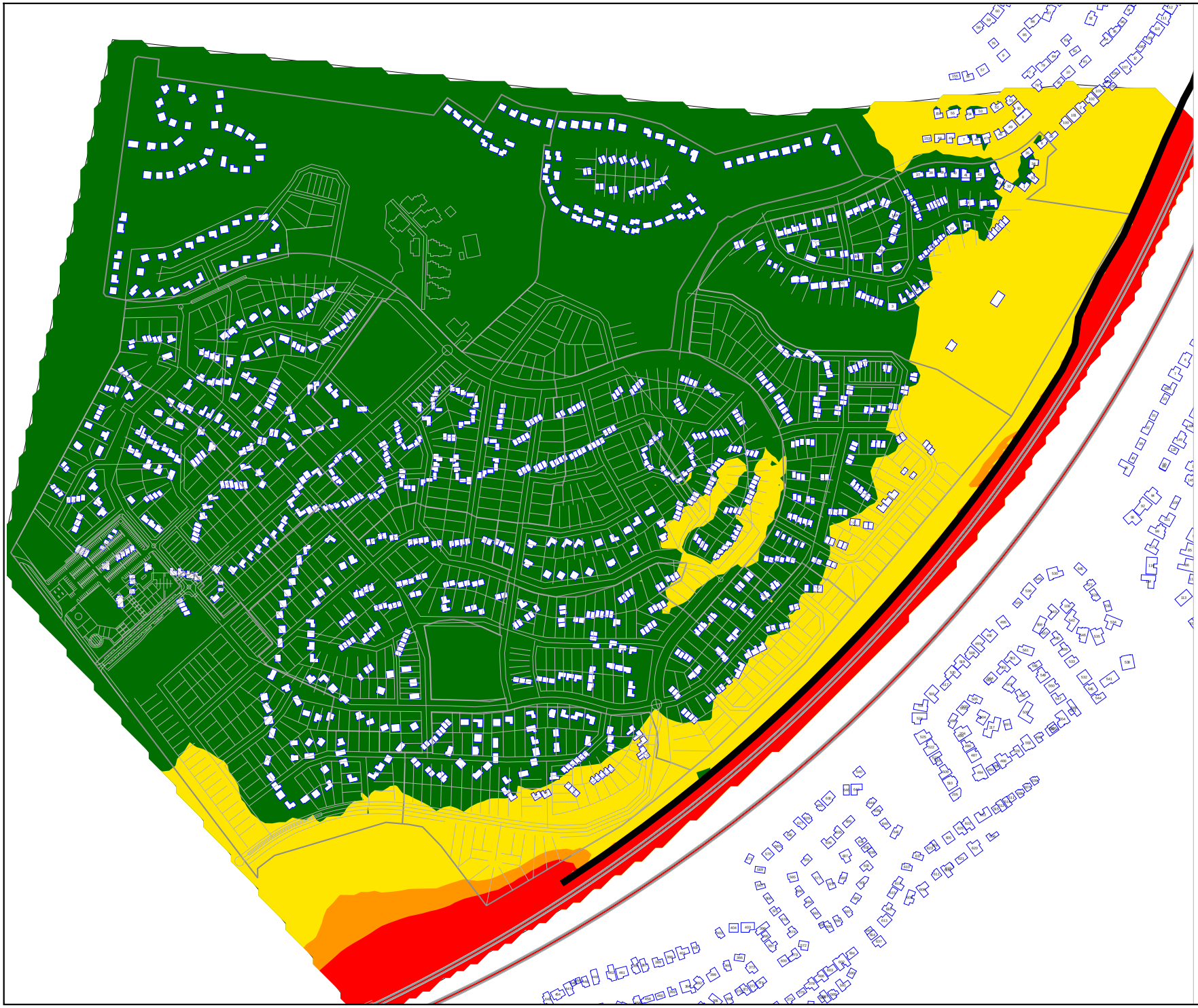
The source noise levels used in this project to model traffic noise levels are contained within the calculation algorithms of the CoRTN88 noise model. Furthermore, the model was verified and calibrated using the long-term noise monitoring results obtained for this project.

The method uses the average 1-hour traffic volume for the 'assessment period' (i.e. day or night) to predict the $L_{10,1hour}$ noise level. A correction of -3dB(A) is applied to obtain the $L_{eq,\ 1\ hour}$ noise level which equates to the L_{Aeq} noise level for the 'assessment period'. So, the noise levels for the time period 7.00am to 10.00pm are determined from the hourly data to derive the daily $L_{eq,15hour}$ noise level. Similarly, the noise levels for the time period 10.00pm to 7.00am are determined from the hourly data to derive the night time $L_{eq,9hour}$ noise level.

The noise prediction model takes into account:

- traffic volume and heavy vehicle forecasts;
- vehicle speed;
- road gradient;
- location of the noise sources on the two carriageways;
- the differing source heights of cars and trucks (3-source heights used);
- ground reference levels of the road and receivers;
- separation distances of the road to receivers;
- ground type between the road and receivers;
- angles of view of the road from the receiver's position;
- attenuation from barriers (natural and purpose built) and cuttings;
- reflections from barriers, cuttings, roadside structures etc;
- corrections for low-noise road pavements (e.g. open-graded asphaltic concrete); and
- corrections for building facade reflections under Australian conditions.

6: F5 Noise Modelling Results



Noise Levels - dB(A)

60.5 <= *Living
57.5 <= < 60.5 *Bedroom
50.0 <= < 57.5
< 50.0 ECRTN

* Areas in which rooms require alternative ventilation & possible envelope upgrade

Legend:
- Road axis
- Emission line
- Mound/Wall
- Existing Dwellings
- Lot Layout

N

Scale: 1:7500
0 37.5 75 150 m

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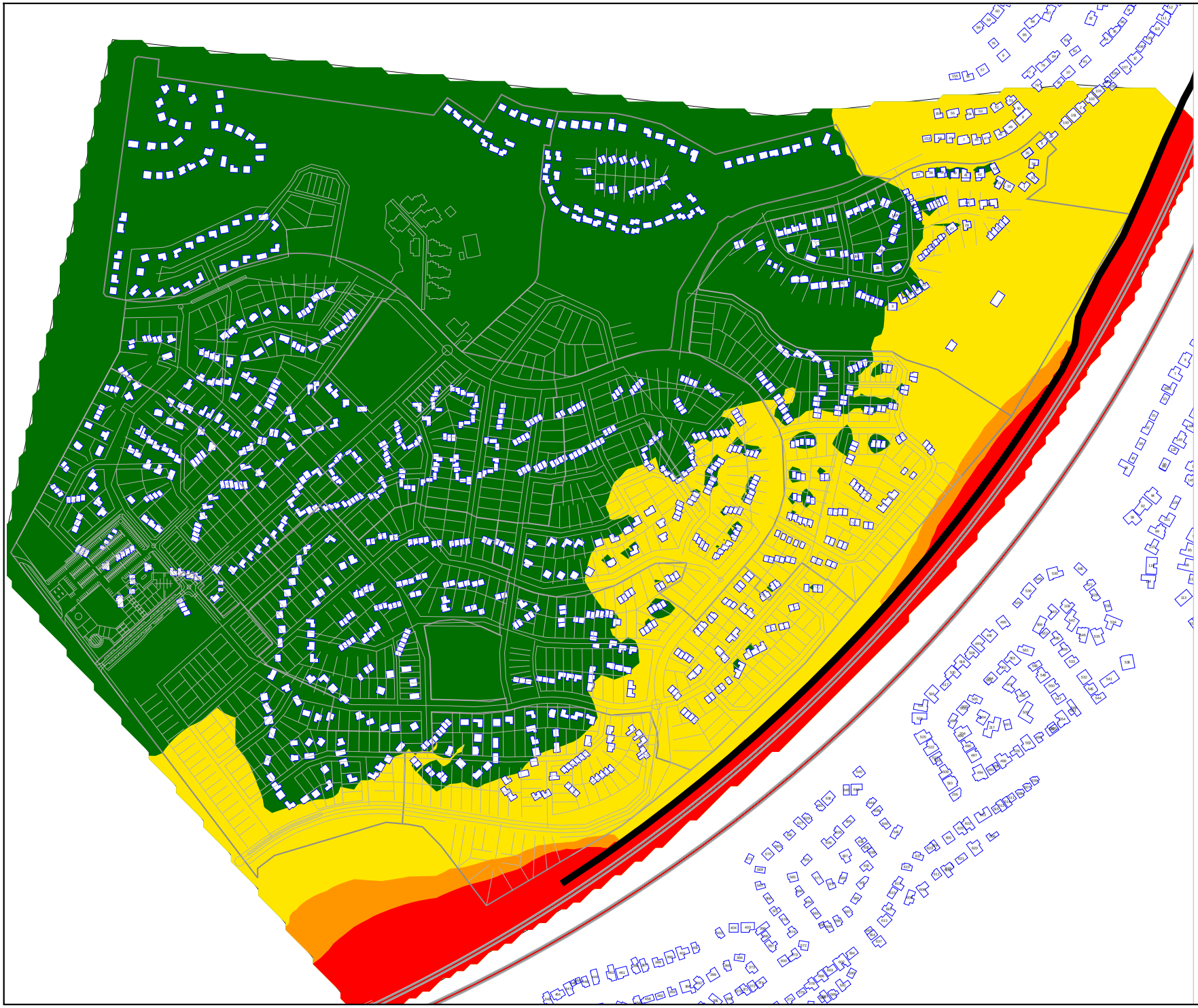
Project:
Claymore Urban Renewal

Description:
LAeq 9hr Night
Grd Floor, 1.5m AGL
Facade Corrected

Date:
11/06/2011

Description:	Figure:	Rev:
TF298-01	P1	2



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Project:
Claymore Urban Renewal

Description:
LAeq 9hr Night
1st Floor, 4.5m AGL
Facade Corrected

Date:
11/06/2011

Description:	Figure:	Rev:
TF298-01	P2	2

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CLAYMORE URBAN RENEWAL

DEMOLITION NOISE AND VIBRATION ASSESSMENT

TF298-01F02 (REV 1) DEMOLITION NOISE AND VIBRATION.DOCX

9 AUGUST 2011

Prepared for:

Landcom

Level 2, 330 Church Street Parramatta NSW 2150

Attention: Michelle Chiu

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DOCUMENT CONTROL

Date	Revision History	Non-Issued Revision	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
08/08/2011	Prepare Draft	0	-	GS	GW	
09/08/2011	First Issue		1	GS	-	GW

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CONTENTS

List of Tables

1 INTRODUCTION

Renzo Tonin & Associates was engaged to provide in-principle acoustical advice for demolition works occurring as part of the Claymore Urban Renewal project. This document covers the demolition for all Stages of the Claymore Renewal site and supplements the acoustic report prepared for the Concept Plan Application [ref: Renzo Tonin & Associates report TF298-01F01 (rev 2)].

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.

This document:

- Identifies the potential sources of noise and vibration during the proposed works;
- Outlines the noise and vibration goals for the proposed works;
- Describes actions and measures which could be implemented to minimise noise emission and vibration in accordance with the relevant guidelines and Standards;

A detailed schedule of plant and equipment and time tabling for the works is not available at this stage and therefore assessment and predictions have not been carried out. Nonetheless given the scale and nature of works, a qualitative assessment is preferred to a quantitative assessment. Based on nature of demolition works and likely equipment to be used during the works, it is likely that potential impacts can be managed using the measures described herein.

Appendix A contains a glossary of acoustic terms used in this noise management plan.

2 DEMOLITION WORKS

2.1 Outline of Works

The demolition works will result in the removal of 952 cottages while retaining 144. It is assumed that the demolition works for the Claymore Urban Renewal project will be carried out in line with the general development Staging Plan, being organised into 12 Stages spanning over an 8 year period.

2.2 Process of Demolition

Based on information received from Housing NSW the process of the demolition of an individual cottage is as follows:

- Asbestos is removed from the cottage and placed in a skip bin. The skip is then removed from site;
- A 22 Tonne excavator 'peels' apart the building including the slab;
- The same excavator then moves the materials of the building into semi-trailer trucks for removal;
- A bob-cat smooths the site and;
- The remainder of the site is hand-raked

Environmental Impact Assessments for past Housing NSW projects indicates that a team of demolition workers will work on up to three houses at one time and each set of three houses is expected to take 1-2 days to demolish. For this project the number of teams working is not yet determined.

2.3 Sensitive Receiver Locations

2.3.1 Retained and Occupied Cottages

Each Stage has a number of retained cottages which are potentially affected if continued to be occupied during the Renewal works. These cottages are spread out across each Stage as are the cottages for demolition. The works move between cottages for demolition as each stage progresses. The movement will mean there will be periods where the works are proximal to retained cottages and periods where there will be a buffer distance between the works and retained cottages.

In addition occupied cottages of adjacent Stages yet to commence, or in the later Stages, redeveloped, have the potential to be impacted during demolition works.

2.3.2 Private Residences Outside Claymore Renewal Area

There are private residential lots bordering the site of several Stages which are also potentially impacted by the demolition works. These are identified as Blairmount to the southeast adjacent Stage 1, Eaglevale to the north east bordering Stages 3a, 3b and 11, and Eaglevale to the north, bordering Stages 9, 10, and 11. It is noted that Blairmount has a greater distance

separation due to Badgally Road, whilst other areas have receptors immediately adjacent dwellings being demolished.

3 NOISE AND VIBRATION GUIDELINES

3.1 Noise Guideline

Construction activities related to the development of the site should be managed and assessed in accordance with the NSW *Interim Construction Noise Guideline*. This document is currently issued as an interim guideline, and is being referred to as the NSW standard policy for assessing construction noise on new projects.

The key components of the ICNG that can be incorporated into this assessment include:

1. Use of L_{Aeq} as the descriptor for measuring and assessing construction noise

In recent years NSW noise policies including DECCW's NSW Industrial Noise Policy (INP) and the NSW Environmental Criteria for Road Traffic Noise (ECRTN) have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor. Consistent with the latest guideline (ICNG) the use of L_{Aeq} as the key descriptor for measuring and assessing construction noise may follow a 'best practice' approach.

2. Application of feasible and reasonable noise mitigation measures

As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints. Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects, including the cost of the measure.

3. Quantitative and qualitative assessment

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment.

A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

A qualitative assessment is recommended for small projects with a short-term duration where works are not likely to affect an individual or sensitive land use for more than three weeks in total. It focuses on minimising noise disturbance through the implementation of feasible and reasonable work practices, and community notification.

Given the significant scale of the construction works proposed for this Project, a quantitative assessment is carried out herein, consistent with the ICNG's requirements.

4. Management Levels

Residences

Table 1 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied. The guideline intends to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints. The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 1 – Noise at Residences Using Quantitative Assessment

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

** 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 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

Commercial and Industrial Premises

The process of defining management levels for commercial and industrial premises is separated into three categories as follow;

- Industrial premises: external $L_{Aeq\ (15\ min)}$ 75 dB(A)
- Offices, retail outlets: external $L_{Aeq\ (15\ min)}$ 70 dB(A)
- Other businesses that may be very sensitive to noise, where the noise level is project specific.

The recommended 'maximum' internal noise levels in AS/NZS 2107:2000 'Acoustics – Recommended design sound levels and reverberation times for building interiors' may be referenced to assist in the determination of relevant noise levels for other noise-sensitive businesses.

3.1.1 Noise Goals

Table 2 below sets out the construction noise goals based on noise monitoring undertaken for the Concept Plan application. It would be recommended that the nearest measurement location to a potential assessment location be used.

Table 2 – Construction Noise Goals, dB(A)

Assessment Location		RBL	Standard Construction Hours		Outside Standard Hours
			Noise Affected	Highly Noise Affected	
L1	2 Carter Place, Claymore	38	48	75	42
L2	11 Dobell Road, Claymore – Guardian Angel Child Care Centre	42	52	75	47
L3	11 Waler Place Blairmount	42	52	75	47

3.2 Construction Vibration Guidelines

3.2.1 Disturbance to Buildings Occupants

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

Vibration sources are defined as Continuous, Impulsive or Intermittent. Section 2 of the technical guideline defines each type of vibration as follows:

> '***Continuous*** *vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).*

Impulsive *vibration is 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.*

Intermittent *vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude.'*

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

'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

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

Table 3 – Preferred & Maximum Weighted rms Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 1-80Hz

Location	Assessment period[1]	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous Vibration					
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					
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

Notes:
1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

Intermittent vibration is assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can

be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline. Preferred and maximum VDV values are defined in Table 2.4 of the guideline and are reproduced below.

Table 4 – Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: *1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am*
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992

3.2.2 Structural Damage to Buildings

Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy. Therefore, reference is made to both the British and German standards below which are relevant to the assessment of structural damage.

3.2.2.1 British Standard

British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration. BS 7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS 7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The levels from the standard are given below in Table 5.

Table 5 – BS 7385 Structural Damage Criteria

Group	Type of Structure	Peak Component Particle Velocity, mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings		50	
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration limits set for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Group 2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Group 1; constant across all frequencies). 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values. These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

3.2.2.2 German Standard

The German standard DIN 4150 – Part 3 – "Structural vibration in buildings – Effects on Structures", also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

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 (e.g. historical with preservation orders etc.), it is 3mm/s. These limits increase as the frequency content of the vibration increases

The limits are presented in Table 6 below and are generally recognised to be conservative.

Table 6 – DIN 4150-3 Structural Damage Limits

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation and at Frequency of			Plane of Floor Uppermost Storey
		Less than 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

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation and at Frequency of			Plane of Floor Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
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 (e.g. buildings under a preservation order)	3	3 to 8	8 to 10	8

4 RECOMMENDATIONS

As the duration for demolition of individual lots is only a few days, extended exposure to both noise and vibration is not expected for nearby sensitive receiver locations. Also as the works are not isolated to a fixed location, it is not considered reasonable to construct any physical noise mitigating barriers or structure to minimise noise emission.

On this basis, the primary focus is to ensure that potential structural damage to nearby dwellings is addressed. In this regard, it is not expected that the plant equipment or activities are particularly vibration intensive; however methods of demolition should have regard to this issue. Management measures and guidance for both noise and vibration management have been provided below.

4.1 General Noise and Vibration Management Measures

Table 7 below outlines a number of techniques and options for managing construction noise and vibration, where considered reasonable and feasible.

Table 7 –Noise and Vibration Management Options

Noise and Vibration Management Options	
Source Controls	
Time constraints	Limit work to within the approved hours. Consider implementing respite periods with low noise/vibration-producing construction activities.
Equipment restrictions	Select low-noise plant and equipment. Ensure equipment has quality mufflers installed.
Emission restrictions	Establish stringent noise emission limits for specified plant and equipment.
Substitute methods	Use quieter and less vibration emitting demolition methods where possible.
Limit equipment on site	Only have necessary equipment on site.
Limit activity duration	Where possible, concentrate noisy activities at one location and move to another as quickly as possible. Any equipment not in use for extended periods during demolition work should be switched off.
Equipment Location	Noisy plant and equipment should be located as far as possible from noise sensitive areas, optimising attenuation effects from topography.
Site access	Vehicle movements outside construction hours, including loading and unloading operations, should be minimised and avoided where possible.
Equipment maintenance	Ensure equipment is well maintained and fitted with adequately maintained silencers which meet the design specifications.
Reduced equipment power	Use only necessary size and power.
Quieter work practices	For example, implement worksite induction training, educating staff on noise sensitive issues and the need to make as little noise as possible. For example loading and unloading of materials shall be done in a manner so as to reduce impact noise from materials being dropped from a height.
Reversing Alarms	Consider alternatives, such as manually adjustable or ambient noise sensitive types ("smart" reversing alarms). Practicality of implementing alternative reversing alarms will be based upon equipment supply. Alternative site management strategies can be developed, in accordance with the *Occupational Health and Safety Plan*, with the concurrence of the Occupational Health and Safety Officer.

Path controls	
Noise Barriers and Enclosures	Whilst construction of temporary barriers and enclosures may be feasible in some areas of the site, the time, cost and noise associated with constructing the temporary barriers is deemed unreasonable given the length of the demolition phase.
Site Access	Select and locate site access roads as far away as possible from noise-sensitive areas.
Receptor Controls	
Structural surveys and vibration monitoring	Pre-construction surveys of the structural integrity of vibration sensitive buildings is recommended for premises immediately adjacent the site and within the critical buffers distances for the vibration generating activities. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
Consultation	Community consultation, information, participation and complaint responses are essential aspects of all demolition noise management programs. They typically involve: A community information program before demolition and/or high risk activities are commenced. This usually involves a leaflet distribution and direct discussions and negotiations with affected residents, explaining the type, time and duration of expected noise emissions. The involvement of affected residents in the development of acceptable noise management strategies. A nominated community liaison officer with a contact telephone number. Timely responses to complaints, providing information on planned actions and progress towards the resolution of concerns. Local residents should be informed by direct mail of a direct telephone line where any noise complaints related to the operation of the demolition activities will be recorded.
Noise / Vibration Monitoring	Noise and vibration monitoring can be undertaken at any identified sensitive receptor location as required.

4.2 Vibration Buffer Distances

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (e.g. dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency content and number of occurrences of a vibration, all play an important role in both the annoyance caused and the strains induced in structures.

As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 8. The safe working distances are quoted for both "cosmetic" damage (refer BS 7385) and human discomfort (refer NSW DEC Assessing Vibration – A Technical Guideline Feb 2006).

Table 8 – Recommended Safe Working Distances for Vibration Generating Plant

Plant Item	Rating / Description	Safe Working Distance		
		Cosmetic Damage		Human Response
		Residential	Heritage	Daytime
Bulldozers/Loaders	-	5m	5m	5m
Silenced Rock Breaker	22 tonne	2m	2m	2m
Jackhammer	-	5m	5m	5m
Rockbreaker	-	5m	10m	5m
Ripper	D10	1m	1m	1m
Pulveriser	30 tonne	4m	4m	4m

Notes: *1. TIDC Construction Noise Strategy (Rail Projects) November 2007.*
2. Renzo Tonin & Associates project files, databases & library.

5 CONCLUSION

Renzo Tonin & Associates have been engaged to provide advice regarding potential noise and vibration impacts of demolition works from the Claymore Urban Renewal site. A review of project plans has been undertaken and the following has been found:

- There is potential for noise and vibration impacts onto nearby residential development, both within the Claymore Renewal Area and surrounding residential areas due to the proximity of demolition works to adjacent dwellings;
- However due to the duration of individual demolition works, it is not considered reasonable to construct any physical noise barriers. Therefore other management strategies, as set out in this report are recommended to be implemented;
- Potential structural damage as a result of vibration intensive activities is however paramount. The equipment and activities however are consider low vibration generating and distances to adjacent dwelling are likely to be safe working

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

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

Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 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.
Lmax	The maximum sound pressure level measured over a given period.
Lmin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L90	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).
Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 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.