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Marsden Park Industrial Precinct

Noise and Vibration Assessment

Document ref AAc/205788/R01

REV A

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Noise and Vibration Assessment

May 2009

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Arup Pty Ltd ABN 18 000 966 165

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Job number 205788

Job title	Marsden Park Industrial Precinct	Job number	205788
Document title	Noise and Vibration Assessment	File reference	
Document ref	AAc/205788/R01		

Revision	Date	Filename	0005Report_NVAssessment_Draft.doc		
Draft 1	04/02/09	Description	First draft		
			Prepared by	Checked by	Approved by
		Name	Lisa Howard	Cameron Hough	Frank Butera
		Signature			
Issue	18/03/09	Filename	0006Report_NVAssessment_Issue.doc		
		Description			
			Prepared by	Checked by	Approved by
		Name	Lisa Howard	Cameron Hough	Frank Butera
		Signature			
Rev A	11/05/09	Filename	0007Report_NVAssessment_Issue.doc		
		Description			
			Prepared by	Checked by	Approved by
		Name	Cameron Hough	Frank Butera	Frank Butera
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

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1 Introduction

The Marsden Park Industrial Precinct is proposed to be developed as part of Sydney's North West Growth Centre. The precinct is located approximately 50 kilometres from the Sydney CBD and falls in the local government area of the City of Blacktown.

The locality is bounded by two major arterial roads: Richmond Road, which runs in a north-south direction; and Garfield Road West, which runs in an east-west direction. A west-bound arterial road connecting Richmond Road to Stony Creek Road is proposed as part of the development. A number of roads, either currently or potentially in the future, connect between these arterial roads. The proposed development will consist of industrial, commercial and residential areas.

This report addresses the noise and vibration impacts on residential areas associated with the proposed new industrial areas and the increase in traffic noise levels. It contains:

- A traffic noise assessment undertaken in accordance with the ECRTN.[1]
- The results of unattended measurements undertaken in November 2008 at five (5) locations along the higher order roads and in other parts of the study area. This was done in order to assess the existing noise environment.
- The description and the results of traffic noise modelling used to predict the noise environment for the future proposed upgrades to the road network.
- Development of strategies required to comply with ECRTN requirements for developments adjacent to the road network.
- Development of strategies required to comply with the Industrial Noise Policy requirements for the residential and industrial areas.
- Advice for the design of housing sound insulation to achieve the recommendations of relevant Australian standards.

Acoustic terminology used throughout this report is presented in Appendix A.

1.1 General Noise and Vibration Impacts from Road Traffic

Noise is a consequence of both the construction and use of roads. Noise from construction and operation is assessed separately, and applicable codes and standards are discussed in Section 4. The following paragraphs describe the key issues and effects.

During construction works, airborne noise is generated by construction equipment such as bulldozers, rock-breakers, compactors and generators. Road traffic generates airborne noise, from the rolling noise of vehicle wheels on the road surface and engine/exhaust noise of vehicles (especially for heavy vehicles such as articulated truck/trailer units).

Airborne noise spreads concentrically from the source, with sound levels reducing progressively with distance. For a source of significant length, such as many vehicles travelling along the same stretch of road, the attenuation of sound with distance is less than for a "point" source such as a stationary vehicle or an item of construction plant.

Some noise sources have particular directivity characteristics, ie the noise is radiated more intensely in certain directions. For example, exhausts from earth moving machinery are often noisier in the direction that the exhaust is pointing. The height of the source above ground level can also be a relevant factor in noise propagation. Elevated sources such as the exhaust of a heavy diesel truck or the hammer of a percussive piling rig may result in a sound propagation path that is less obstructed by topographical features or noise barriers, resulting in higher noise levels at a given distance.

1 *Environmental Criteria for Road Traffic Noise,* NSW DECC (Formerly Environmental Protection Authority), May 1999. Available at http://www.epa.nsw.gov.au/resources/roadnoise1.pdf

Features that block the sound propagation path, such as terrain ridge lines, buildings or noise barriers, result in shielding of noise relative to an uninterrupted path. Care must be taken as large sound reflecting surfaces, such as buildings, can also result in the reflection of additional sound that can adversely impact noise sensitive receivers.

Airborne noise is generally assessed in terms of the external noise level at a receiver position. Internal noise levels within buildings will be lower as a result of the sound insulation provided by the building envelope. The extent of this noise reduction depends on the building construction; with windows open, internal noise levels are typically 10 dB(A) lower than external levels. With windows closed, external levels may be attenuated by 20 dB(A) or more.

Noise and vibration impacts on the community may be categorised as follows, in order of increasing severity:

- Community/resident annoyance
- Disturbance to community/resident activities
- Adverse effects on human health (e.g. increased blood pressure, heart rate or impaired performance due to lack of sleep)

Airborne noise has been known to have other adverse effects, such as sleep disturbance for humans, and effects on wildlife, but less research has concentrated on these impacts, and the evidence demonstrating the extent of the impacts is not clear.

2 Site Description

Marsden Park Industrial Precinct (MPIP) is a major new development and is proposed to be developed over a total land area, under various ownerships, of approximately 550 hectares, generally to the west of Bells Creek and to the north and west of the locality known as Colebee. The core development area of the precinct is roughly rectangular and is approximately 2.5 kilometres from east to west and approximately 2 kilometres from north to south. An additional smaller precinct area to the east is isolated from the rest of the precinct by both Bells Creek and Richmond Road. This eastern area is likely to be primarily used in the future as a “conservation area” and retained in an undeveloped state to provide “environmental offsets” for the future development of other areas, so it will be unlikely to have significant noise generating potential in the future.

The majority of the land in the precinct lies to the west of Richmond Road and is bounded to the south by the “Castlereagh Motorway” road reservation. It is generally bounded to the west by another major land parcel, the “Air Services Australia” land, for which there is no urban development proposal either currently or in the foreseeable future.

The precinct currently contains mainly low intensity rural and rural industrial land uses, former quarries, some commercial/industrial uses located on Richmond Road and the Town and Country Caravan Park (140 Hollinsworth Road) and Ahmadiyya Muslim Association mosque (20 Hollinsworth Road), which are located near the southern edge of the precinct.

Figure 1 presents a small-size site plan of the proposed Marsden Park Industrial Precinct. A large-size site plan is presented in Appendix B.

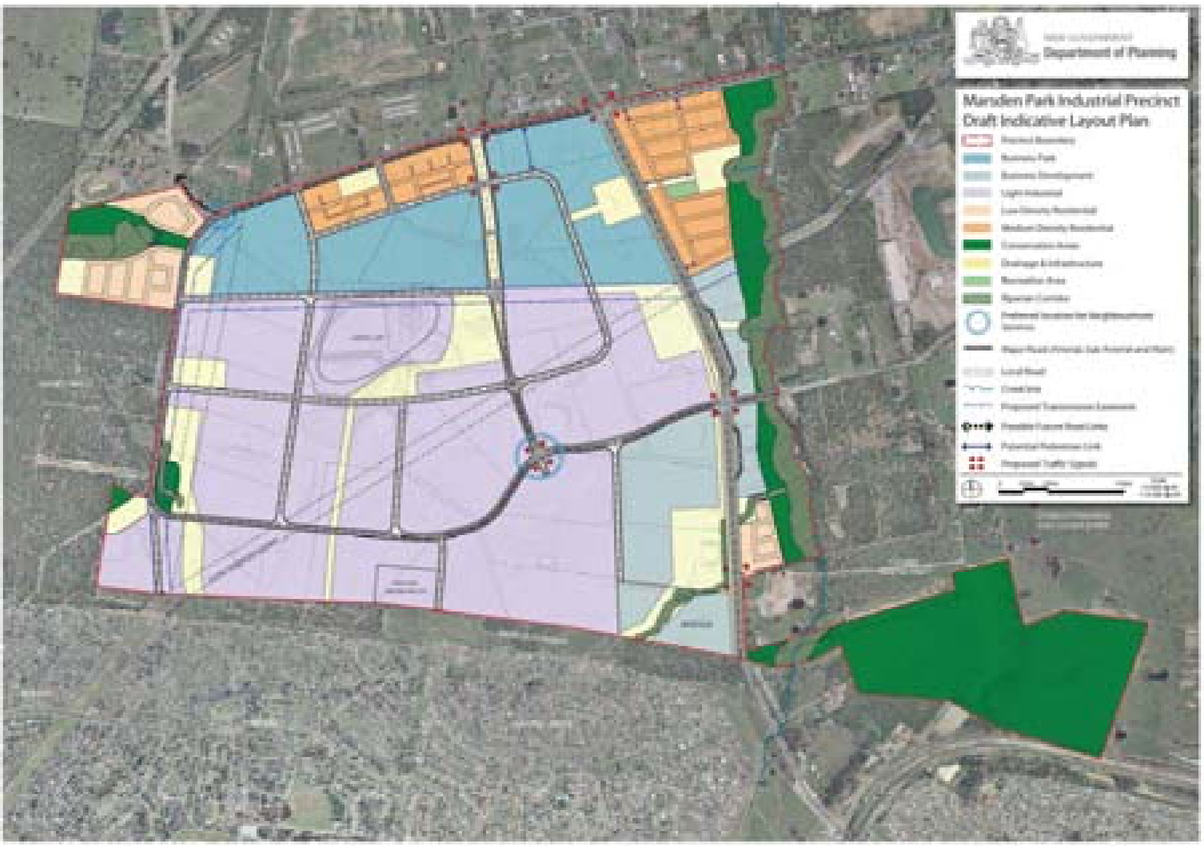

Figure 1 Site Plan of Marsden Park Industrial Precinct

The proposed development of the precinct consists primarily of industrial and commercial land, including possible commercial/business park areas for a future total workforce of up to

10,000 persons, together with a smaller area of residential development (1,500 additional dwellings approximately).

The residential areas are located on Richmond Road and South Street, which form the eastern and northern boundaries of the precinct, and consist of a mixture of low- and medium-density residential zoning. These roads form part of the arterial road network of the proposed MPIP precinct, and are predicted to have future (2036) traffic flows in the range 40,000-90,000 vehicles per day.

3 Existing Noise Environment

3.1 Noise Survey Methodology

Marsden Park Industrial Precinct will consist of a mixture of industrial, commercial and residential properties. The major existing and future noise sources are traffic noise from Richmond Road and noise from industrial premises.

Traffic noise measurements were conducted over a two week period in November 2008. Unattended noise loggers were used to continuously measure noise at five different locations.

The noise loggers and the sound level meter were mounted on tripods 1.5 m above ground level and set to *fast* time response for all measurements. The L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} noise indices were measured in free-field conditions (i.e. away from noise reflecting structures) with a sample period of 15 minutes.

Weather conditions were noted throughout the measurement periods and noise measurements were discarded where weather conditions were not suitable for noise monitoring (ie rain and/or wind speed > 5m/s).

Noise measurements were performed in accordance with Australian Standards AS1055 and AS2702.

3.2 Equipment

The equipment used to measure the baseline noise levels is described in Table 1. The equipment was checked for calibration before and after each set of measurements.

Equipment manufacturer & type	Description of equipment	Serial No.
Brüel & Kjær 2236	Type 1 sound level meter	1778333
Brüel & Kjær 2236	Type 1 sound level meter	2449851
Brüel & Kjær 4231	Sound level calibrator	1790603
RTA Technology Type 01	Environmental noise logger	RTA-01 #082
RTA Technology Type 01	Environmental noise logger	RTA-01 #083
RTA Technology Type 02	Environmental noise logger	RTA-02 #009
RTA Technology Type 02	Environmental noise logger	RTA-02 #035
RTA Technology Type 02	Environmental noise logger	RTA-02 #050

Table 1 Summary of noise measurement equipment

3.3 Measurement Locations

The measurements were undertaken along higher order roads and at other locations within the study area where existing traffic conditions were expected to change. Measurements were undertaken to establish the current traffic noise levels and identify noise sensitive receivers at five noise monitoring positions. These measurement positions and noise sensitive receiver locations are presented in Figure 2 and Table 2 below:

Receiver	Address	Property Description
1	1 Stony Creek Road	Rural Residential
2	Ganian Property	Industrial
3	829-847 Richmond Road	Commercial
4	155 South Street	Residential
5	1032 Richmond Road	Residential

Table 2 Summary of unattended noise measurements positions

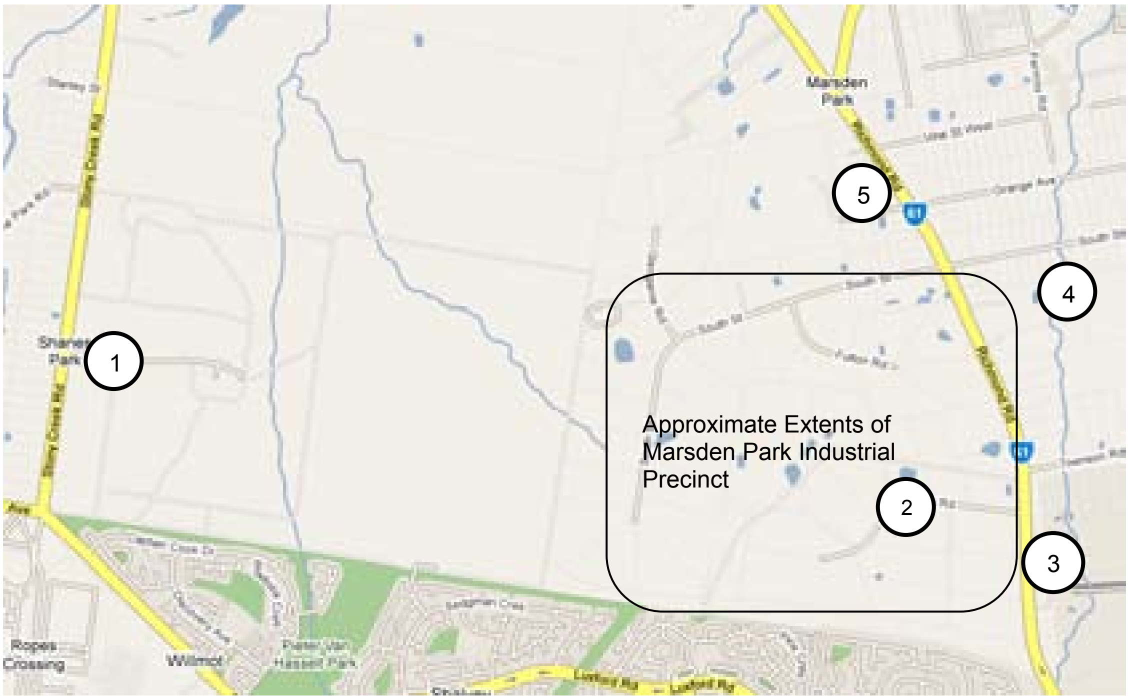

Figure 2 Noise monitoring locations

3.4 Unattended Monitoring Results

Table 3 presents a summary of the noise level statistics measured at each of the locations. Average weekday noise levels from the measured noise levels are presented to show the typical noise environment at each measurement location.

Average L_{A10} and L_{Aeq} noise levels in Table 3 are considered to be representative of the existing traffic noise levels at the measurement position, while the Rating Background Level is defined in the NSW Industrial Noise Policy as a single-number level which can be used to represent the characteristic background noise level at a measurement location.

Logger Address		Rating Background Level (RBL)	L_{Aeq}		L_{A10}
		Day (0700-1800)	15 hr (0700-2200)	9 hr (2200-0700)	18 hr (0600-2400)
1	1 Stony Creek Road	39 dB	61 dB	53 dB	62 dB
2	Ganian Property	43 dB	58 dB	54 dB	58 dB
3	829-847 Richmond Road (Heartbreak Ridge Paintball)	59 dB	71 dB	68 dB	74 dB
4	155 South Street	46 dB	62 dB	54 dB	53 dB
5	1032 Richmond Road	58 dB	69 dB	65 dB	71 dB

Table 3 Average Weekday Noise Level Statistics at Logger Locations, 17 November– 30 November 2008, dB re 20 μPa

Presented in Appendix C are graphs of the average weekday summary of the unattended existing traffic noise measurements at each location. A summary table has also been provided. A copy of the raw data can be provided upon request.

4 Noise Criteria

4.1 Objectives, Criteria and Principles

Criteria for the assessment of noise and vibration impact are generally related to the following noise and vibration characteristics brought about by a scheme:

- Existing noise and vibration exposure
- Anticipated changes in the level or character of ambient noise or vibration.
- The average level of noise and vibration exposure.
- The maximum level of the noise or vibration (e.g. during transient events).
- The duration and time of day at which noise or vibration occurs.

4.2 Policy References

For reference, the criteria adopted in this study are based primarily on the Department of Environment and Climate Change (DECC) Environmental Criteria for Road Traffic Noise (ECRTN) and guidance given in the NSW RTA Environmental Noise Management Manual (ENMM)[2]. The following documents and recognised standards have been used to form the criteria presented in this report:

- Department of Transport Welsh Office, HMSO, *Calculation of Road Traffic Noise* (CoRTN), (1988)
- NSW DECC Environmental Criteria for Road Traffic Noise (ECRTN)
- NSW RTA Environmental Noise Management Manual (ENMM)
- Australian Standard 2702-1983: *Acoustics – Methods for the Measurement of Road Traffic Noise*
- AS3671-1989, *Acoustics - Road traffic noise intrusion - Building siting and construction*
- AS2107-2000, *Acoustics - Recommended design sound levels and reverberation times for building interiors*
- The NSW Department of Environment and Climate Change, *Draft Construction Noise Guideline* (2008)
- The NSW Department of Environment and Climate Change, *Industrial Noise Policy* (INP) (2000).

4.3 Road Traffic Noise Criteria

The basic noise criteria are given in the ECRTN. The noise criteria are measured at the façade of the building at a height of 1.5 m and the applicable criteria are listed below in Table 4.

In addition, the ECRTN provides specific criteria for cases with ‘sensitive land use’, where a more stringent criterion is required, as shown in Table 5,

It should be noted that the road traffic noise criteria are provided as guidelines and are “non-mandatory”. They provide target noise levels that it is desired to meet where it is *feasible and reasonable* to do so. The policy document states that in some instances this may be achievable only through “long-term strategies such as improved planning; design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage”.

2 *Environmental Noise Management Manual*, Roads and Traffic Authority, December 2001, available at http://www.rta.nsw.gov.au/environment/downloads/noiseindex_dl1.html

In particular, Practice Note IV of the ENMM provides detailed guidance on “selecting and designing ‘feasible and reasonable’ treatment options for road ‘acute’ traffic noise”. This practice note also suggests that noise mitigation should be provided if noise levels are *acute*, i.e. greater than or equal to 65 $dBL_{Aeq,15hr}$ (daytime) and 60 $dBL_{Aeq,9hr}$ (night-time), regardless of whether noise levels increase due to the development.

In some cases the existing traffic noise levels may already be above the ECRTN targets. The ECRTN provides allowances for a small increase (no more than 2 dB(A)) over the existing noise levels where it is not “feasible and reasonable” for the development to achieve the noise targets. In this case, the primary noise objective for any proposal is, as a minimum, to contain any increases in noise impact to within the ECRTN allowances.

For new freeways or arterial roads, such as New Shanes Park Road, which is proposed to extend west from the Marsden Park Industrial Precinct to join Stony Creek Road at Shanes Park, this allowance is reduced to 0.5 dB(A) – i.e. if existing noise levels exceed the ECRTN criteria, the new road should not increase existing noise levels by more than 0.5 dB(A).

The types of roads and the relevant criteria that will be affected by the Marsden Park Industrial Precinct are presented in Table 4 below. The ECRTN groups arterial roads and sub-arterial roads together as freeway/arterial roads.

Type of Development	Noise Criterion Day (7 am – 10 pm)	Noise Criterion Night (10 pm – 7 am)
1. New freeway or arterial road corridor	55 dB $L_{Aeq(15hr)}$	50 dB $L_{Aeq(9hr)}$
2. New residential developments affected by freeway/arterial traffic noise	55 dB $L_{Aeq(15hr)}$	50 dB $L_{Aeq(9hr)}$
3. Redevelopment of existing freeway/arterial road	60 dB $L_{Aeq(15hr)}$	55 dB $L_{Aeq(9hr)}$
4. New collector road corridor	60 dB $L_{Aeq(1hr)}$	55 dB $L_{Aeq(1hr)}$
5. New residential developments affected by collector traffic noise	60 dB $L_{Aeq(1hr)}$	55 dB $L_{Aeq(1hr)}$
9. New local road corridor in a metropolitan area	55 dB $L_{Aeq(1hr)}$	50 dB $L_{Aeq(1hr)}$
11. New residential developments affected by traffic noise from local roads	55 dB $L_{Aeq(1hr)}$	50 dB $L_{Aeq(1hr)}$

Table 4: ECRTN Criteria for Residential Receivers.

Arup Transport Planning has advised that roads within the precinct would be characterised as local, collector or arterial roads based on the traffic volumes:

- Local roads have 3,000 vehicles per day (or less)
- Collector roads have between 3,000 and 10,000 vehicles per day
- Sub-Arterial/Arterial Roads have greater than 10,000 vehicles per day.

Therefore, based on the design traffic volumes for a road within the precinct, the appropriate noise criteria can be determined from Table 4. The proposed residential areas within the precinct are generally located on arterial roads, although some areas have frontage onto collector or local roads.

The ECRTN noise criteria apply for the façade exposed to each road – e.g. for the medium density residential zone located on the north boundary of the precinct the northern façade would be assessed using Category 2 (new developments exposed to noise from freeway/arterial), while the southern façades of this zone (exposed to noise from local roads) would be assessed using Category 11.

Sensitive Land Use	Noise Criterion Day (7 am – 10 pm)	Noise Criterion Night (10 pm – 7 am)
1. Proposed school classrooms	40 $L_{Aeq(1hr)}$ (internal)	N/A
3. Places of worship	40 $L_{Aeq(1hr)}$ (internal)	40 $L_{Aeq(1hr)}$ (internal)
4. Active recreation areas	Collector and local roads: 60 $L_{Aeq(1hr)}$ Freeway/arterial roads: 60 $L_{Aeq(15hr)}$	N/A
5. Passive recreation and school playgrounds	Collector and local roads: 55 $L_{Aeq(1hr)}$ Freeway/arterial roads: 55 $L_{Aeq(15hr)}$	N/A

Table 5 Basic noise level criteria for sensitive land uses

Similarly as for residential developments, where existing traffic noise levels exceed these targets, and where it is not "feasible and reasonable" to comply with the targets, an increase of the targets by a small allowance (0.5 dB(A) for new roads; 2 dB(A) for redeveloped roads or land use developments) is allowable.

4.4 Industrial Noise Criteria

Noise from the proposed industrial and commercial areas within the precinct will need to be controlled so that the acoustic amenity of surrounding noise-sensitive land uses is not adversely affected. New industrial/commercial developments should be designed to comply with the appropriate environmental noise criteria.

The current New South Wales environmental noise policy relating to industrial noise is the *New South Wales Department of Environment and Climate Change*, *Industrial Noise Policy* (INP), dated January 2000. Noise emission from plant and equipment on the subject site is required to comply with the noise limits assessed in accordance with the INP.

The objective of the INP is to protect residential areas from noise generated by commercial, industrial or trade premises. Noise limits are set based on land use in the area and existing background noise levels. Compliance is achieved if the adjusted L_{eq} noise level at any residence affected by noise from the facility is below the noise limit. The adjusted L_{eq} is determined by applying corrections for such noise characteristics as duration, intermittency, tonality, and impulsiveness.

The assessment of noise emission under INP is based on the calculation of a noise limit at a receiver position, taking into account the land-use in the surrounding area and the background noise level.

The INP separates the day into three different time periods – day, evening and night. These time periods are detailed in Table 6 below.

Period	Day of Week	Time period
Day	Monday-Saturday	0700-1800hrs
	Sunday, Public Holidays	0800-1800hrs
Evening	Monday-Sunday	1800-2200hrs
Night	Monday-Saturday	2200-0700hrs
	Sunday, Public Holidays	2200-0800hrs

Table 6 Industrial Noise Policy Time Periods

The INP provides guidance on acceptable noise levels from the introduction of new industrial noise sources to an area. The assessment procedure for industrial noise sources has two components:

- Controlling intrusive noise impacts in the short term for residences.
- Maintaining overall noise level amenity for particular land uses such as residences

Both of these components result in noise criteria that should not be exceeded in order to avoid any adverse noise impacts on the affected areas. Both criteria should be taken into account when assessing the noise impact of industrial source(s) associated with the proposed development, and where the intrusiveness and the amenity criterion differ, the lower of the noise criteria is generally adopted as the project-specific noise criterion, although in some circumstances it is necessary to specify both criteria as the project-specific criteria.

Unattended noise measurements from Loggers 2, 3 and 4 were used to derive the INP criteria for Marsden Park Industrial Precinct, since these loggers were located in the general vicinity of the residential areas of the MPIP.

Logger 2 is considered most characteristic of the noise environment for the residential areas located on the northern boundary of the site (along South Street west of Richmond Road).

Logger 3 is considered representative of the existing noise environment for the residential area located on Richmond Road at the south-east corner of MPIP (south of Townson Road),

Logger 4 is considered representative of the existing noise environment for the residential area located at the north-east corner of MPIP (bounded by South Street east of Richmond Road and by Richmond Road itself).

4.4.1 Intrusiveness Criterion

The intrusiveness criterion only applies at residential noise-sensitive receivers. A 15-minute sampling period is typically used when measuring the level of intrusive noise. This is taken to be a reasonable estimate of the period over which annoyance may occur. Therefore the intrusiveness criterion is summarised as follows:

$$L_{Aeq\ (15\ min)} \leq L_{A90\ (15\ min)} \text{ background Level} + 5 \text{ dB}$$

Because of the variable nature of background noise levels, the INP specifies single number background noise levels for use in setting the intrusiveness noise criterion. The Assessment Background Level (ABL) for each time period of a day is the level exceeded by 90 % of the $L_{A90,15min}$ measurements during that time period. The Rating Background Level (RBL) for a particular time period is the median of the ABL values for that time period for each day of the measurement period.

Industrial noise from the subject development should be controlled to not exceed the Rating Background Level (RBL) + 5 dB at the boundary of any noise sensitive receiver.

Intrusive noise criteria for the noise sensitive receivers for Marsden Park Industrial Precinct are presented in Table 7.

Location	Time Period	RBL dB(A)	Intrusiveness Criterion RBL + 5 dB(A)
Logger 2 (Ganian Property)	Day	44	49
	Evening	41	46
	Night	35	40
Logger 3 (829-847 Richmond Road)	Day	60	65
	Evening	50	55
	Night	38	43
Logger 4 (155 South Street)	Day	49	54
	Evening	46	51
	Night	37	42

Table 7 Intrusive Noise Criteria, Noise Sensitive Receivers.

4.4.2 Amenity Criterion

Criteria for the protection of amenity are given for various types of receiver and different times of the day. The amenity criterion is set so that the L_{Aeq} noise level from the industrial noise source does not increase the total industrial noise levels at the receiver above the acceptable noise level (ANL) for that receiver.

The amenity criterion is set based on how close the existing average L_{Aeq} industrial noise levels are to the ANL, using the adjustment factors given in Table 2.2 of the INP.

In cases where the existing $L_{Aeq,average}$ noise levels exceed the ANL by more than 2 dB(A), and the existing noise levels are unlikely to decrease in future, then the amenity criterion is set to be 10 dB(A) lower than the existing noise levels at the receiver.

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60	**65**
		Evening	55	**60**
		Night	50	**55**
School Classroom	All	Noisiest 1 hour period	35	**40**
Places of worship- internal	All	When in use	40	**45**
Active recreation area	All	When in use	55	**60**
Commercial premises	All	When in use	65	**70**
Industrial premises	All	When in use	70	**75**

Table 8 Acceptable Noise Levels (ANL) for Various Land Uses, as stated in Table 2.1 Industrial Noise Policy

The general noise environment surrounding the Marsden Park Industrial Precinct area is generally considered to be suburban (characterised by intermittent traffic noise); however areas close to Richmond Road currently experience through traffic with "characteristically heavy and continuous traffic flows in peak periods', which is a characteristic of an "urban" noise environment as defined in the INP.

Given that the proposed residential areas of the precinct are to be located close arterial roads (including Richmond Road itself), it is considered appropriate to characterise these areas as being "urban" noise amenity areas.

Industrial noise was not clearly audible at any of the logger locations for this study; this is likely to be due to the high traffic noise levels measured at some logger locations. However the presence of industrial land uses in the area indicates that there is some existing noise exposure, but it is likely masked by the traffic noise levels.

In cases where the existing levels of transportation noise may mask industrial noise, the INP allows for the amenity criterion to be modified based on the measured traffic noise levels. Where the measured existing traffic noise level is 10 dB or more above the ANL for the area, the amenity criterion becomes the measured traffic noise level minus 10 dB.

For Logger 3 (829-847 Richmond Road), the measured traffic noise levels were more than 10 dB above the ANL for an urban area for the day, evening and night time periods. Therefore, the amenity criterion for this receiver becomes the measured traffic noise levels minus 10 dB.

For Loggers 2 and 4, the existing noise level from industry was taken to be equal to the measured L_{A90} value (i.e. the same as the rating background level). This is since industrial noise was not audible at the logger locations and therefore the existing industrial noise levels at these loggers is at most the same as the background noise level.

Table 9 presents the derived amenity criteria for residential receivers in the MPIP.

Logger	Time period	Average L_{eq}, dB(A)	Acceptable Noise Level, ANL L_{eq}, dB(A)	Modification to ANL*	Amenity Criterion Existing L_{Aeq} + modification of ANL (L_{eq},dB(A))
Logger 2 (Ganian Property)	Day	<46	60	0 dB	**60**
	Evening	<43	55	0 dB	**55**
	Night	<35	50	0 dB	**50**
Logger 3 (829-847 Richmond Road)	Day	71**	60	$L_{Aeq,traffic}$ – 10 dB	**61**
	Evening	68**	55	$L_{Aeq,traffic}$ – 10 dB	**58**
	Night	67**	50	$L_{Aeq,traffic}$ – 10 dB	**57**
Logger 4 (155 South Street)	Day	<46	60	0 dB	**60**
	Evening	<43	55	0 dB	**55**
	Night	<35	50	0 dB	**50**

* According to Table 2.2 (NSW Industrial Noise Policy, 2000)

** Measured traffic noise level

Table 9: Noise Amenity Criteria, Noise Sensitive Receivers

4.4.3 Applicable Criteria

The most stringent of the intrusiveness and the amenity criteria shall be the limiting criterion and sets the project specific noise level to be met by the proposed development.

Table 10 compares the intrusiveness and the amenity criteria at the closest residential and commercial Noise Sensitive Receivers, and identifies the limiting criterion for each time period.

Logger	Time Period	Intrusiveness Criterion	Amenity Criterion	Limiting Criterion
Logger 2 (Ganian Property)	Day	49	60	**49**
	Evening	46	55	**46**
	Night	40	50	**40**
Logger 3 (829-847 Richmond Road)	Day	65	61	**61**
	Evening	55	58	**55**
	Night	43	57	**43**
Logger 4 (155 South Street)	Day	54	60	**54**
	Evening	51	55	**51**
	Night	42	50	**42**

Table 10 Project Specific Noise Criteria, dB L_{Aeq}

The intrusiveness criterion is generally the lowest for the day, evening and night-time periods for each receiver. This is as expected, considering that existing industrial noise was not audible at the logger locations.

The most stringent of the intrusiveness and amenity criteria forms the limiting noise criterion for industrial noise from industrial/commercial developments located in the Marsden Park Industrial Precinct.

4.5 Australian Standard 3671-1989

AS3671[3] recommends that satisfactory indoor sound levels should be determined from AS2107[4]. For houses and apartments near major and roads, AS2107 recommends the indoor sound levels detailed in Table 11.

Type of space	Recommended noise level for houses and apartments near minor roads	Recommended noise level for houses and apartments near major roads
Sleeping areas	30-35dBA	30-40dBA
Living areas	30-40dBA	35-45dBA
Common areas	45-55dBA	45-55dBA

Table 11 Recommended indoor sound levels: AS2107-2000

3 Australian Standard 3671-1989 Acoustics: Road traffic noise intrusion – Building, Siting and Construction.

4 Australian Standard 2107[4]-2000 entitled *Acoustics: Recommended Design Sound Levels and Reverberation Times for Building Interiors*

5 Community Effects

5.1 Annoyance

The effect of environmental noise on communities is often quantified in terms of the proportion of the community that considers the noise to be highly annoying. Figure 3 shows the relationship between noise level and community annoyance determined by a synthesis of over 50 annoyance studies from all over the world undertaken by the Netherlands' Organisation for Applied Scientific Research (TNO).

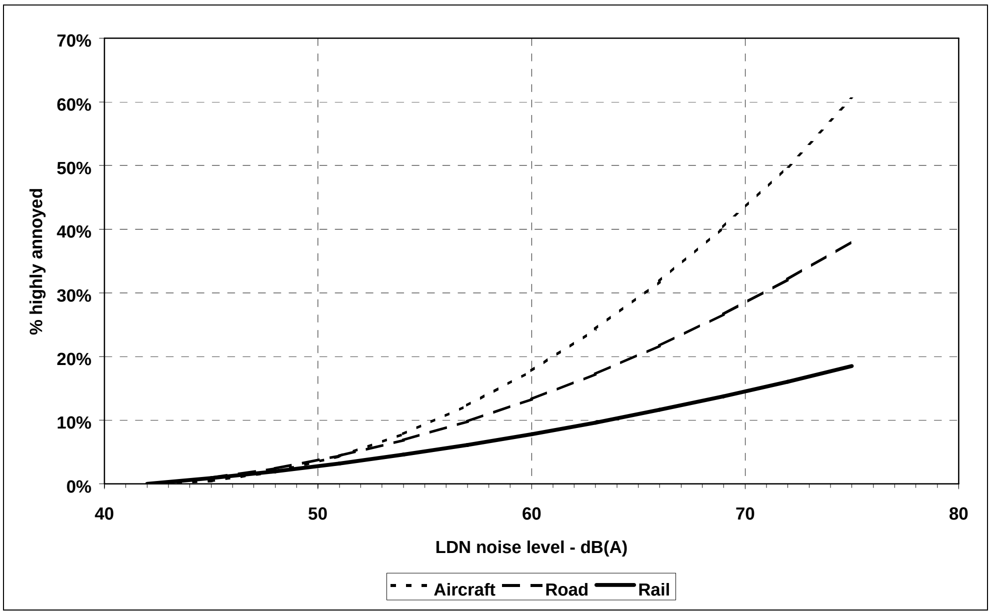

Figure 3 Relationship between average noise level and community annoyance

Day/night equivalent sound level is a rating based on L_{eq}, where the energy is averaged over 24 hours and the noise level in the night time period is penalised by the addition of 10 dB(A).

It is generally considered that the TNO relationship applies to situations in which the community has not recently been exposed to relatively sudden changes in noise exposure. This type of exposure is often referred to as steady-state noise exposure.

When communities are exposed to relatively sudden changes in noise exposure that are associated with particular developments such as the construction of high order roads, community response will generally be much greater than would be predicted by the TNO curves. Figure 4 shows the relationship determined by an analysis of 14 studies of community response to changes in traffic noise exposure. Note that the change in community annoyance has been related not to the change in noise level, but to the change in traffic volume.

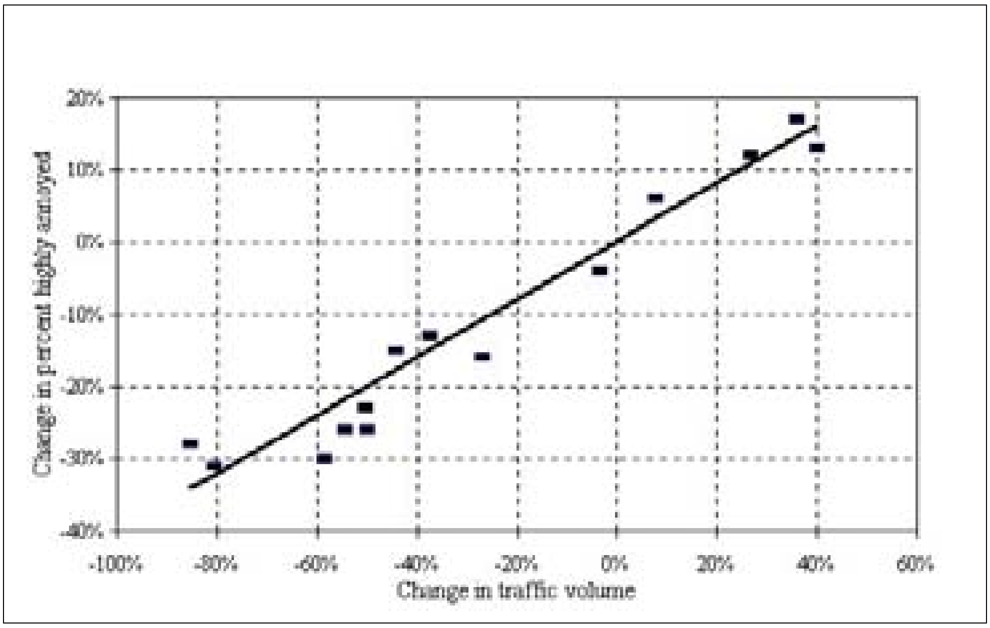

Figure 4 Community annoyance and traffic volume

This type of community response to changes in noise exposure is sometimes referred to as short term response but studies have shown the effect to be extremely long lived amongst people resident at the time of the change, taking up to 20 years to return to steady-state annoyance levels.

5.2 Annoyance and Heavy Vehicle Movements

There is much anecdotal evidence that noise from heavy vehicles is a significant aspect of the noise environment near major transport routes. It is common for complaints about road traffic noise to include references to heavy vehicle noise especially when such vehicles travel at night.

Noise from engine and exhaust brakes can also be a source of annoyance. An extensive and detailed review of the noise-related Australian Design Rules and engine brake noise from heavy vehicles has been recently completed by the National Road Transport Commission (NRTC). This report states that *"the use of* (engine brakes) *has often been identified by the community as one of the most intrusive road vehicle noises".*

There are studies that suggest that community annoyance can be directly related to heavy vehicle numbers. One study, by Dr Ragnar Rylander of the Institute of Social and Preventative Medicine at the University of Geneva, Switzerland, found a correlation between community annoyance and noise exposure when the number of noisy events and their maximum noise levels are used as a measure of noise exposure. He extended this approach by describing a relation between the number of truck movements per day (in traffic) and the level of community annoyance. This relation is shown in Figure 5, which shows Rylander's relationship between the number of truck movements per 24-hour day and the level of community annoyance for two groups of data, one with a typical maximum noise level of 85 dB(A) and the other with a typical maximum noise level of 95 dB(A).

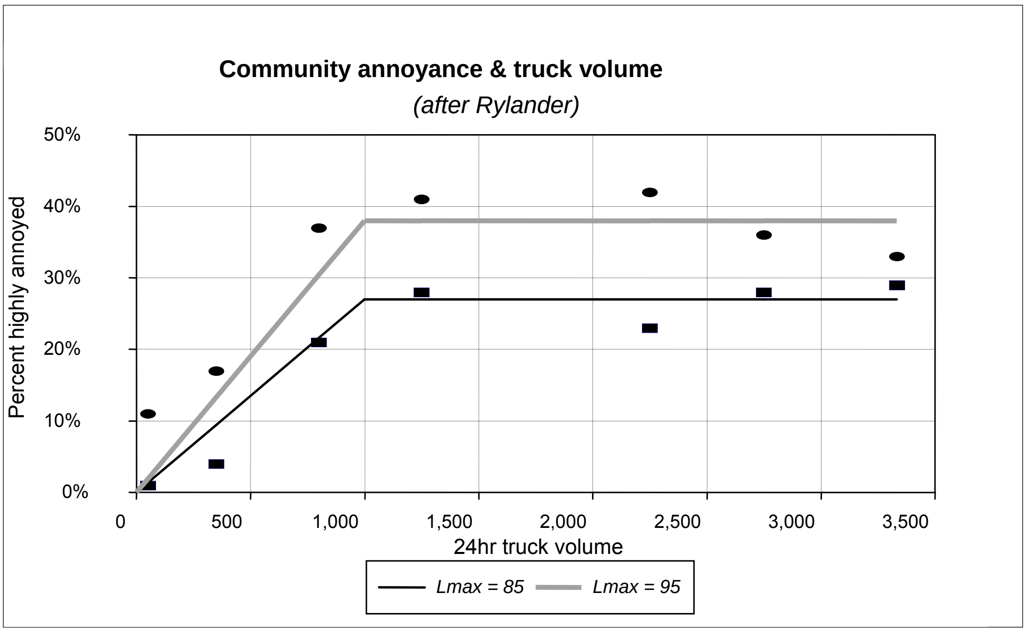

Figure 5 Relationship between annoyance and truck volume

5.3 Changes in Heavy Vehicle Numbers

As discussed in Section 5.2, noise from heavy vehicles is considered to be an important factor attributing to community annoyance. As shown in Figure 5, it appears that long-term reductions in community annoyance with heavy vehicle noise can only be achieved if the number of trucks per day is reduced to less than 1,000.

5.4 Sleep Disturbance Criteria

There are a number of ways of assessing noise exposure when evaluating risk of sleep disturbance. For this initial appraisal, the most useful way of assessing exposure is the guidance provided by Dr Ragnar Rylander:

> *"Sleep is likely to be disturbed with a rather low number of passes of 10-15 heavy vehicles at about 55 dB(A) [measured indoors, per night]."*

The relationship between event maximum noise levels from road traffic and sleep disturbance is not currently well defined. The ECTRN discuss sleep disturbance in relation to the number of noise events causing awakenings during the night-time period. As the relationship between noise and sleep disturbance is not fully understood, the ECTRN acknowledges sleep disturbance from road traffic and states that the continuation of research into its assessment is important.

It identifies that:

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

The RTA ENMM provides a protocol for assessing maximum noise levels in Practice Note III (PN-III). PN-III suggests that;

- At locations where road traffic is continuous rather than intermittent, the $L_{eq,9hr}$ (night-time) target noise levels should sufficiently account for sleep disturbance impacts.
- However, where the emergence of maximum levels (L_{max}) over the ambient (L_{eq}) is greater than 15 dB(A), the $L_{Aeq,9hr}$ criteria may not sufficiently account for sleep disturbance impacts.

Therefore, an assessment of the impact of sleep disturbance on residents is made in terms of likely maximum noise levels from road traffic, the extent to which these maximum noise levels exceed the ambient level, and the expected number of noise events from road traffic during the night.

5.5 Summary

When viewed in combination, the studies discussed above indicate that there are several aspects of the noise environment that contribute to community effects such as annoyance and sleep disturbance. In particular, it may be useful to characterise community noise exposure in terms of the frequency of noisy events, as well as in terms of noise levels.

6 Construction Noise and Vibration Criteria

6.1 DECC Environment Noise Control Manual

6.1.1 Criteria for Airborne Construction Noise

Chapter 171 of the DECC Environmental Noise Control Manual (ENCM) sets out noise criteria for construction projects. However, the DECC has recently released a *Draft Construction Noise Guideline*[5], which is intended to replace the guideline given in the ENCM[6].

The L_{A10} noise parameter is used in the ENCM as the descriptor to assess construction site noise (i.e. the noise level that is exceeded for 10% of the time, indicative of the average maximum level). The relevant criterion depends on the pre-existing L_{A90} noise level and the duration of the construction activity.

The relevant criteria are as follows:

- For construction periods of four weeks or less, the L_{A10} noise level from construction activity should not exceed the existing L_{A90} background noise level by more than 20 dB.
- For construction periods of between four and 26 weeks, the L_{A10} noise level from construction activity should not exceed the existing L_{A90} background noise level by more than 10 dB.
- For construction periods greater than 26 weeks, the L_{A10} noise level from construction activity should not exceed the existing L_{A90} background noise level by more than 5 dB.
- For construction noise that is tonal or impulsive in nature, a 5 dB penalty is applied.

A summary of these criteria is given in the Table 12 below.

Construction Period	Criteria
4 weeks or less	$L_{A10} \leq L_{A90}$ + 20 dB
4 weeks to 26 weeks	$L_{A10} \leq L_{A90}$ + 10 dB
Greater than 26 weeks	$L_{A10} \leq L_{A90}$ + 5 dB
Tonal or impulsive noise	+5 dB penalty

Table 12 Summary of construction noise criteria

While the total construction period for the entire project is likely to be greater than 26 weeks, many construction activities will progress along the route during the construction period. It is expected that construction periods will vary for construction periods across the precincts.

For large construction projects such as this it is considered appropriate to treat noisy stages of work (such as the earthworks associated with a bridge replacement, for example) as discrete construction periods and assess them against the short and medium term guidelines, provided the cumulative affect of longer-term works is carefully managed.

5 NSW DECC (2008) *Draft Construction Noise Guideline*, Draft for Consultation, August 2008.

6 NSW DECC *Draft Construction Noise Guideline* website, http://www.environment.nsw.gov.au/noise/draftconstructgline.htm

Where construction noise is audible at residential premises, the DECC guideline recommends that construction should be limited to the following times:

- Monday to Friday, 0700-1800hrs (7:00am to 6:00pm), with a maximum of nine hours per day.
- Saturday 0700-1300hrs (7:00am - 1:00pm) if inaudible on premises, otherwise 0800-1300hrs (8:00am-1:00pm).
- No construction work to occur on Sundays or public holidays.

Due to the nature of road projects, some construction work may be required to take place outside of those preferred hours. These activities will require very careful noise management, including close liaison with the local community, and the implementation of best practical measures to limit disturbance to the surrounding community.

Experience also shows that certain noisy processes, such as sheet piling, are likely to exceed the DECC guidelines at nearby locations even if carried out during the preferred hours. Practical alternatives are not always available and, in these cases, it will be necessary to ensure that the quietest suitable equipment is selected, that temporary noise screening is implemented where practical, and that the timing of the works is subject to prior discussion with the community.

In addition to the major construction activities and processes, some construction plant may be required to operate continuously (24 hours a day). These items of equipment should be treated as “semi-permanent” and the lowest criterion is appropriate (i.e. L_{A10} noise level should not exceed the existing L_{A90} background noise level by more than 5 dB). This is broadly similar to the criterion that would be imposed under the DECC Industrial Noise Policy (INP) for permanent industrial noise sources.

Noise generated by haulage trucks and other construction related traffic is dealt with in two ways. Firstly, while trucks are operating on the construction site (e.g. during deliveries or soil removal, including reversing beepers), noise must be assessed in the context of the contribution to the overall site activity noise. Secondly, when trucks leave the site to join the surrounding roads, the noise impact of the construction traffic must be assessed in terms of the change in overall traffic noise level. The criteria given in the DECC's ECRTN will then be adopted. In this context the criterion is:

- For land use developments with potential to create additional traffic on existing roads, the traffic arising from the development should not lead to an increase in existing noise of more than 2 dB.

6.1.2 Criteria for Groundborne Construction Vibration

Criteria for construction vibration must address both:

- the potential for disturbance and annoyance to building occupants
- the potential for damage to buildings and other structures.

With regard to disturbance and annoyance, AS 2670.2-1990[7] defines limits for both continuous and transient vibration events. These limits are given in the form of multiplying factors to be applied to base curves representing the threshold of human perception. Table 13 below shows the applicable multiplying factors. For example, the base curve (representing the threshold of human perception) for vertical vibration is a velocity of 0.1 mm/s (rms) and is shown in Figure 2b of AS2670. Applying a multiplying factor of 4 would result in an applicable vibration limit of 0.4 mm/s (rms).

[7] Australian Standard, Evaluation of Human Exposure to whole-body vibration-Continuous and shock-induced vibration in buildings

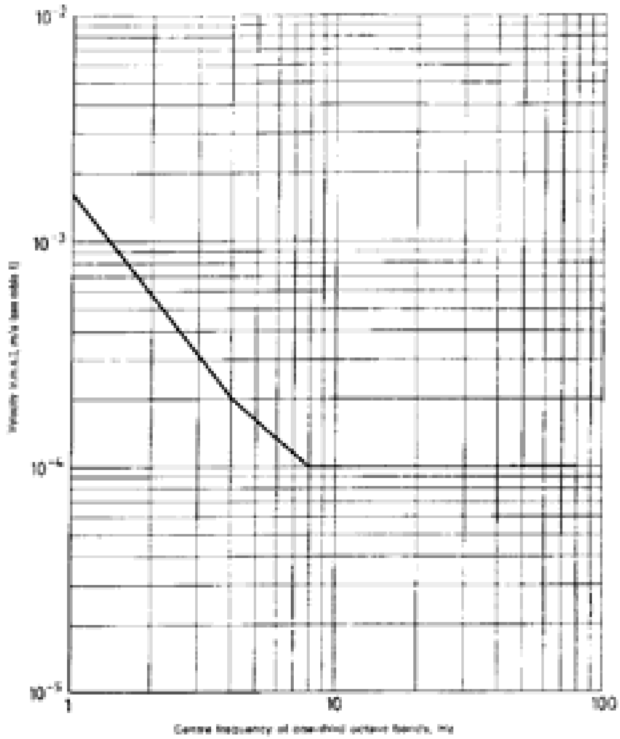

Figure 2b — Building vibration z-axis base curve for velocity
(this represents the foot-to-head vibration base curve, see 4.2.1)

Figure 6 Building vibration z-axis base curve for velocity (Figure 2b of AS2670)

When these noise levels are applied to the base curve, they show the continuous, intermittent and transient vibration levels below which the probability of adverse comment is low.

Type of Building Occupancy	Time	Continuous or intermittent vibration	Transient vibration
Residential	Day	2 to 4	30 to 90
	Night	1.4	1.4 to 20
Office	Day	4	60 to 128
	Night		
Workshop	Day	8	90 to 128
	Night		

Table 13 Multiplying factors to be applied to base curves (see Fig 2b AS2670)

Intermittent vibration can be assessed by using Vibration Dose Values (VDV's) calculated according to BS 6472.1992[8]. The Vibration dose value takes into account the length of the exposure as well as the maximum levels. Table 14 shows acceptable vibration dose values for intermittent vibration. There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values.

Location	Daytime (0700 – 2200)		Night-time (2200-0700)	
	Preferred Value	**Maximum Value**	**Preferred Value**	**Maximum Value**
Residences	0.20	0.40	0.10	0.20
Offices; schools; places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 14 Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

With regard to the potential for ground vibration to cause damage to structures, it should be noted that vibration levels may reach much higher values than those applicable to human perception and comfort before the onset of any structural risk. There are no directly applicable Australian Standards or guidelines for damage criteria, but a number of overseas standards are helpful. It is recommended that the guidelines and limits in the British Standard BS 7385[9]are adopted as damage criteria for this project, together with a more conservative limit of 5 mm/s in the first instance.

The standard states in Annex A that 'the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration of any other ground borne disturbance'. It is recommended that buildings of importance are considered on a case-by-case basis with detailed engineering analysis being carried out if appropriate.

6.2 Blasting and Vibration Exposure

Ground vibration and airblast (also called blast overpressure) are two environmental impacts from blasting. The airblast is generally more noticeable than the ground vibration. High levels of vibration transmitted through the ground and the airblast could annoy residents, or in the extreme, cause damage to buildings or structures.

Appendix J of AS2187.2[10] provides general guidance on appropriate limits for ground vibration and airblast overpressure from blasting.

Recommended limits for the vibration level and blast overpressure from blasting are also found in guidelines from the Australian and New Zealand Environment Conservation Council (ANZECC)[11]. These limit blast overpressure to 115 dB (lin, peak) at any residence, and ground vibration to 5 mm/s peak particle velocity (PPV). The guidelines also restrict blasting to between 9 am and 5 pm on weekdays and Saturday, and recommend only one detonation per day. Blasting at night should be avoided unless it is absolutely necessary. (These criteria are generally slightly more stringent than those documented in AS2187.2-2006).

8 BS 6472 Guide to evaluation of human exposured to vibration in buildings
9 BS 7385: Part 2: 1993 *Evaluation and measurement for vibration in buildings, Guide to damage levels from groundborne vibration*, British Standards Institution.
10 AS 2187.2-2006 *Explosives - Storage, transport and use, Part 2 Use of explosives*, Standards Australia, 2006.
11 *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*, Australia and New Zealand Environment Council, September 1990.

Building damage is unlikely to be caused below these vibration levels, while building damage and human discomfort will be minimal below the overpressure limits. 'Conventional' blasting at 'normal' distances is unlikely to create ground vibration levels of sufficient magnitude to cause building damage. Cracks in buildings are far more likely to be caused by local ground and foundation movements caused by the settlement and swell of the ground due to prolonged wet or dry weather.

The DECC acknowledges that there could be some exceedance of the overpressure limit of 115 dB and ground vibration limit of 5 mm/s on infrequent occasions. This should be limited to not more than 5% of total blasts. During this time the overpressure level should not exceed 120 dB at any time and the ground vibration limit should not exceed 10 mm/s at any time.

The Maximum Instantaneous Charge (MIC) will typically be limited to prevent unacceptable levels of air overpressure and noise.

Criteria for operational vibration can be found in AS2670.1 and AS2670.2[12]. Vibration from road traffic is likely to be well below these criteria at all residences.

6.3 DECC Draft Construction Noise Guideline

The Draft Guideline allows two methods of assessment of construction noise: quantitative and qualitative assessments. "Major construction projects" are required to be assessed quantitatively, while smaller projects may be assessed qualitatively. The Draft Guideline states that major construction projects are typically subject to the Environmental Assessment (EA) process.

Marsden Park Industrial Precinct would likely be categorised as a "major construction project" under the Draft Guideline and a quantitative assessment would be required.

Standard construction hours are given in the Draft Guideline as follows for 'normal construction':

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays

These hours of work are consistent with the ECNM guidance.

Two noise criteria components are set out in Table 4.1 of the Draft Guideline for residential receivers:

- A "Noise affected" level ($L_{Aeq,15min}$) of the Rating Background Level (RBL) + 10 dB(A) during standard construction hours, which "represents the point above which there may be some community reaction to noise".
- A "Highly noise affected level" of 75 dB $L_{Aeq,15min}$, which "represents the point above which there may be strong community reaction to noise".

For works outside standard hours, a criterion of RBL + 5 dB(A) applies, but works outside the standard hours would not normally be acceptable without "strong justification". Where all feasible and reasonable practices have been applied and noise is more then 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

The Draft Guideline also presents criteria for ground-borne noise and sleep.

12 AS2670.1-1990 *Evaluation of human exposure to whole-body vibration Part 1: General Requirements*
AS2670.2-1990 *Evaluation of human exposure to whole-body vibration Part 2: Continuous and shock induced vibration in buildings (1 to 80 Hz)*, Standards Australia.

- During the evening between 6.00 pm and 10.00 pm, internal noise levels assessed at the centre of the most affected habitable room should not exceed $L_{Aeq,15min}$ 40 dB(A). At night-time between 10.00 pm and 7.00 am levels should not exceed $L_{Aeq,15min}$ 35 dB(A).

The level of mitigation of ground-borne noise should take into account the community as to whether they identify days where there are more sensitive to noise or prepared to accept a longer duration of the upgrade in exchange for days of respite.

Where construction work is intended to extend for more then two consecutive nights, the analysis should cover the maximum noise level, and the extent and the number of times that the maximum noise levels exceed the RBL.

7 Typical Noise Control Treatment

The survey of existing noise levels and the noise modelling of traffic noise from the existing road network shows that noise control measures are required to ensure that traffic and industry noise levels comply with the criteria. Potential noise control measures include setbacks of sensitive land uses from roadways and the use of noise barriers. In this case, "noise barrier" can refer to a free standing noise barrier or the sealed façade of an appropriately constructed dwelling, or a combination of both.

Recommendations for noise control measures are discussed below.

7.1 Noise Modelling

7.1.1 Situations

Traffic noise from a variety of traffic flows, obtained from Arup Transport Planning, has been modelled using the UK Department of Transport Calculation of Road Traffic Noise (CoRTN) methodology. Although developed in the UK, CoRTN has been widely validated for the prediction of road traffic noise in Australia, and is an appropriate method to obtain indicative traffic noise levels from the development.

CoRTN predicts a one-hour L_{A10} single number value at a distance of 10 m from the edge of the road. Predicted traffic noise levels for each road were corrected to the appropriate source receiver distance.

7.1.2 Model Parameters

The noise prediction model takes account of the overall traffic volume, the number of heavy vehicles and the vehicle speed. The propagation model takes account of losses due to geometrical spreading from the noise source, absorption from the ground, shielding from the ground topography and physical noise barriers, where they are provided.

In accordance with NSW RTA criteria, noise levels have been predicted at 1 m from the receiver façade, and a +2.5 dB façade correction has been applied where appropriate to the noise predictions to take account of reflections of sound from the façade.

The maximum posted traffic speed of the proposed higher order roads within the Marsden Park Industrial Precinct has been assumed to be 80 km/h. Other roads within the precinct have been assumed to have a 60 km/h posted speed limit.

A proportion of 10% heavy vehicles in the traffic flow has been used for calculation.

Traffic noise has been assessed against the criteria of the ECRTN. The proposed residential areas within MPIP are located on or adjacent to the higher-order (arterial or sub-arterial) roads within the precinct, and therefore the Category 2 criteria from the ECRTN apply (for new residential developments affected by freeway or arterial road traffic noise).

The ECRTN recommends a daytime (i.e 7 am to 10 pm criterion) of 55 dB $L_{Aeq(15hr)}$ and a night time (10 pm to 7 am) criterion of 50 dB $L_{Aeq(9hr)}$.

7.1.3 Methodology

Existing traffic noise levels on-site were measured at five locations in the study area, in the vicinity of noise sensitive receivers that will be affected by future increased traffic noise.

The existing traffic volumes for the higher order roads were entered into the model and the predicted noise levels were compared to the measured noise levels to calibrate the model.

7.1.4 L_{10} to L_{eq} Correction

As the CoRTN methodology predicts 18 hour or one hour L_{A10} noise levels, corrections have been also derived to convert the basic L_{A10} results to 15 hour L_{Aeq} for the daytime and nine hour L_{Aeq} noise levels used for night-time by the DECC. The corrections were derived from the measured traffic noise levels. The following corrections were derived from the measured traffic noise levels:

- $L_{Aeq,15hr} = L_{A10,18hr}$ – 3.0 dB (daytime)
- $L_{Aeq,9hr} = L_{A10,18hr}$ – 6.5 dB (night-time)

7.2 Detached dwellings with noise barrier

Indicative barrier heights have been calculated for detached dwellings with a separate noise barrier in Table 15 below. The noise barrier edge has assumed to be fifteen metres from the centreline of Richmond Road, with eleven metres assumed for the rear yard of dwellings.

Predicted barrier heights for several traffic segments adjacent to proposed residential areas are presented in Table 15 below. Note that the actual barrier height is dependant on the source-receiver geometry; however, the calculated values are expected to be indicative of the likely barrier height.

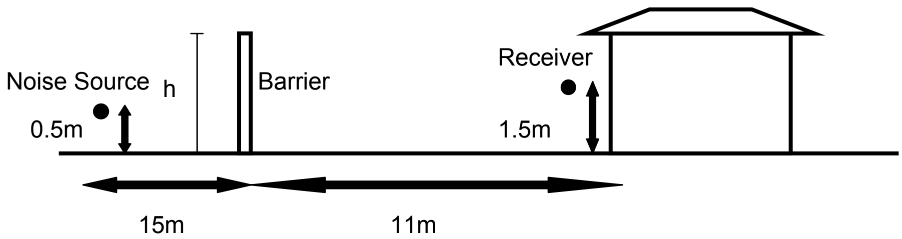

Figure 7 Detached dwellings with noise barrier

Traffic Flow (Vehicles)	Example Road with Proposed Equivalent Volumes in 2036	Predicted Barrier Height Required (m)
1,000	Internal roads forming southern boundary of Medium-Density Residential Area at northern edge of MPIP.	0 m
3,000	Internal Road forming eastern boundary of Low-Density Residential Area at north-west corner of MPIP	1.5 m
40,000	New Shanes Creek Road/South Street west of Richmond Road	6.0 m
50,000	South Street east of Richmond Road	6.5 m
60,000	Richmond Road between South Street and Townson Road	7.0 m
90,000	Richmond Road south of Townson Road	8.0 m

Table 15 Predicted barrier height required for various traffic flows in order to meet ECRTN criteria at residential receivers.

7.3 Continuous Dwellings as Noise barriers

Indicative barrier heights to achieve the ECRTN criteria for continuous terrace-style dwellings, with a sealed façade facing the road, acting as a noise barrier to screen subsequent rows of houses, are illustrated in Figure 8 below.

The noise barrier has been assumed to be fifteen metres from the centreline of the road, and residential dwelling blocks have been assumed to be 35 m depth, divided into six metres front yard, ten metres dwelling and eleven metres rear yard. For traffic flows of 40,000 or less; the continuous dwelling acting as the noise barrier must be one storey (approximately three metres) and for traffic flows greater then 35 000 (up to the maximum predicted traffic flow in the precinct of approximately 90,000 vehicles per day) the continuous dwelling must be two stories (approximately six metres).

Figure 8 Continuous dwelling acting as noise barrier

7.4 Typical Buffer Distances

Table 16 below outlines the calculated distances from the road required for a variety of non-residential land uses in order to achieve appropriate ECRTN and AS2107 criteria for these land uses. The different land uses include:

- Schools and places of worship where there is a 25 dB(A) loss through the façade
- Commercial and industrial where there is a 35 dB(A) loss through the façade.

Traffic Flow (Vehicles per day)	Distance from road (m)	
	ECRTN	AS2107
	Schools and Places of Worship	**Commercial and industrial**
1,000	No setback required	No setback required
3,000	4 m	
7,500	16 m	
10,000	22 m	
15,000	35 m	
20,000	48 m	
40,000	180 m	2 m
50,000	230 m	4 m
60,000	280 m	5 m
90,000	415 m	10 m

Table 16 Required set-back distances from roads with various traffic flows in order to comply with ECRTN and AS2107 internal criteria for various land uses

7.5 Noise Barrier Construction

The effectiveness of a noise barrier is determined by the extent to which it interrupts the line of sight between the noise source and any receiver. Hence, the preferred position for noise barriers is either near the road alignment or near the noise sensitive receiver. To minimise the height and length of noise barriers, in most cases, barriers are positioned either near the noise source (road) or near the noise sensitive receiver (dwelling).

Generally, each source and receiver must be individually reviewed and a noise barrier appropriately designed.

Noise barriers can consist of walls, fences, earth mounds or a combination of any of these. A noise barrier should consist of a material with a surface mass greater than 10 kg/m^2 and with no gaps between the lower portion of the noise barrier and the ground.

7.6 Dwellings as Noise Barriers

Where dwellings are located in close proximity to higher order roads and are intended to act as a noise barrier to reduce noise levels in other areas, the façade facing the noise source should be constructed on the property boundary. The façade of the dwelling will then shield the remainder of the property from traffic noise. Façade construction should incorporate:

- 150mm concrete or 220mm brick construction
- No windows
- Roof not to be exposed to noise source
- No ventilation openings.

Where adjacent dwellings are not joined by a common wall, a sealed noise barrier should be installed between the dwellings in order to create an unbroken line of barrier.

A row of unbroken dwellings in the vicinity of higher order roads will act as a noise barrier for the majority of the affected development.

Residential areas directly affected by traffic noise are to be individually assessed during the detail design phase of the project. Dwelling construction, set backs and orientation are to be considered when recommending noise control treatment.

7.7 Commercial and Recreational Zones as Noise Barriers

Strategic land-use planning can dramatically reduce the noise transmitted from industrial sites to residential and noise sensitive areas. In the initial planning stage the compatibility of different land uses should be considered, and internal subdivision that allocates the least noise sensitive land uses (for example, shopping centres, parks, sporting complexes) that can act as “buffer zones” between noise producing zones and noise sensitive zones should be incorporated into the design. This can be further enhanced by dividing industrial areas based on anticipated noise levels and placing those that are expected to emit higher noise levels further away from potential noise sensitive areas and closer to the higher-order roads.

7.8 Noise Buffer Distances from Arterial and Sub-arterial Roads

A noise buffer may be incorporated for arterial and sub-arterial roads. A noise buffer or set back may be in the form of service access roads or parklands to allow for adequate distance between the road and noise sensitive areas.

8 Acoustic Master-Planning

8.1 Current Master-Plan

The current master-plan for the Marsden Park Industrial Precinct (Option 6, dated 2 February 2009) incorporates several features which will benefit the overall acoustic effectiveness of the land use. Arup Acoustics has provided input into the development of this master-plan.

In particular, the current plan features some use of commercial/business zones to act as a buffer between residential areas and industrial areas, which will help to provide some acoustic separation or “buffer” between potential noise-producing uses (industrial areas) and noise-sensitive uses (residential areas).

Locating residential areas and industrial areas without an intervening buffer zone is likely to restrict the types of industrial use possible for the industrial area. Land uses which generate high noise levels may not be able to use this land without considerable noise control measures or potentially degrading the acoustic amenity of residents.

Therefore, the provision of this intervening buffer zone of less-sensitive land uses is likely to increase the overall flexibility of land use within the industrial zoned areas of the Marsden Park Industrial Precinct.

However, there are some areas where modifying the land uses can potentially have a great effect on the acoustic amenity of the precinct.

8.2 Residential Areas Located adjacent to Major Roads

The proposed residential areas in the Industrial Precinct generally are not accessed directly from the higher-order roads in the development. This allows scope for providing noise-control measures between the higher-order road and the residential areas, e.g. noise barriers or sealed-façade buildings.

However, the location of residential areas directly adjacent to major roads exposes the residential areas to the highest levels of traffic noise within the precinct, and means that a greater degree of noise control treatment is required for these residential areas.

Moving residential zones away from the higher-order roads to within the precinct itself rather than on the edges may assist in reducing the amount of noise control required.

Acoustically, an effective solution might consist of locating residential, commercial and industrial areas in concentric “bands”, with a central residential area towards the centre of the precinct surrounded by a “band” of business/commercial zoning to act as a buffer zone, with industrial areas located around the edges of the precinct.

This provides acoustic separation between industrial areas and residential areas and also provides separation between residential areas and higher-order roads. Industrial areas, which are least sensitive to noise, are adjacent to higher-order roads, which produce higher levels of traffic noise which may act to mask the impact of industrial noise on surrounding areas.

The co-location of higher-noise areas with land uses which are less-sensitive to noise and of noise-sensitive land uses in lower-noise areas is likely to result in an overall benefit to the acoustic amenity of the area and minimise the amount of noise control required.

Appendix A

Acoustic Terminology

A1 Glossary of Acoustic Terminology

ASSESSMENT BACKGROUND LEVEL (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

‘A’-WEIGHTED SOUND LEVEL dB(A)

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. An increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise. A change of 2 to 3 dB is subjectively barely perceptible.

DECIBEL

The ratio of sound pressures which we can hear is a ratio of 10^6:1 (one million : one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the ‘sound level’ (L) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

Some typical noise levels are given below:

Noise Level dB(A)	Example
130	Threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside disco
90	Heavy lorries at 5 m
80	Kerbside of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 1m
40	Living room
30	Theatre
20	Remote countryside on still night
10	Sound insulated test chamber
0	Threshold of hearing

EQUIVALENT CONTINUOUS SOUND LEVEL (L_{Aeq})

Another index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level, which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

FREQUENCY

The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kilohertz (kHz), eg 2 kHz = 2000 Hz. Human hearing ranges from approximately 20 Hz to 20 kHz. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. For more detailed analysis, each octave band may be split into three one-third octave bands or, in some cases, narrow frequency bands.

MAXIMUM SOUND LEVEL, L_{max}

The maximum sound level is the maximum weighted sound pressure level experienced during the measurement period.

RATING BACKGROUND LEVEL (RBL)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.

STATISTICAL NOISE LEVELS

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index, which allows for this variation. 'A'-weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, eg. $dBL_{A10, 5min}$ or $dBL_{A90, 8hr}$.

$L_{A90(T)}$

Refers to the sound pressure level measured in dB(A), exceeded for 90% of the time interval (T) –i.e. measured noise levels were greater than this value for 90% of the time interval. This is also often referred to the background noise level.

$L_{A10(T)}$

Refers to the sound pressure level measured in dB(A), exceeded for 10% of the time interval (T). This is often referred to as the average maximum noise level and is frequently used to describe traffic noise.

VIBRATION

Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structureborne noise or human comfort issues respectively. Vibration amplitude may be quantified as a peak value, or as a root mean squared (rms) value.

Vibration amplitude can be expressed as an engineering unit value eg $1mms^{-1}$ or as a ratio on a logarithmic scale in decibels:

Vibration velocity level, L_V (dB) = 20 log (V/V_{ref}),

(where the preferred reference level, V_{ref}, for vibration velocity = 10^{-9} m/s).

The decibel approach has advantages for manipulation and comparison of data.

Appendix B

Site Plan


NSW GOVERNMENT
Department of Planning
Marsden Park Industrial Precinct
Draft Indicative Layout Plan
Precinct Boundary
Business Park
Business Development
Light Industrial
Low Density Residential
Medium Density Residential
Conservation Areas
Drainage & Infrastructure
Recreation Area
Riparian Corridor
Preferred location for Neighbourhood Services
Major Road (Arterial, Sub Arterial and Main)
Local Road
Creek line
Proposed Transmission Easement
Possible Future Road Links
Potential Pedestrian Link
Proposed Traffic Signals
0
100m
200m
500m
Scale
1:5,000 @ B1
1:12,500 @ A3
GLENAGARRIE ROAD
SOUTH STREET
BELLS CREEK
LANDFILL SITE
SHANES PARK
SOUTH STREET
TOWNSON ROAD
STONECUTTERS RIDGE
GOLF COURSE ESTATE
COLEBEE
RELEASE AREA
EXISTING TRANSMISSION EASEMENT
PROPOSED
WATERBOARD SITE
MOSQUE
PROPOSED FREEWAY
RICHMOND ROAD
SHALVEY
BIDWILL
HASSALL GROVE

ArupAcoustics

Appendix C

Noise Survey Data

C1 Average Weekday Noise Data

Location 1 – 1 Stony Creek Road

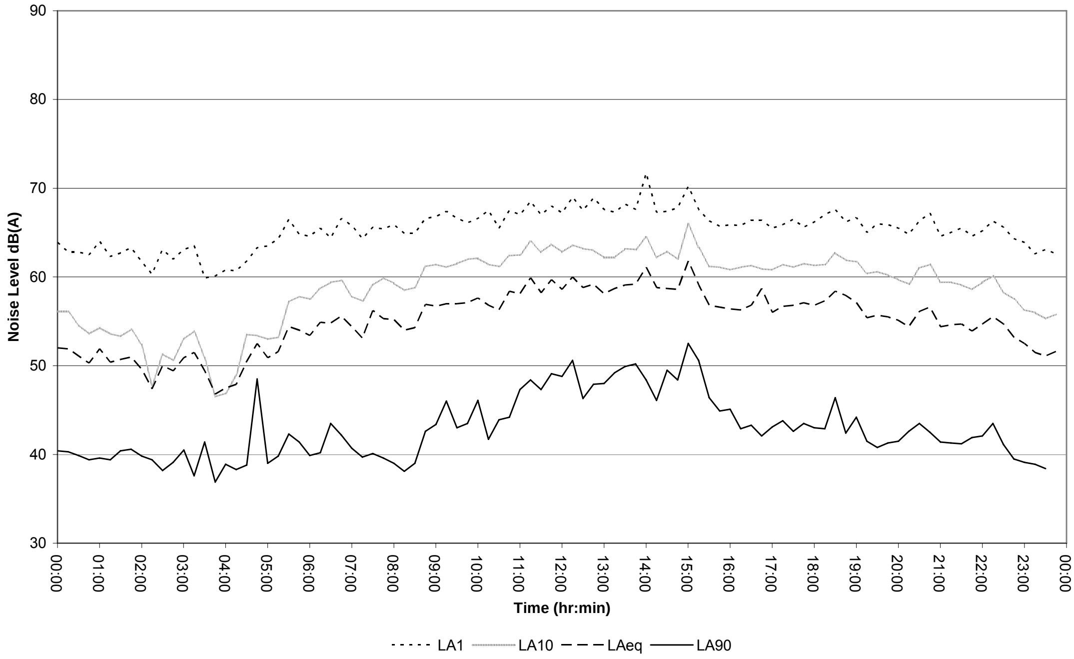

Figure 9 Existing average weekday traffic noise levels with acceptable weather conditions at 1 Stony Creek Road during the monitoring period 17 November 2008 – 30 November 2008.

Location 2 – Ganian Property

Noise at Ganian property, located approximately 530 meters from Richmond Road and 15 meters from Hollinsworth Road, is presented in Figure 10 below.

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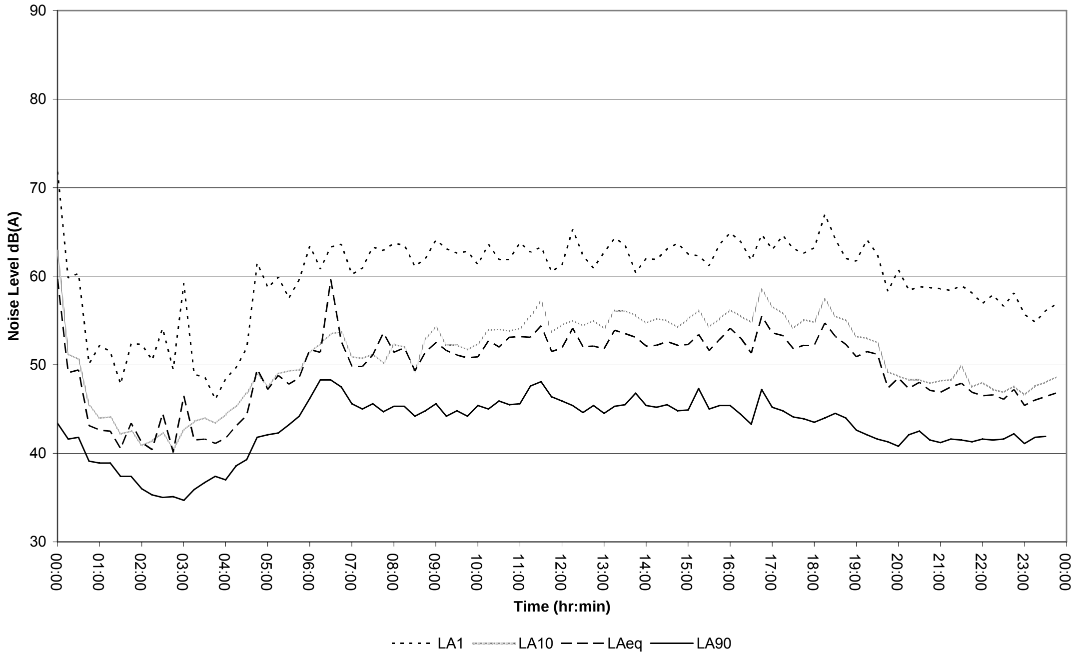

Figure 10 Existing average weekday traffic noise levels with acceptable weather conditions at the Ganian Property during the monitoring period 17 November 2008 – 30 November 2008

Location 3 – 829 – 847 Richmond Road (Heartbreak Ridge Paintball)

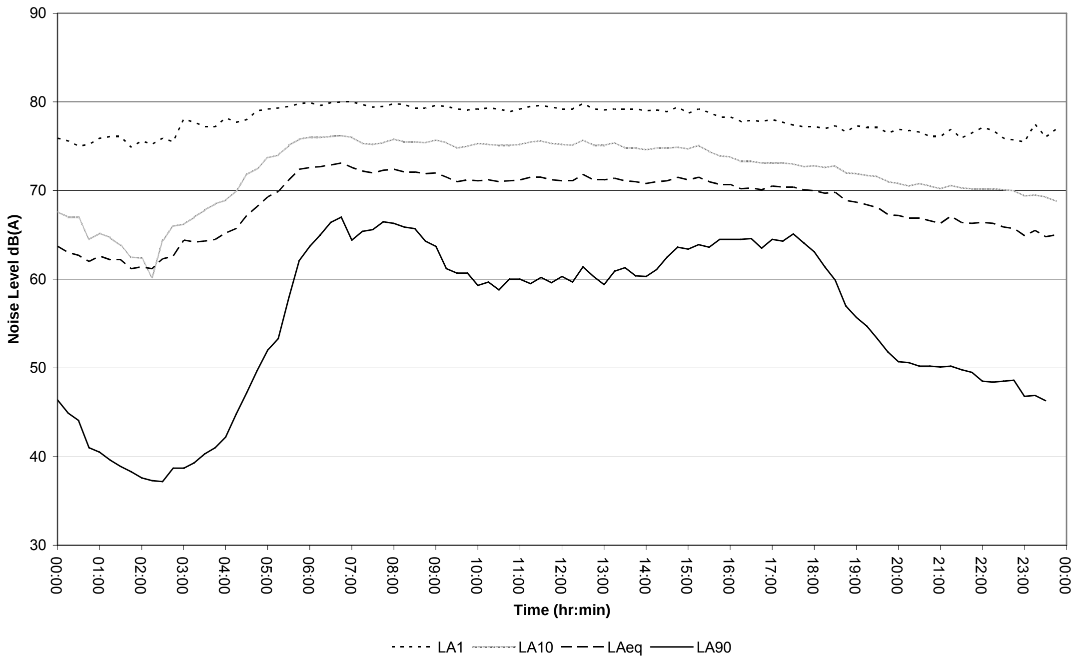

Figure 11 Existing average weekday traffic noise levels with acceptable weather conditions at 829 847 Richmond Road, during the monitoring period 17 November 2008 – 30 November 2008.

Location 4 – 155 South Street

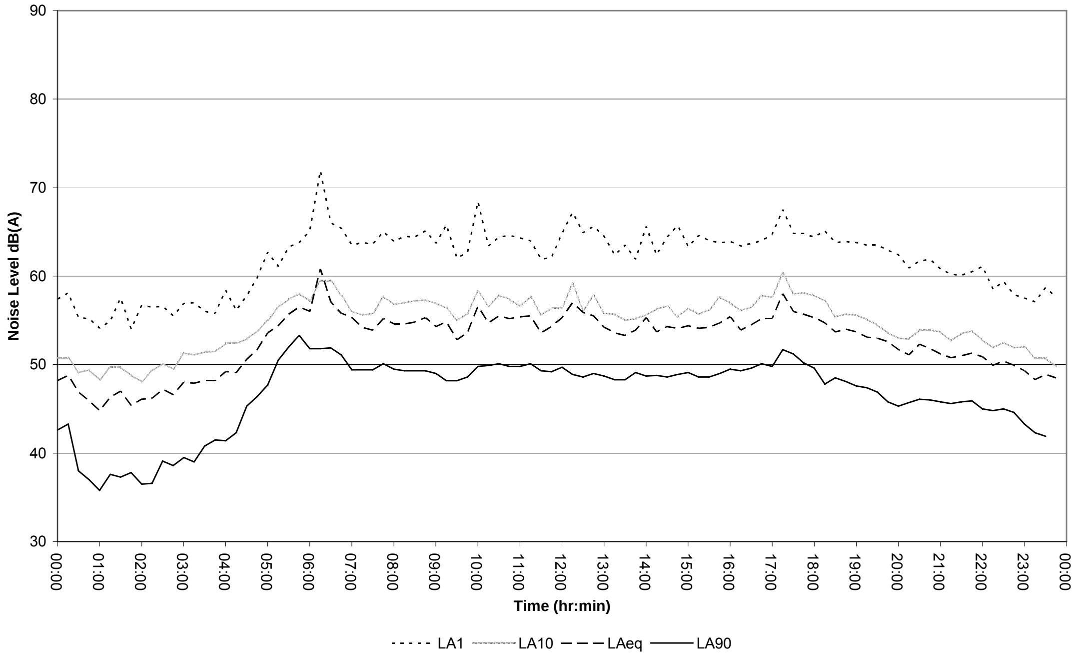

Figure 12 Existing average weekday traffic noise levels with acceptable weather conditions at 155 South Street, during the monitoring period 17 November 2008 – 30 November 2008.

Location 5 – 1032 Richmond Road

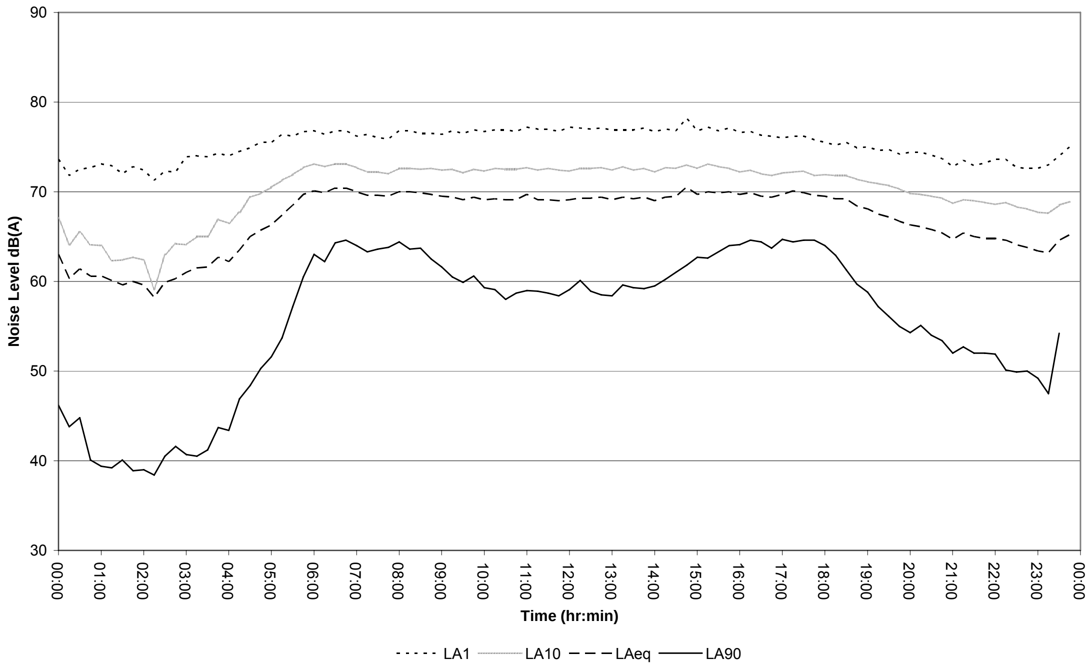

Figure 13 Existing average weekday traffic noise levels with acceptable weather conditions at 1032 Richmond Road, during the monitoring period 17 November 2008 – 30 November 2008.