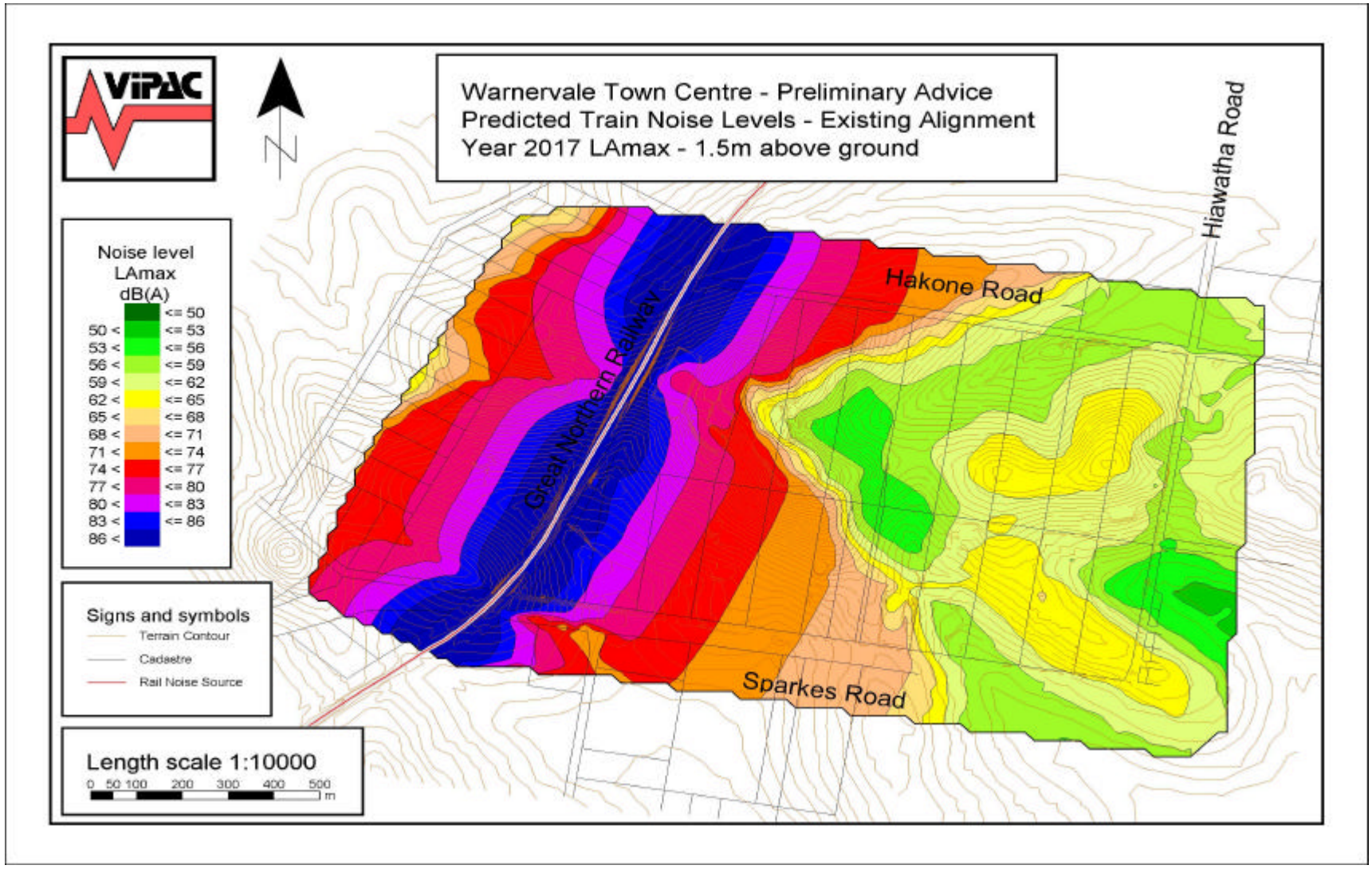
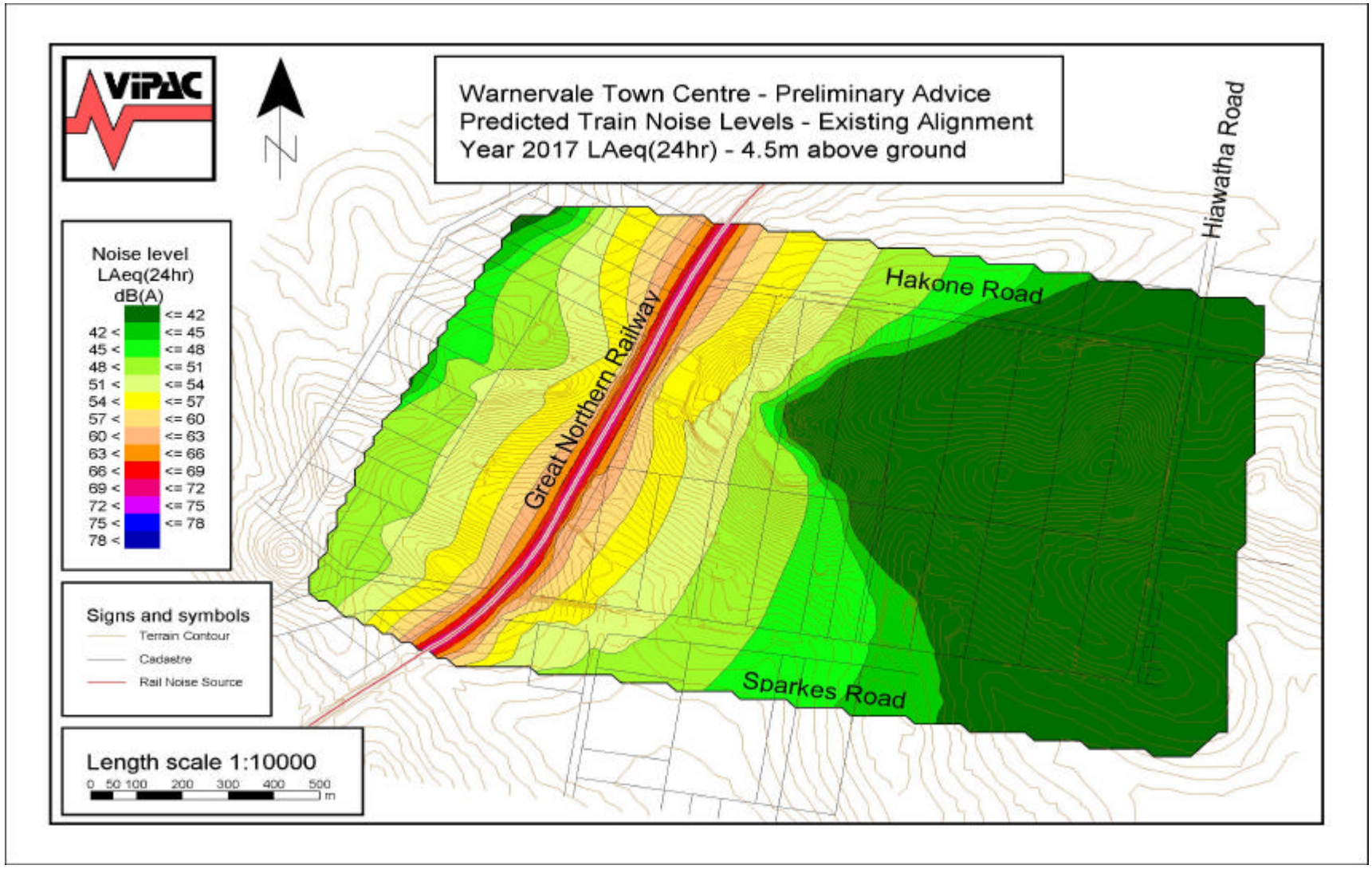
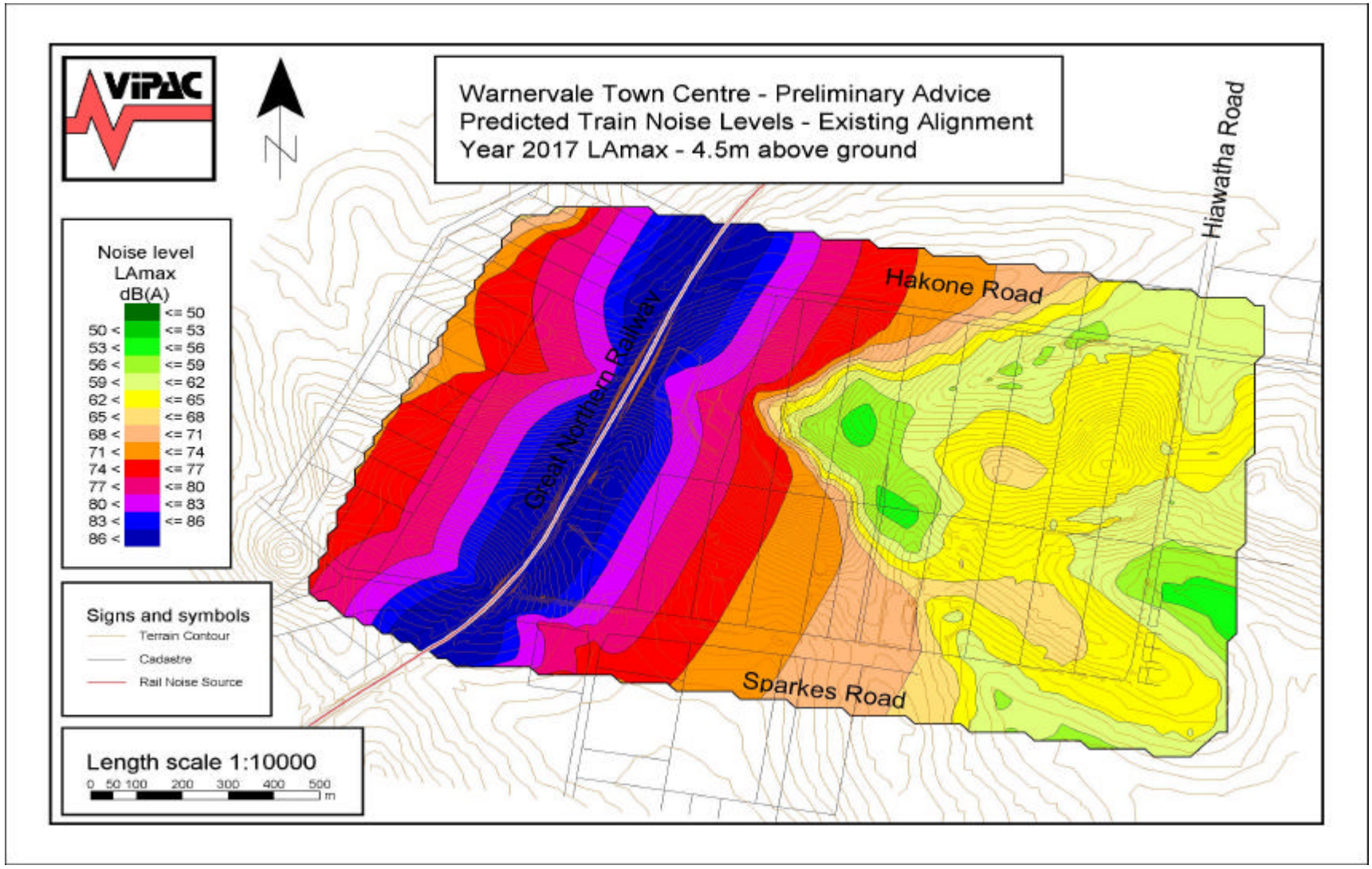

Warnervale Town Centre - Preliminary Advice
Predicted Train Noise Levels - Existing Alignment
Year 2017 LAmax - 1.5m above ground
N
Noise level
LAmax
dB(A)
<= 50
50 < <= 53
53 < <= 56
56 < <= 59
59 < <= 62
62 < <= 65
65 < <= 68
68 < <= 71
71 < <= 74
74 < <= 77
77 < <= 80
80 < <= 83
83 < <= 86
86 <
Signs and symbols
Terrain Contour
Cadastre
Rail Noise Source
Length scale 1:10000
0 50 100 200 300 400 500 m
Great Northern Railway
Hakone Road
Hiawatha Road
Sparkes Road


Warnervale Town Centre - Preliminary Advice
Predicted Train Noise Levels - Existing Alignment
Year 2017 LAeq(24hr) - 4.5m above ground
N
Noise level
LAeq(24hr)
dB(A)
<= 42
42 < <= 45
45 < <= 48
48 < <= 51
51 < <= 54
54 < <= 57
57 < <= 60
60 < <= 63
63 < <= 66
66 < <= 69
69 < <= 72
72 < <= 75
75 < <= 78
78 <
Signs and symbols
Terrain Contour
Cadastre
Rail Noise Source
Length scale 1:10000
0 50 100 200 300 400 500 m
Great Northern Railway
Hakone Road
Hiawatha Road
Sparkes Road


Warnervale Town Centre - Preliminary Advice
Predicted Train Noise Levels - Existing Alignment
Year 2017 LAmax - 4.5m above ground
Noise level
LAmax
dB(A)
<= 50
50 < <= 53
53 < <= 56
56 < <= 59
59 < <= 62
62 < <= 65
65 < <= 68
68 < <= 71
71 < <= 74
74 < <= 77
77 < <= 80
80 < <= 83
83 < <= 86
86 <
Signs and symbols
Terrain Contour
Cadastre
Rail Noise Source
Length scale 1:10000
0 50 100 200 300 400 500 m
Great Northern Railway
Hakone Road
Hiawatha Road
Sparkes Road

APPENDIX C: TABLE 1 AND 2 OF THE ECRTN

Table 1. Road traffic noise criteria for proposed road or residential land use developments

For an explanation of the terms used here, see the sections 'Guide to terms used in the tables' and 'Technical notes to the tables' immediately following the tables.

TYPE OF DEVELOPMENT	CRITERIA		
	DAY (7 am–10 pm) dB(A)	NIGHT (10 pm–7 am) dB(A)	WHERE CRITERIA ARE ALREADY EXCEEDED
1. New freeway or arterial road corridor	$L_{Aeq(15hr)}$ 55	$L_{Aeq(9hr)}$ 50	The new road should be designed so as not to increase existing noise levels by more than 0.5 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. 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. New residential land use developments affected by freeway/arterial traffic noise	$L_{Aeq(15hr)}$ 55	$L_{Aeq(9hr)}$ 50	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria via judicious design and construction of the development. Locations, internal layouts, building materials and construction should be chosen so as to minimise noise impacts.
3. Redevelopment of existing freeway/arterial road	$L_{Aeq(15hr)}$ 60	$L_{Aeq(9hr)}$ 55	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

Environmental criteria for road traffic noise

TYPE OF DEVELOPMENT	CRITERIA		
	DAY (7 am–10 pm) dB(A)	NIGHT (10 pm–7 am) dB(A)	WHERE CRITERIA ARE ALREADY EXCEEDED
4. New collector road corridor	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	The new road should be designed so as not to increase existing noise levels by more than 0.5 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In some instances this may only be achievable 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.
5. New residential developments affected by collector traffic noise	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria via judicious design and construction of the development. Locations, internal layouts, building materials and construction should be chosen so as to minimise noise impacts.
6. Redevelopment of existing collector road	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies, such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.
7. Land use developments with potential to create additional traffic on existing freeways/arterials	$L_{eq(15hr)}$ 60	$L_{eq(9hr)}$ 55	Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.

Environmental criteria for road traffic noise

TYPE OF DEVELOPMENT	CRITERIA		
	DAY (7 am–10 pm) dB(A)	NIGHT (10 pm–7 am) dB(A)	WHERE CRITERIA ARE ALREADY EXCEEDED
8. Land use developments with potential to create additional traffic on collector road	$L_{Aeq(1hr)}$60	$L_{Aeq(1hr)}$55	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.
9. New local road corridor in a metropolitan area	$L_{Aeq(1hr)}$55	$L_{Aeq(1hr)}$50	The new road should be designed so as not to increase existing noise levels by more than 0.5dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through medium-term and long-term strategies, such as regulation of exhaust noise from in-service vehicles; limitations on exhaust brake use; restricted access for sensitive areas or during sensitive times to low-noise vehicles; improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards; and alternative methods of freight haulage.
10. New local road corridor in a rural area	$L_{Aeq(1hr)}$50	$L_{Aeq(1hr)}$45	
11. New residential developments affected by traffic noise from local roads	$L_{Aeq(1hr)}$55	$L_{Aeq(1hr)}$50	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria for occupants by judicious design and construction of the development. Relevant strategies will include optimum location and orientation of buildings on the site; planning internal layouts carefully; choosing the most appropriate building materials; and using good construction techniques.

Environmental criteria for road traffic noise

TYPE OF DEVELOPMENT	CRITERIA		
	DAY (7 am–10 pm) dB(A)	NIGHT (10 pm–7 am) dB(A)	WHERE CRITERIA ARE ALREADY EXCEEDED
12. Redevelopment of existing local roads	$L_{Aeq(1hr)}$55	$L_{Aeq(1hr)}$50	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through medium-term and long-term strategies, such as regulation of exhaust noise from in-service vehicles; limitations on exhaust brake use; restricted access for sensitive areas or during sensitive times to low-noise vehicles; improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards; and alternative methods of freight haulage.
13. Land use developments with potential to create additional traffic on local roads	$L_{Aeq(1hr)}$55	$L_{Aeq(1hr)}$50	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB.

Environmental criteria for road traffic noise

Table 2. Road traffic noise criteria for sensitive land uses

For an explanation of terms used here see the sections 'Guide to terms used in the tables' and 'Technical notes to the tables' immediately following the tables.

SENSITIVE LAND USE	CRITERIA		
	DAY 7 am–10 pm dB(A)	NIGHT 10 pm–7 am dB(A)	NOISE MITIGATION MEASURES
1. Proposed school classrooms (For existing schools see Technical Note x)	$L_{Aeq(1h)}$ 40 (internal)	-	To achieve internal noise criteria in the short term, the most practicable mitigation measures are often related to building or façade treatments. In the medium to longer term, strategies such as regulation of exhaust noise from in-service vehicles, limitations on exhaust brake use, and restricting access for sensitive areas or during sensitive times to low noise vehicles can be applied to mitigate noise impacts across the road system. Other measures include improved planning, design and construction of sensitive land use developments; reduced new vehicle emission standards; greater use of public transport; and alternative methods of freight haulage. These medium- to long-term strategies apply equally to mitigating internal and external noise levels. Where existing levels of traffic noise exceed the criteria, all feasible and reasonable noise control measures should be evaluated and applied. Where this has been done and the internal or external criteria (as appropriate) cannot be achieved, the proposed road or land use development should be designed so as not to increase existing road traffic noise levels by more than 0.5 dB(A) for new roads and 2 dB(A) for redeveloped roads or land use development with potential to create additional traffic.
2. Hospital wards	$L_{Aeq(1h)}$ 35 (internal)	$L_{Aeq(1h)}$ 35 (internal)	
3. Places of worship	$L_{Aeq(1h)}$ 40 (internal)	$L_{Aeq(1h)}$ 40 (internal)	
4. Active recreation (for example, golf courses)	Collector and local roads: $L_{Aeq(1h)}$ 60 Freeway/ arterial roads: $L_{Aeq(15h)}$ 60	-	
5. Passive recreation and school playgrounds	Collector and local roads: $L_{Aeq(1h)}$ 55 Freeway/ arterial roads: $L_{Aeq(15h)}$ 55	-	

Environmental criteria for road traffic noise

APPENDIX D: APPLICABLE NOISE REGULATIONS

Regardless of the final mitigation strategies, all development proposed in noise impacted areas should be in compliance with the relevant regulations. These include, but are not limited to:

- NSW Environmental Protection Authority (DEC) *'Environmental Criteria for Road Traffic Noise*' (ECRTN);
- Rail Infrastructure Corporation & State Rail Authority *'Consideration of Rail Noise and Vibration in the Planning Process'*, November 2003;
- AS 2107 - 2000 "Acoustics – Recommended Design Sound Levels and Reverberation times for Building Interiors";
- AS3671 - 1989 "Acoustics - Road traffic noise intrusion - Building siting and construction" ;
- SRA Document 'Rail Related Noise and Vibration' (October 1995);
- NSW DEC Environmental Noise Control Manual (ENCM);
- All relevant Sections of the BCA (2004).

APPENDIX E: NOISE BARRIER ACOUSTIC SPECIFICATION

1. AIM

The noise barriers shall provide the appropriate acoustic performance (Sound Transmission Loss and Sound Absorption Coefficient, in the case where absorptive barriers are required) as specified below.

2. CONSTRUCTION AND INSTALLATION

To aid meeting the acoustic specification (and helping to maintain the requirements over time), the following construction and installation is recommended:

- Barriers shall be continuous and solid over the length and height specified. Any holes or gaps shall be avoided. At the joints (horizontal and vertical) between panels, or if small gaps appear during construction, an appropriate flexible and durable packer/filler (such as dense closed-cell compressible foam or rubber, using PVC/polyurethane or EPDM material) or weather-resistant sealant (such as silicone or polyurethane) should be used.
- Careful attention shall be paid to drainage requirements to avoid gaps along the ground line (eg. recommend minimum 100mm backfill of soil against base of wall). Where drainage is required, pipes shall be used rather than gaps.
- Allowance shall be made in the construction for any settling or movement of a barrier or barrier segment, as a result of embedded foundations or other causes.
- The effect of environmental considerations such as sunlight/UV attack, shrinkage/warping and cracking with age, rot, settling of porous infill etc. shall be considered and minimised as far as practicable. The infill or clogging of the porous structure or cavities of absorptive barriers over time shall be considered.
- The barriers shall be constructed and treated in such a way that minimises the impact of vandals or graffiti.
- The types of construction material that are likely to meet the following acoustic requirements include (but not limited to): concrete, pre-cast concrete, aerated concrete, autoclaved concrete, fibreglass reinforced concrete, fibreglass reinforced plasterboard with dense infill material, crib or retaining walls (with soil/rock infill).

3. ACOUSTIC REQUIREMENTS

The acoustic requirements given below depend on a range of factors such as the required noise reduction, the location and height of the barrier and aspects such as reflection effects.

3.1 Transmission Loss

The transmission loss of a barrier depends on frequency. It is common to simplify this to a single number rating known as the Sound Transmission Class (STC) or Weighted Sound Reduction Index, Rw. This rating is commonly used in the building industry, and has relevance to occupancy type noise sources, with particular relevance to mid and high frequency sources (ie. between 500 Hz and 4kHz).

Where the noise is dominated by low frequencies (ie. between 63 Hz and 500 Hz), the individual components for these frequencies must be considered with regard to the human ear's sensitivity to these frequencies and the spectrum of the noise. As the transmission loss at 63 Hz is rarely measured, suppliers shall use a linear average of the octave band data at 125 Hz, 250 Hz, 500 Hz and 1 kHz, to give the required Average Transmission Loss.

Manufacturers shall submit acoustical test data showing the performance of their barriers. The transmission loss data shall be measured in a test facility approved by a National Accreditation Testing Authority. All measurements are to be performed in accordance with AS 1191-1985 *"Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions"*.

The Average Transmission Loss, measured on a square metre basis in a reverberation chamber, shall be a minimum of **25** (this is likely to correspond approximately to an STC or Rw of around 30 and depends on the frequency response of the barrier material).

3.2 Sound Absorption Coefficient

The sound absorption of a barrier depends on frequency. It is common to average 250 Hz, 500 Hz, 1 kHz and 2 kHz to give a single number rating known as the noise reduction coefficient (NRC). Where the noise is dominated by low frequencies (ie. between 63 Hz and 500 Hz) the individual components for these frequencies must be considered with regard to the ear's sensitivity to these frequencies. As sound absorption coefficients are rarely measured at 63 Hz, suppliers shall use a linear average of the octave band data at 125 Hz, 250 Hz, 500 Hz and 1 kHz, to give the required Average Equivalent Sound Absorption Coefficient.

Manufacturers shall submit acoustical test data showing the performance of their barriers, where absorptive types have been specified. The sound absorption data shall be measured in a test facility approved by a National Accreditation Testing Authority. All measurements are to be performed in accordance with AS 1045-1988 *"Acoustics - Measurement of Sound Absorption in a Reverberation Room."*

The Average Equivalent Sound Absorption Coefficient, measured on a square metre basis in a reverberation chamber, shall be a minimum of **0.6** (this requirement only applies to absorptive barriers). Such a requirement would roughly relate to an approximate NRC in the range of 0.7 to 0.8 (depending on the frequency response of the barrier material).

APPENDIX F: EXAMPLES OF NOISE BARRIER DESIGNS

Demonstration Panel – Timber Patterned Prestressed Concrete panels

Demonstration Panel – Prestressed Concrete panel Cobblestone pattern