Road noise aspects of the NSW Infrastructure SEPP's '*Development in Rail Corridors and Busy Roads – Interim Guideline*'

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ABSTRACT

On 21 December 2007 State Environmental Planning Policy (*Infrastructure*) 2007 (known as the 'Infrastructure SEPP') was gazetted and subsequently came into effect in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. Key objectives of this planning policy were to: protect the safety and integrity of key transport infrastructure from adjacent development; and ensure that adjacent development achieves an appropriate acoustic amenity by meeting the internal noise criteria specified in the Infrastructure SEPP. A major initiative of this SEPP is that for the first time a planning instrument has established internal noise levels [35dB(A) for bedrooms and 40dB(A) for other habitable rooms] in new residential developments planned along identified transport corridors. To support the Infrastructure SEPP, the NSW Department of Planning released *Development in Rail Corridors and Busy Roads – Interim Guideline* in December 2008. This document was developed with significant input from acoustic experts and other government agencies, and provides guidance on building design, internal layout and architectural principles to achieve an acceptable internal acoustic environment as well as synergies in addressing air and noise impacts. The Guideline also provides general guidance on strategic planning for Councils and other government agencies, or private proponents investigating possible locations for new residential and other sensitive development that require development approval. In addition, it provides guidance on site selection to reduce or avoid the need for mitigation measures for new residential (eg single/dual occupancy, multi-unit, etc) dwellings. The present paper focuses on the aspects of the Guideline which apply to the management of road traffic noise. It presents a summary of the technical background, assumptions and considerations given in relation to all of the road traffic noise information contained within the Guideline. It covers how the road noise triggers were established; how the processes were developed to assess project specific noise levels for residential and other sensitive land uses; how the generic deemed-to-comply building acoustic design requirements were derived to improve the acoustic amenity of building occupants; and discusses the cost-savings in noise mitigation measures that can be achieved through good acoustic planning and design.

INTRODUCTION

Traditionally, residential development in Sydney has often occurred along busy transport corridors. Whilst in many cases the residential development occurred when the corridor carried low levels of traffic, natural growth has often resulted in the residences now adjoining heavily trafficked high speed transport routes. In other cases, residential development may have occurred due to low land costs or proximity to a centre with services and public transport.

Regardless of the original reasons for the development occurring, the quality of life of the residents may be adversely affected unless appropriate site layout, design or other mitigation measures to minimise noise and air quality impacts have been integrated into the development.

As part of its forward strategic planning, the NSW State Government released the *State Plan – A New Direction for NSW* as a draft in 2006 with a final in 2009. This Plan defines the goals, outcomes and priorities of the government including recognition that to provide environmentally sustainable and affordable housing for a growing population with smaller household sizes would require renewal of existing urban areas. Moreover, while this new housing, should ideally be located near a centre, within walking distance of frequent public transport, this should only occur where adverse noise and air quality impacts of the road can be minimised and good quality high amenity residential developments are created.

To support the State Plan, and address land use conflicts, State Environmental Planning Policy (*Infrastructure*) 2007 (known as the 'Infrastructure SEPP') was gazetted and subsequently came into effect in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. Key objectives of this planning policy were to:

- protect the safety and integrity of key transport infrastructure from adjacent development; and
- ensure that adjacent development achieves an appropriate acoustic amenity by meeting the internal noise criteria specified in the Infrastructure SEPP.

A major initiative of this SEPP is that for the first time a planning instrument has established internal noise levels, which in this case are 35dB(A) for bedrooms and 40dB(A) for other habitable rooms, in new residential developments planned along identified transport corridors.

DEVELOPMENT OF GUIDELINES

Guidance on the scope and application of the acoustic criteria contained in the Infrastructure SEPP required the development of supporting documentation. To achieve this, a working group of key government agencies was established along

with input from an acoustic consultancy. The authors were part of this working group and primarily worked on the development of guidelines for assessing and managing road traffic noise. The output of this working group was the *Development in Rail Corridors and Busy Roads – Interim Guideline* (the Guideline) released in December 2008. The present paper focuses on this aspect of the Guideline.

Objectives on providing guidance on road traffic noise for new residential developments in close proximity to nominated roads, included:

1) defining the level of acoustic management expected for a development

2) providing a simple method for determining whether an acoustic assessment is required

3) develop guidance on how to achieve good acoustic performance from a building

4) provide advice on deemed-to-comply developments

These objectives are described in more detail below.

Acoustic Management Zones

More specifically, the Infrastructure SEPP refers to guidelines which must be taken into account where development is proposed in, or adjacent to, specific roads corridors. In particular clause 102 requires that**:**

> *development for any of the following purposes that is on land in or adjacent to a road corridor for a freeway, a tollway or a transit way or any other road with an annual average daily traffic (AADT) volume of more than 40,000 vehicles (based on the traffic volume data available on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:*

- *building for residential use;*
- *a place of public worship;*
- *a hospital;*
- *an educational establishment or childcare centre.*

In addition:

If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded:

- in any bedroom in the building: 35dB(A) at any time between 10pm–7am
- anywhere else in the building (other than a garage, kitchen, bathroom or hallway): 40dB(A) at any time.

In keeping with the underlying objective that traffic noise in NSW should not exceed the noise levels recommended in the *Environmental Criteria for Road Traffic Noise* (ECRTN), the Guideline has been developed partly based on some of the criteria in that document. The internal L_{Aeq} noise limits set by the Infrastructure SEPP are defined in the Guideline to have matching metrics with the external noise metrics set in the ECRTN, namely $L_{Aeq,9h}$ for bedrooms at night and $L_{Aeq,15h}$ for any other habitable room.

The rationale for identifying roads with an AADT of 40,000 is based on the premise that such a traffic volume and a speed of approximately 70 km/h, noise levels in excess of the noise level targets outlined in the ECRTN for existing situations [$L_{Aeq,15h}$ = 60dB(A), $L_{Aeq,9h}$ = 55dB(A)] occur at distances around 100 metres, and for new situations [$L_{Aeq,15h}$ = 55dB(A), $L_{Aeq,9h}$ = 50dB(A)] occur at distances around 300 metres, from a roadway where there are no intervening structures and where the ground cover is lawn, gardens, pastures, bushland or similar. Under this Guideline only those new residential and noise sensitive building developments with a clear line-of-sight to the road traffic need to be assessed for noise mitigation measures.

Note that it is recommended that while not mandatory, consideration be given to adoption of the principles in the Guideline for all roads with an AADT of 20,000 or greater.

Acoustic Assessment

The Guidelines contain a flowchart which provides guidance on whether a development is likely to achieve the required internal noise levels, whether it requires noise control treatment or whether a specialist detailed acoustic assessment is required.

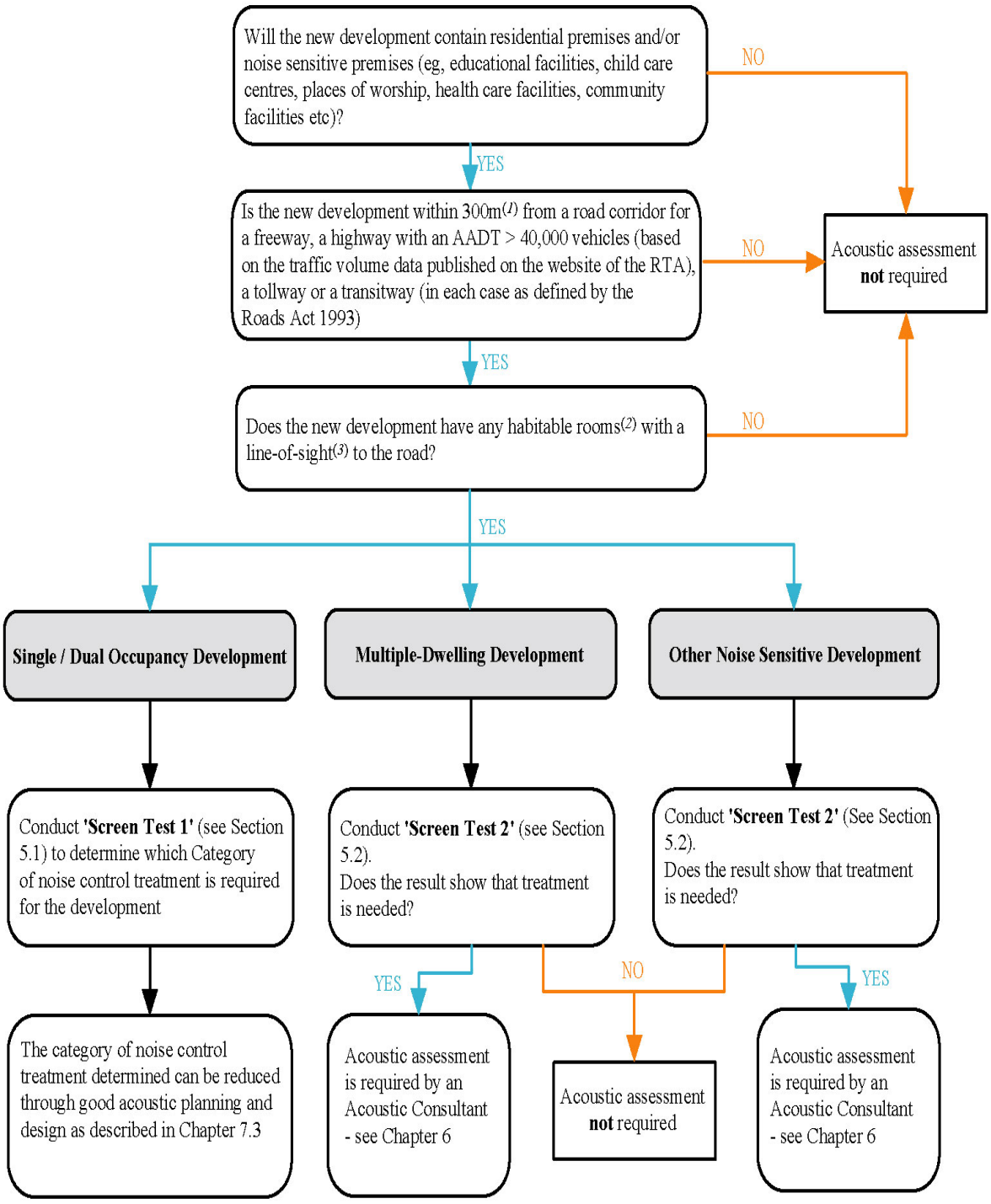
In general most single/dual occupancy developments located on busy roads would not require a specialist acoustic assessment if the recommended building specifications are adopted where deemed necessary, however it is likely that multi-story developments and other sensitive development would require a detailed acoustic assessment confirming that internal noise criteria would be met.

Figure 1 presents a more detailed flow chart which sets out the process that can be followed to determine whether or not an acoustic assessment is required for any particular proposed development that is potentially affected by traffic noise.

Determining Traffic Noise Impacts and Mitigation Categories

In developing the Guideline, a number of ways were considered and evaluated for determining the traffic noise exposure of a site proposed for development. The main objective driving the decision on which approach should be taken, was to have a simple method that would, for most cases, permit developers and consent authorities to determine traffic noise levels and mitigation measures without having to rely on an acoustics engineer. Two key methods evaluated were:

- develop a website with maps presenting categories of noise treatments specified for sites along every major road throughout NSW – this would add significant costs and time delays for the government as it would require computer noise modelling of all major roads in the State and the regular update of noise models and website maps to account for changes to roads, noise barriers and buildings that may influence outcomes



Notes: 1. Although road traffic noise impacts are unlikely to occur at a distance greater than 300m from a road, there are situations where the intervening area between a high trafficked road and a development site is not built-up and is without noise shielding (eg in rural areas) and road traffic noise impacts may occur.

2. The Building Code of Australia defines a habitable room as a room used for normal domestic activities (eg bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room and sunroom).

3. Where the line-of-sight between a development and a road is totally blocked by solid objects such as buildings, walls or land topography, then the development would not automatically require noise treatment.

Source: (Renzo Tonin & Assoc)

Figure 1. Flow Chart Setting Process for Determining Assessment Requirements

- develop a set of simple-to-use graphs that allow the user to determine the category of noise treatments that would apply to any site based on information that is readily available, such as a road's traffic volumes (from an RTA website), its posted speed limits and the distance of the proposed development site to the road

In the interest of expediting the preparation of the Guideline, it was decided that the later method would be developed and adopted in the Guideline, despite the later method not being as accurate as the former method.

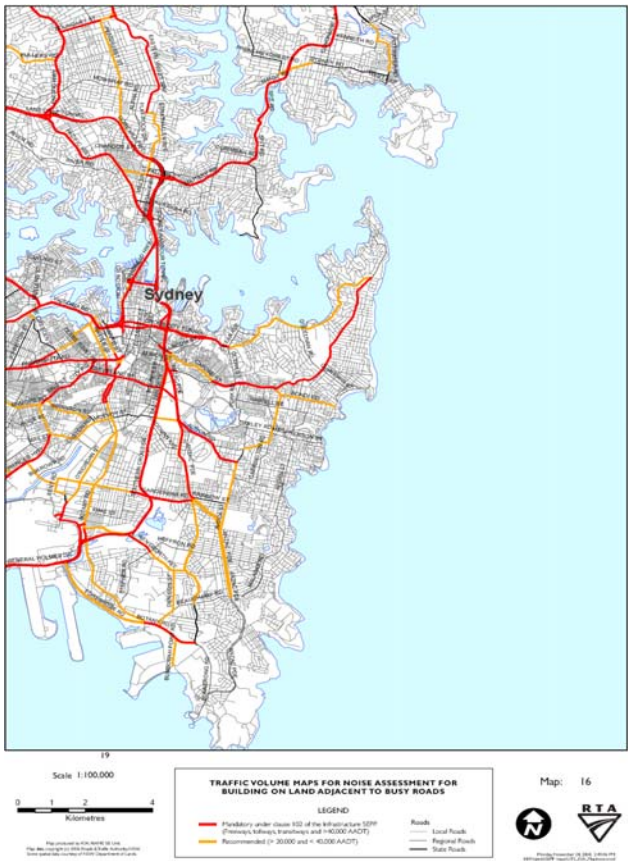
Determining Traffic Volumes

The impact of road traffic noise can vary considerably depending on site characteristics and layout, as well as surrounding geography and land use. The level of traffic noise from a road is directly related to the volume, type and speed of traffic, road surface, distance (unobstructed) from a road and the type of ground cover, with its influence increasing with distance from the road.

The NSW Roads and Traffic Authority provide traffic volume maps which can be used to determine traffic volumes for the nominated roads that are relevant to the site being assessed. The RTA's traffic volume maps can be found at:

http://www.rta.nsw.gov.au/publicationsstatisticsforms/traffic_vol_maps.html

Figure 2 presents an example from the RTA website.



Source: (RTA Web Site)

Figure 2. Example of Traffic Volume Map

Screen Tests

Screen tests were developed for single/dual dwelling developments and for multiple dwelling and other sensitive developments. So that onerous requirements to conduct detailed acoustic assessments and/or apply noise control measures, are not imposed carte blanche, multiple screen tests were developed to be applied to less sensitive scenarios relating to single/dual dwelling developments and to multiple dwelling and other sensitive developments.

An example of the screen test which applies to low traffic speed zones (60-70km/h) for single/dual dwellings is shown in Figure 3. A second screen test was also developed for single/dual dwelling developments, which applies to high traffic speed zones (100-110km/h).

These screen tests take into account the volume of traffic and the distance between the proposed development and the road.

The screen tests work by assigning standard noise control treatments over six categories. Category 1 areas are those likely to have low road traffic noise [ie $L_{Aeq,15h}$ =55-60dB(A), $L_{Aeq,9h}$ =50-55dB(A)] and Category 6 areas are likely to have the highest road traffic noise [ie $L_{Aeq,15h} \geq$ 74dB(A), $L_{Aeq,9h} \geq$ 69dB(A)]. Category increments are in 5dB steps for Categories 1 to 2, and 3dB steps for Categories 3 to 6. Smaller incremental increases are used in assigning standard noise control treatments for the higher traffic noise areas because small increases in noise often require large increases in noise control measures to achieve the desired internal noise goals.

Each category, except for Category 6, refers to a set of standard deemed-to-comply construction methods and building materials for each key element of a building with the aim of achieving the internal performance criteria for noise identified in the clauses of the Infrastructure SEPP. Category 6 requires assistance from an acoustic engineer to conduct a more detailed and accurate assessment and to determine the appropriate site-specific noise control treatment.

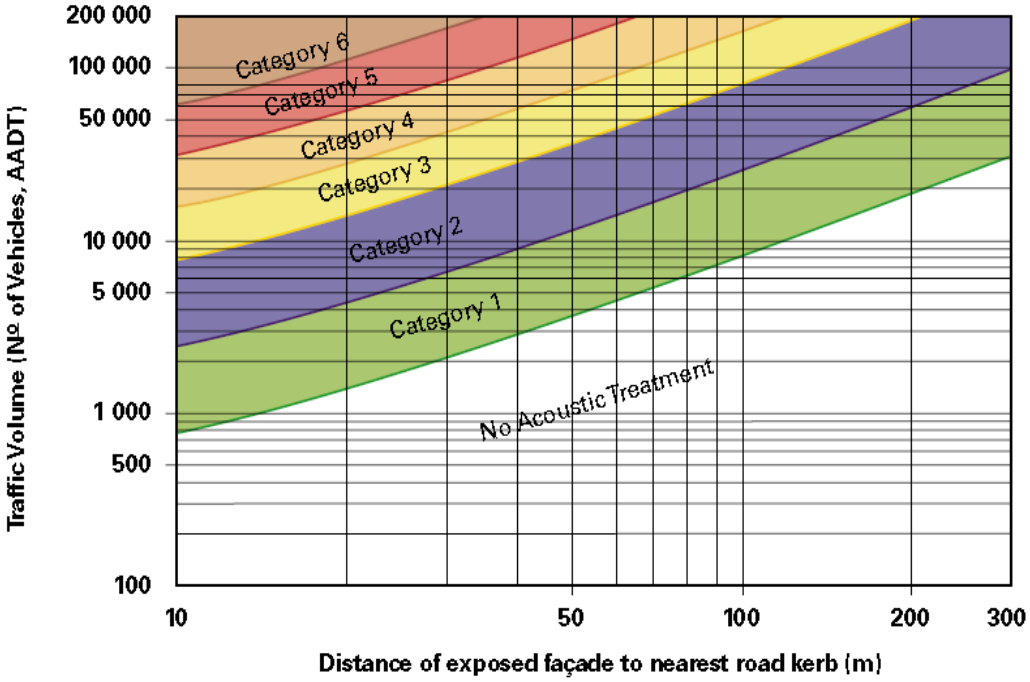
In developing the categories of traffic noise and standard deemed-to-comply constructions, reference was made to Australian Standard 3671 'Acoustics – Road traffic noise intrusion – Building siting and construction'.

In recognition that more detailed level of acoustic design is needed for multiple dwelling developments compared to single/dual occupancy dwellings (primarily due to greater complexity of building design and lay-out with more people likely to be affected), screen tests were developed to assess if an acoustic assessment is required. The screen tests for these developments were developed for two traffic speed zones, but unlike the screen tests developed for single/dual dwellings, they do not categorise what level of traffic noise treatment is needed. Instead, where the screen test determines that an assessment is required, an assessment should be conducted by a qualified acoustic engineer.

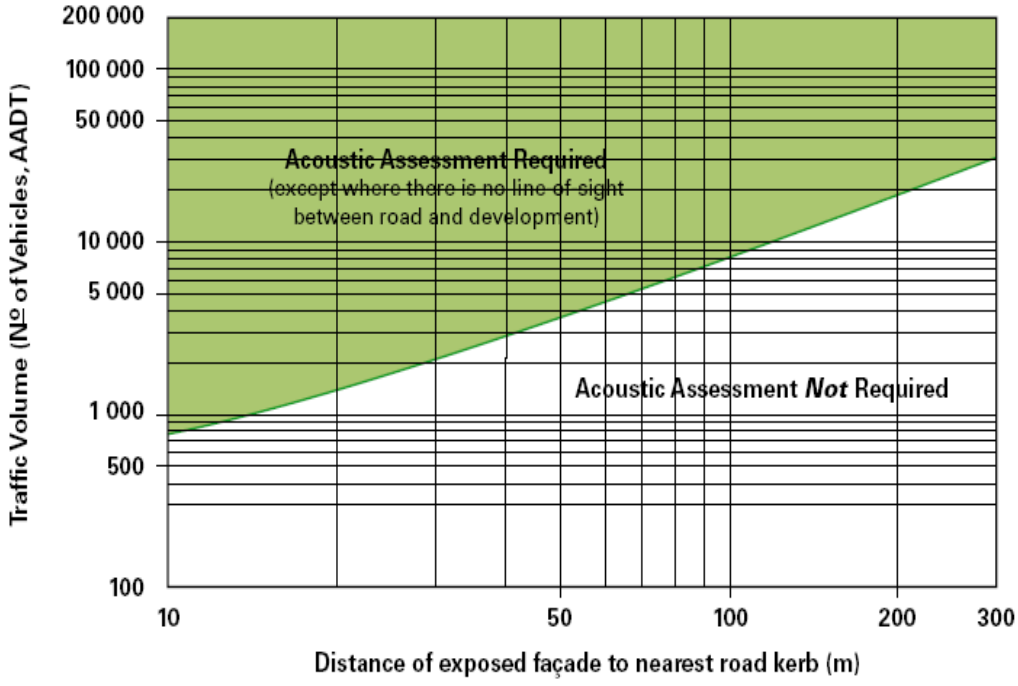
An example of the screen test which applies to low traffic speed zones (60-70km/h) for multiple dwellings and other sensitive developments is shown in Figure 4.

A second screen test was also developed for multiple dwelling and other sensitive developments, which applies to high traffic speed zones (100-110km/h).

The screen tests provided in the Guideline apply within a range of distances from 10 to 300 metres from the road kerb and only to areas of a development (or facades of buildings) which are exposed to traffic noise and which have a direct line-of-sight to the road. The noise-affected facades can be on the noisy side of the building (with a direct exposure or line-of-sight) or on the flanks of a building (with an angled or indirect exposure to the road).



Source: (Renzo Tonin & Assoc)
Figure 3. Screen Test 1(a) − Habitable Areas 60/70 km/h



Source: (Renzo Tonin & Assoc)
Figure 4. Screen Test 2(a) − Habitable Areas 60/70 km/h

To develop the screen tests and the relevant categories of noise control treatment described above, certain traffic volume, vehicle classification and vehicle speed assumptions were agreed to by the working group, as set out in Table 1.

Table 1. Assumptions of Road Traffic Conditions

Traffic Volume Distribution of AADT		% Heavy Vehicles		Vehicle Speed
Day, 15hr	Night, 9hr	Day, 15hr	Night, 9hr	(km/h)
87%	13%	10	10	60 / 70
87%	13%	10	10	100 / 110

Source: (NSW RTA 2007)

In addition, the following noise modelling assumptions were made:

- Calculation of Road Traffic Noise (CoRTN), 1988 noise algorithms
- acoustic energy of light and heavy vehicles split over three source heights = 0.5m, 1.5m and 3.6m
- road surface = dense graded asphalt
- flat ground between the road and receiver
- receiver height at 1st floor = 5m above ground
- no barriers or shielding between road and receiver
- traffic flow equal in both directions of travel
- 2 lanes for each way of travel (ie total 4 lane road)
- average roadway lane width = 3.5m
- separation distance between opposite travelling carriageways = 1m
- angle of view of road from receiver = 160 degrees
- no gradient on road
- 50% hard & 50% soft ground between road and receiver
- facade correction = +2.5dB(A)
- ARRB correction for Australian conditions = -1.7dB(A)

Deemed-to-Comply Constructions

While there isn't a guarantee of achieving a level of compliance offered by the Guideline, there is guidance on noise treatments which are likely to reduce internal noise to acceptable levels, such as the standard deemed-to-comply construction examples shown in Figure 5.

The acoustic performances assumed of each building element in deriving the standard deemed-to-comply constructions for each category of noise control treatment, are presented in Table 2 in terms of Weighted Sound Reduction Index (Rw) values, which can be used to find alternatives to the standard constructions. These combinations of performances for building elements were determined based on typical layouts of modern dwellings taken from a recent large residential development in an outer Sydney suburb.

Table 2. Acoustic Performance of Building Elements

Category of Noise Control Treatment	R_w of Building Elements (minimum assumed)				
	Windows / Sliding Doors	Frontage Facade	Roof	Entry Door	Floor
Category 1	24	38	40	28	29
Category 2	27	45	43	30	29
Category 3	32	52	48	33	50
Category 4	35	55	52	33	50
Category 5	43	55	55	40	50

Alternately where an accurate and site-specific assessment is required, the proponent/consent authority may choose to engage an acoustic engineer to undertake a detailed determination of noise impacts and appropriate noise control measures.

GUIDANCE ON GOOD ARCHITECTURAL ACOUSTIC PRINCIPLES

Some practical guidance was developed for the Guideline on how judicious orientation of buildings, the internal layout and building design can reduce noise impacts to sensitive rooms. This included consideration to the location of road, existing noise levels, topography and nearby buildings. The potential benefit of noise barriers and acoustic shielding from other structures is also noted for consideration along with the use of appropriate windows, doors, ventilation and facade materials. Planning the development from site location, through concept design and materials selection is identified in the Guideline as greatly minimising acoustic impacts and substantially reducing the requirement and costs of attenuation measures that may need to be applied to the development.

COST SAVING FROM 'GOOD' ACOUSTIC PLANNING MEASURES

Orientation

To assess the potential cost savings that can be realised through the use of 'good' acoustic planning measures, a comparison was conducted of a hypothetical typical modern three-bedroom 'project home' (single-storey) with its noise-sensitive rooms facing a busy road, to the same home after applying 'good' acoustic planning by orientating the building so that noise-sensitive rooms are on the opposite side to the busy road. The home comprises building materials for the walls, roof and floor that are typical of a modern 'project home'. Figure 6 presents the floor plan of the home and one of the orientations that were assessed.

Both the internal and external noise levels associated with the two orientations as well as three different building specifications were determined and presented in the Guideline.

External Noise Levels

For each orientation, external road traffic noise was modelled around each building at 1m from critical windows and doors based on a traffic noise exposure of 68dB(A) L_{Aeq} at 1 metre from the most exposed facade. SoundPLAN noise modelling software package was used to determine all external noise levels. The noise modelling assumed the same size buildings exist on each adjacent side of the subject property with a separation of 2m to the common boundary (ie 4m spacing between adjacent buildings) to account for shielding of road noise typically provided by buildings adjacent to developments.

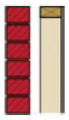
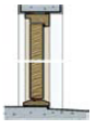
Category No.	Building Element	Standard Constructions	sample
4	Windows/Sliding Doors	Openable with minimum 10.38mm laminated glass and full perimeter acoustic seals	
	Frontage Facade	**Brick Veneer Construction:** 110mm brick, 90mm timber stud or 92mm metal stud, minimum 50mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	
		Double Brick Cavity Construction: 2 leaves of 110mm brickwork separated by 50mm gap	
	Roof	Pitched concrete or terracotta tile or sheet metal roof with sarking, 2 layers of 10mm sound-rated plasterboard fixed to ceiling joists, R2 insulation batts in roof cavity.	
	Entry Door	45mm solid core timber door fitted with full perimeter acoustic seals	
	Floor	Concrete slab floor on ground	

Figure 5. Example of Standard Deemed-to-Comply Building Element Constructions – Category 4
Source: (Renzo Tonin & Assoc)

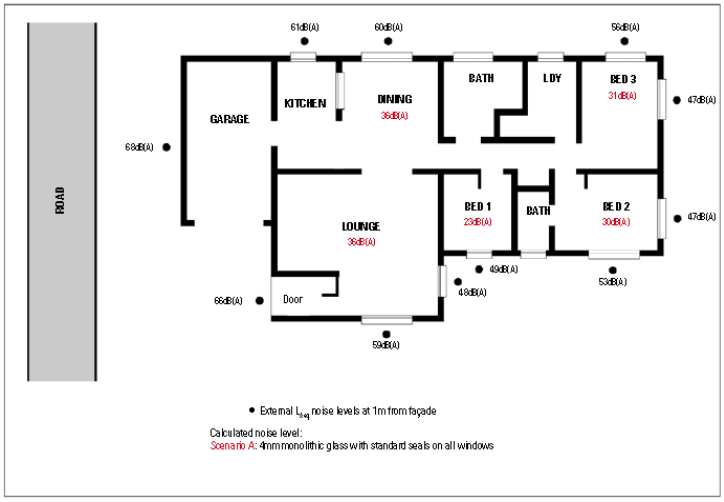


Figure 6. Example of Building Orientation
Source: (Renzo Tonin & Assoc)

Ref	Description	Qty	Unit	Orientation 1 Specification	Orientation 1 Rate	Orientation 1 Total	Orientation 2 Specification	Orientation 2 Rate	Orientation 2 Total
Bed 1									
1	Window	1.8	m^2	A	325	585.00	B	500	900.00
2	Wall	6.3	m^2	A	250	1,575.00	A	250	1,575.00
3	Ceiling	9	m^2	A	60	540.00	A	60	540.00
Bed 2									
1	Window	2.7	m^2	A	325	877.50	B	500	1,350.00
2	Wall	5.4	m^2	A	250	1,350.00	A	250	1,350.00
3	Side window	4.4	m^2	A	325	1,430.00	B	500	2,200.00
4	Side wall	6.4	m^2	A	250	1,600.00	A	250	1,600.00
5	Ceiling	12	m^2	A	60	720.00	C	90	1,080.00

Figure 7. Example of Comparative Costs

Internal Noise Levels

To calculate the internal noise levels and estimate potential savings from applying 'good' acoustic planning principles, building specifications used were determined for each building element of each orientation. The selection of building specifications required was based on achieving the internal noise goals set out in the Infrastructure SEPP. Traffic noise intrusion levels to inside were modelled using OutsideIN, a model developed by Renzo Tonin & Associates.

In-principle cost estimates were determined by a quantity surveyor and included to allow cost comparisons and estimates of potential cost savings when using good acoustic planning principles. The assumptions made assumed reverberation times of 0.6 seconds for bedrooms and 1.0 second for other habitable rooms.

Table 3 presents one of the three building element specifications that were determined for the Guidelines.

Table 3. Specification A from the Guideline

Architectural Feature	Description	Rw Index
Windows	Standard 4mm monolithic glass with standard weather seals	Rw 25
Doors	External - 30mm solid core timber, Internal - aluminium framed glass sliding lounge and dining room	Rw24
Walls	Brick veneer and standard plasterboard on timber studs with insulation in cavity	Rw 52
Roof	Tiled roof and standard plasterboard ceiling with insulation	Rw 43
Floor	Concrete slab	N/A

NB. Rw is the weighted sound reduction index of the building element
Source: (Renzo Tonin & Assoc)

Costs Associated with Achieving Acceptable Noise Levels

Cost estimates were determined based on achieving acceptable internal noise levels by either architectural treatments or by a combination of orientation and treatment, where required.

Cost estimates were determined for each of the two orientations and for each of the three building specifications, as necessary. Figure 7 presents a sample of cost comparisons for two bedrooms.

The cost rates adopted are considered to be averages, applicable in the Sydney metropolitan area, for normal residential projects, as at June 2008. The results show that a cost difference of $4,076 was found between the two orientations which represent approximately 10% of the total building element costs considered. This illustrates the potential cost savings when good acoustic planning and design measures are used, and this information is presented in detail within Appendix B of the Guideline.

CONCLUSIONS

NSW has for the first time introduced a planning instrument which establishes internal noise levels. Supporting this instrument is a Guideline which provides guidance on building design, internal layout and architectural principles to achieve an acceptable internal acoustic environment as well as synergies in addressing air and noise impacts. The Guideline also provides general guidance on strategic planning for Councils and other government agencies, or private proponents investigating possible locations for new residential and other sensitive development that require development approval. In addition, it provides guidance on site selection to reduce or avoid the need for mitigation measures for new residential (eg single/dual occupancy, multi-unit, etc) dwellings and other sensitive developments.

This paper presents a summary of the technical background, assumptions and considerations given in relation to the road traffic noise information contained within the Guideline. It addresses and describes:

- how road noise levels are established,
- how the processes were developed to assess noise levels for residential and other sensitive land uses,
- how the generic deemed-to-comply building acoustic design requirements were derived to improve the acoustic amenity of building occupants; and
- discusses the cost-savings in noise mitigation measures that can be achieved through good acoustic planning and design.

The authors intend to monitor the effectiveness of the Guideline and hope to report on how it influences building design along busy roads in the future.

ACKNOWLEDGEMENTS

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