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Coffs Harbour Highway Planning
Coffs Harbour Section

Strategic Noise Assessment
Working Paper No 4

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Connell Wagner

PACIFIC HIGHWAY, COFFS HARBOUR

INNER BYPASS AND EXISTING HIGHWAY UPGRADE

NOISE ASSESSMENT

Report No 02122-IB
Version C

February 2004

Prepared for

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1. INTRODUCTION

The purpose of this working paper is to present a strategic overview of the impacts of road traffic noise associated with three future highway options identified by the Coffs Harbour Highway Planning Strategy. The options reviewed in this paper are: -

- "Do Nothing" approach. No bypass or major upgrade of the existing Highway. Upgrade of some intersections on the existing Highway to cater for increasing traffic volumes. In terms of this noise assessment, intersection upgrades are assumed to have no impact on traffic noise levels.

- Inner Bypass Options. This would deviate from the existing Pacific Highway alignment just south of Englands Road and rejoin the existing highway in the vicinity of Bruxner Park Road and extend to the southern part of the proposed Sapphire to Woolgoolga upgrade.

- Upgrade Existing Highway through Coffs Harbour. This would include grade separated interchanges at a number of the key locations along the existing alignment and one short section of tunnel to straighten out under Macauleys Headland to avoid the existing relatively tight bends.

The approach taken for this study has been to undertake a SWOT analysis (strengths, weaknesses, opportunities and threats) in relation to potential noise impacts for each of the given options. Technical information used in this working paper, including road surface details, traffic flow volumes and likely traffic speeds has been provided by Connell Wagner. For each option, a marginally conservative approach has been adopted. This is considered valid when drawing comparisons between the different options.

One of the complications of this comparative study is that a high proportion of daytime traffic on the existing Pacific Highway is localised (Coffs Harbour) traffic. Under the Inner Bypass Options, considerable volumes of local traffic would remain on the bypassed section of highway. It is acknowledged that some intersections on the bypassed section of the existing highway may need upgrading. For the purpose of this working paper, it is considered that the potential intersection upgrades on the bypassed section of highway will have negligible impacts on traffic noise levels.

We have made reference (Chapter 3) to the current DEC *Environmental Criteria for Road Traffic Noise (ECRTN)* in order to provide the reader with some information in relation to distances from the proposed highways where current noise level criteria would be achieved. A sensitivity analysis, assuming 20% higher growth in traffic, is also considered. Reference has also been made to the Roads and Traffic Authorities (RTA) *Environmental Noise Management Manual (ENMM)*.

The following scenarios have been considered to compare the future highway options:-

- Road at ground level
- Road on low to medium fill (between 1m and 5m)
- Road on medium to high fill (greater than 5m)
- Road in shallow cut or with low mound (between 1m and 3m)
- Road in deep cut or with high mound (greater than 6m)
- Road with 4m barriers

Noise level predictions have assumed gradients of 0% (level), 2%, 4% and 6%.

In addition, the distances at which barriers and/or mounds of different heights achieve the *ECRTN* criteria have been provided. This information is useful in determining a preferred road profile in order to include as much natural shielding as possible through the use of cuttings. By lowering the road level through cuts, which generate extra fill material, and also lowering the height of fills, the additional spoil material may be used to provide earth mounding rather than barriers.

Given that each individual residential receiver has a slightly different aspect to the road, information regarding the influence of the elevation of receivers on noise levels has also been provided. This information considers receivers at ground level (ie. up to 2.5m) elevated (receivers up to 5-6m in height where the ground is still relatively flat) or super elevated (where receivers sit at much higher elevations than the road (at least 20-30m) irrespective of their height above local ground level with clear line of sight to the road below).

Based on the traffic flow volumes for the Inner Bypass option, it is clear that the night time period, which includes a high percentage of heavy vehicles, is by far the most sensitive. However, for the residual volumes on the existing highway, the daytime period is the most sensitive. For the Existing Highway Upgrade option, the differences between day and night are not as significant, although the night time still remains the most sensitive. This report therefore focuses on the night time period.

2. DESCRIPTION OF OPTIONS

The location of residential receivers along the existing highway is summarised in Table 2-1 below.

Table 2-1 Receiver Types Adjacent to Existing Highway

Highway Section	Receivers and Distance to Road		
	To West	**Road Description**	**To East**
South of Englands Rd	-	Flat	90m
Englands Rd to Halls Rd	Caravan Park, 40m Residential, Motel, Commercial	Flat Flat	Base Hospital, 100m Residential, 160m (shielded by commercial)
Halls Rd to Combine St	Residential 40-80m (Low down), motels	Uphill then downhill (quite steep)	Residential, (40m high up), Commercial
Combine St to Coff St	Res 55m (on service road) Motel (10m), Hotel, Commercial	Flat	Motels 40m (service road), Commercial
Coff St to Bray St	Res 15m (multi storey) Commercial, Residential, 20m	Flat Flat	Caravan Park, Showgrounds, Commercial
Bray St to Arthur St	Residential, 40-100m Commercial Doctor/Dentist	Flat	Shopping Centre, Commercial
Arthur St to James Small Dr	Res, 30m (high), Big Banana, Motel, 50m Caravan Park and Res, 45m slightly higher	Uphill then Downhill Undulating	Res 20m (behind wall and lower), 40-60m (lower, no wall) 60m (lower, no wall), Resort
North of James Small Dr	Res 60-200m (higher)		Re 50-150m generally lower, School (behind wall)

2.1 Do Nothing

The range of traffic volumes along the study route for 2021 are detailed in Table 2-2. Speeds are typically 60-80km/hr. It is assumed that a dense grade asphalt surface exists throughout this section.

Table 2-2 Range of Traffic Volumes 2021

Period	Volume (v.p.d.)[1]	% Heavy Vehicles
Daytime (7am – 10pm)	25,300 – 41,300	9
Night time (10pm – 7am)	2,700 – 3,800	23 - 33

1. All volumes rounded to nearest 100 vpd

2.2 Inner Bypass

The Inner Bypass option includes two sub-options: -

- Inner South 1 and 2; and
- Inner North 1 and 2.

The Inner Bypass options pass through or close to the North Boambee Urban Release, through rural 1A and 1B agricultural living zones, through the eastern part of the West Coffs urban release area, through existing residential 2B medium density zone, more rural 1B living areas and the rural residential investigation area and finally the Korora rural residential area.

The range of traffic volumes along the study route for the year 2021 provided by Connell Wagner have been summarised in Table 2-3 as follows:

Table 2-3 Range of Traffic Volumes 2021

Period	Inner Bypass		Residual on Existing Highway[2]	
	Total Vehicles[1]	% of Heavy Vehicles	Total Vehicles[1]	% of Heavy Vehicles
Daytime (7am-10pm)	10,500 – 15,000	9	20,200 – 32,900	9
Night Time (10pm-7am)	1,600 – 1,900	43 – 52	1,500 – 2,400	2 - 4

1. All volumes rounded to nearest 100 vpd.
2. Residual volumes are for the bypassed section of the highway.

For the Inner Bypass option, it is assumed that a speed limit of 100km/hr would apply and a concrete road surface with a hessian drag finish and transverse tining (surface correction of +1dBA compared to dense grade asphaltic concrete) is assumed. It is anticipated that by the time this road is built that the development of quieter concrete road surfaces will have developed to such an extent that lower noise levels would be achieved. However, a conservative approach is adopted at this stage.

2.3 Existing Highway Upgrade

The Existing Highway Upgrade option involves the upgrading of the existing highway to a new urban motorway standard, with service roads mostly directly adjacent. From a noise perspective, the total traffic noise from the highway and service roads need to be considered. Although speed on the new highway would be typically 80km/hr, speeds on the service roads would be lower (60km/hr). Given there would be more stop/start noise on the service roads, a marginally conservative approach would be to consider the total corridor traffic volumes at the higher speed.

The range of traffic volumes along the study route for 2021 are summarised in Table 2-4. It is assumed that the wearing surface of the upgraded highway is dense grade asphaltic concrete, and the speed limit 80km/hr. This section would include grade separated interchanges where the highway may be above the local roads. It is preferred at the interchanges that the highway would be the lower of the roads, however, this may be impractical at most locations.

Table 2-4 Range of Corridor Traffic Volumes 2021[1]

Period	Flow Volumes (v.p.d.)[2]	% Heavy Vehicles
Daytime (7am – 10pm)	31,300 – 45,800	9
Night time (10pm – 7am)	3,100 – 4,800	21 - 34

1. The range of traffic volumes and % heavy vehicles are based on the total traffic predicted in the corridor and include traffic on the upgraded highway plus the service roads, where applicable.
2. All volumes rounded to nearest 100 vpd

3. CURRENT DEC NOISE LEVEL CRITERIA

The *ECRTN* takes into account the road's classification and any proposed road upgrades. Since the future highway options relate to the Pacific Highway, all options fall under the Freeway and Arterial Road category for which criteria apply over the 15 hour daytime (7.00am – 10.00pm) and 9 hour night time (10.00pm – 7.00am) periods.

The criteria also depend on whether a new road is being built or an existing road is being redeveloped. Clearly, the Inner Bypass would be a new road. Depending on it's precise alignment, it is possible that the Existing Highway Upgrade would either constitute a redeveloped road or a new road. For the majority of residential receivers close to the road where the noise impact would be the greatest, the Existing Highway Upgrade would constitute a redevelopment of an existing Freeway. The criteria from the *ECRTN* are therefore summarised as follows:

- New Freeway / Arterial Road $L_{Aeq,15hr}$ = 55dBA
  $L_{Aeq,9hr}$ = 50dBA

- Redeveloped Freeway / Arterial Road $L_{Aeq,15hr}$ = 60dBA
  $L_{Aeq,9hr}$ = 55dBA

These noise levels are termed the *Base Criteria* which should be achieved where feasible and practicable. However, the DEC accept that it may not be possible to achieve these *Base Criteria* and also recommend an *Allowance Criteria* which limits any increases in noise level to no more than 2dBA above the existing L_{Aeq} level for a redeveloped road and 0.5dBA for a new road.

This assessment is normally conducted 10 years after the road project has opened. This is not practicable for this study since it is currently considering 20-30 year timeframes.

4. ASSESSMENT OF NOISE LEVELS

This section provides an assessment of the different options from a road traffic noise perspective.

4.1 Do Nothing

At the range of typical (40m-80m) residential set backs from the existing highway, L_{Aeq} noise levels (dBA) would range as shown in Table 4-1 below.

Table 4-1 Predicted Night time L_{Aeq} Noise Levels 2021

Period	Traffic Volumes (v.p.d.)			
	Minimum 25,300 Day, 2,700 Night)		Maximum (41,300 Day, 3,800 Night)	
	40m	80m	40m	80m
Daytime (7am – 10pm)	70.5	66.5	72	68
Night time (10pm – 7am)	66.5	62.5	68	64

These noise levels are all typically 10dBA or more above the Base Criteria for Redeveloped Roads of 60dBA daytime and 55dBA night time (refer Chapter 3) and would therefore fall into the category where the RTA would define traffic noise levels as "acute" (refer *ENMM*).

For this reason, any upgrade of the existing highway would need to address noise control. In addition, any requirement to upgrade sections of the existing highway bypassed by the Inner Bypass options would require additional noise control considerations. This is discussed in more detail in section 4.2 of this working paper.

Strengths

The least total number of residences would be affected since traffic noise would be confined to the one corridor. Only those residences already affected by traffic noise would be subjected to increases in traffic noise.

Weaknesses

Noise levels would remain above the Base Criteria as the *ECTRN* would be unlikely to require the provision of noise mitigation measures. If noise mitigation measures were provided in association with minor improvements to a section of the existing highway, it is unlikely that it would be reasonable or feasible to reduce the noise levels to below the Base Criteria.

Opportunities

With the inclusion of this section of the Pacific Highway in the RTA's ongoing commitment to treating "loud spots", barriers could be provided to mitigate noise where practicable. At most receivers noise levels could be reduced to lower than current noise levels.

Threats

The main threat is that the road system will eventually provide such a low level of service it will fail to meet the needs of a national highway and local backbone and some traffic, with associated noise impacts, could divert to local streets.

4.2 Inner Bypass

Table 4-2 below summarises the approximate range of distances to achieve the *ECRTN* criteria for a new road at night time (50dBA), based on the assumption discussed in Section 2 for a concrete road surface for the Year 2021. Table 4-2 contains typical options for noise control to show the effect these mitigation measures have on the distance (buffer zone) to meet *ECRTN* criteria.

Traffic noise modelling is based on the "angle of view" which relates to how much of the road can be seen from a residence. At a residence close to the road, the angle of view is typically 170^0. Once distances above approximately 500m are reached the angle of view would reduce since the road would most likely pass through sections of cut, or does not maintain a high gradient over the angle of view assumed in the calculations. For this reason. the distances nominated in table 4-2 have only been included if they are considered likely to occur.

Table 4-2 Approximate Distances to Achieve *ECRTN* Criteria at Night Time

Scenario	Approximate distance to achieve *ECRTN* night time criteria of $L_{Aeq,9hr}$ = 50dBA (m)											
	Elevation of Receiver											
	At Ground Level (up to 2.5m above ground level)				Elevated (5m to 6m above ground level)				Superelevated (much higher than road)			
	Avg Road Gradient				Avg Road Gradient				Avg Road Gradient			
	0%	2%	4%	6%	0%	2%	4%	6%	0%	2%	4%	6%
Road at Ground Level												
No noise mitigation	500	575	650	-	550	625	800	-	600	675	775	-
4m Barrier or Mound	100	120	140	170	120	140	120	200	300	350	400	450
4m Mound with 4m Barrier	50	60	70	80	60	70	80	90	150	190	230	280
Road on Low to Medium Fill												
No noise mitigation	500	625	700	-	600	675	750	-	650	725	825	-
4m Barrier or Mound	100	120	140	170	120	140	170	200	300	350	400	450
4m Mound with 4m Barrier	50	60	70	80	60	70	80	90	150	190	230	280
Road on Medium to High Fill												
No noise mitigation	600	675	750	-	650	725	800	-	700	775	875	-
4m Barrier or Mound	100	120	140	170	120	140	170	200	300	350	400	450
4m Mound with 4m Barrier	50	60	70	80	60	70	80	90	150	190	230	280
Road in Shallow Cutting												
No noise mitigation	250	280	310	350	320	350	390	450	600	675	775	-
4m Barrier	100	120	140	170	120	140	170	200	300	350	400	450
Road in Deep Cutting												
No noise mitigation	100	120	140	170	120	140	170	200	250	280	310	350

For an increase in traffic volume by 20%, noise levels would increase by approximately 1dBA. This is equivalent to increasing these distances by approximately 20%.

In noise sensitive locations, the use of quieter road surfaces could result in at least a 2 to 3 dBA reduction in noise levels which would typically reduce the distance to achieve *ECRTN* criteria of $L_{Aeq,9hr}$ = 50dBA from two thirds to one half of the distances detailed in Table 4-2.

Without noise mitigation and assuming any receiver has a relatively large angle of view to the road with typical gradient conditions, the *Base Criteria* of 50dBA at night time (the most sensitive period) could typically be achieved at 500m – 800m from the edge of the alignment depending on the topography, gradient and receiver elevation. Theoretically, distances of 1km could be achieved in specific situations. Residential areas already encroach this distance and land release also extends into these areas. In reality, due to the likely location, depth of cuts and intervening shielding provided by surrounding topography, a reduction of the larger distances in Table 4-2 by around 30-50% is possible, which also reduces the zone of potential impact.

Noise mitigation measures such as barriers and/or mounds would be required to allow residential development closer to the Inner Bypass options. Figure 1 shows the approximate night time 50dBA noise contour achievable with feasible noise mitigation measures. Barriers of excessive height may not be acceptable or suitable in this semi rural/rural residential environment. Landscaped mounds, possibly incorporating a low barrier, would be a more suitable arrangement in this environment from an urban design perspective. In addition, quieter road surfaces could be used in noise sensitive locations to either eliminate the need for barriers and/or mounds or to reduce their height.

These contours, as detailed in Figure 1, indicate that the Inner North 1 and Inner South 1 sub-options would affect a greater number of existing receivers and land already zoned for residential purposes. For the Inner North 2 and Inner South 2 sub-options, it would appear that there is greater opportunity to provide the buffer zones required.

The current land use zonings should also be reconsidered where possible in order to provide a buffer zone to the nearest residences, either through open land, commercial or light industrial, although the impacts of industrial uses close to residences would also need to be addressed.

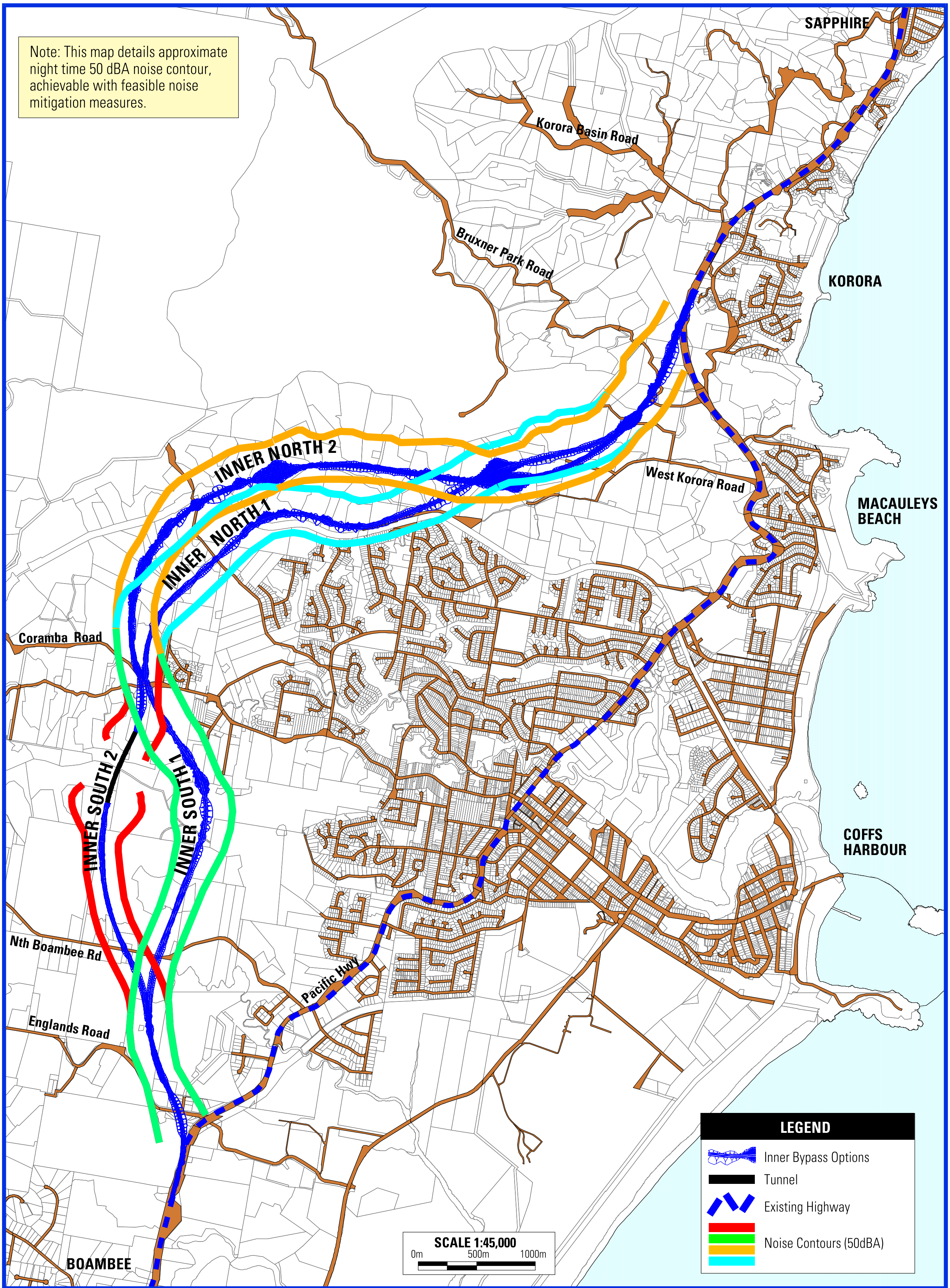
The range of noise levels from residual volumes on the existing highway (if the Inner Bypass Option was adopted) are summarised in Table 4-3 below.

Table 4-3 Noise Levels from Residual Traffic on Existing Highway

Period	Traffic Volumes (v.p.d.)			
	Minimum (20,200 Day, 1,500 Night)		Maximum (32,900 Day, 2,400 Night)	
	40m	80m	40m	80m
Daytime (7am – 10pm)	68.5	64.5	70	66
Night time (10pm – 7am)	60.5	56.5	62	58

In comparison to the "Do Nothing" Option, these L_{Aeq} noise levels show a marginal reduction of typically 2-3dBA for the daytime period. However, a more significant reduction of 6dBA for the night time period is achieved. Given that the main source of complaint is often night time heavy vehicle movements, this is considered of some benefit to residents along the existing highway.

Table 4-3 indicates that, even after traffic would have been diverted onto the Inner Bypass, the residual traffic on the existing highway would result in noise levels above the *Base Criteria* at residences within 100m of the alignment which have a direct line of sight to the existing highway.



COFFS HARBOUR HIGHWAY PLANNING
COFFS HARBOUR SECTION
NOISE ASSESSMENT - INNER BYPASS OPTION

FIGURE 1
NOISE CONTOURS $L_{Aeq\ 9hr}$ NIGHT TIME (WITH MITIGATION)

Strengths

The Inner Bypass options would remove a high proportion of heavy vehicles at night time from the existing highway where it passes close to a currently higher number of residences. Fewer total residences would be affected by these night time heavy vehicle movements.

Weaknesses

This option would affect residences currently exposed to little or no traffic noise. Unless restrictions are placed on further residential development in the vicinity of the Inner Bypass, land already zoned for residential purposes and further land releases by Council could mean more residences would be affected by this option.

Since a high number of vehicles would still use the existing highway at daytime, the total number of residences exposed to traffic noise would increase and, without the provision of noise mitigation, the number of residences where noise levels are above the *Base Criteria* would increase.

Opportunities

The topography traversed by the Inner Bypass could be utilised to help shield the road from the adjacent residential development - particularly to the north of the railway line. Tunnels also provide high levels of noise attenuation although particular attention needs to be given to the tunnel portals.

Lowering the profile of the road would help shield it from adjacent development and generate extra spoil material which may be used to provide earth mounding rather than barriers. The road corridor would need to be wide enough to accommodate the roadway, proposed noise mitigation measures and landscaping.

Noise control in the form of barriers and/or mounds can be used to control noise to existing receivers. In suitable locations, barriers and/or mounds could be designed at the time the detail road design is undertaken, but only provided when required to mitigate noise from new residential areas being developed near the bypass.

Noise control in the form of buffer zones or land use planning with less sensitive uses such as industrial, commercial or sporting facilities could be used to provide separation to new residential areas.

Threats

The barrier options may not be well regarded from an urban design perspective from both the motorist and also local residential perspective, particularly for the areas of fill. Difficulties could be encountered when providing noise mitigation for isolated, elevated residences.

4.3 Existing Highway Upgrade

The range of noise levels for the Existing Highway Upgrade option are summarised in Table 4-4 below.

Table 4-4 Predicted Noise Levels for Existing Highway Upgrade 2021

Period	Corridor Traffic Volumes (v.p.d.)			
	Minimum (31,300 Day, 3,100 Night)		Maximum (45,800 Day, 4,800 Night)	
	40m	80m	40m	80m
Daytime (7am – 10pm)	72	68	74	70
Night time (10pm – 7am)	67	63	69	65

These levels are typically 1-2dBA higher at daytime and 0-1dBA higher at night time than the "Do Nothing" option.

Since it is possible that some widening of the highway could occur and sections of the Existing Highway Upgrade may be elevated, the DEC *Allowance Criteria* would be exceeded for all sections of the upgrade. Noise control would therefore require detailed investigation in order to ensure that the mitigation measures, as a minimum, would meet the *Allowance Criteria*. However as required by the *ENMM,* significant control must be evaluated to preferably reduce noise levels to meet the Base Criteria, although this would not be possible in most areas, since reductions of over 10dBA would be required.

It is considered the use of an Open Graded Asphaltic Concrete (OGAC), or similar, rather than a Dense Grade Asphaltic Concrete (DGAC) surface would be sufficient in most areas to meet the DEC *Allowance Criteria* and control noise levels to the levels prior to construction.

Noise barriers in the vicinity of all residential areas would therefore be required to reduce noise levels to below existing levels.

It is likely that barrier heights of 6m would be required to meet the DEC base criteria at receivers set back 40m. This is unlikely to be considered feasible from a design perspective and it is likely that barrier heights along the length of the upgrade would be limited in height by urban design considerations.

Mitigation treatment should also be provided at these receivers where noise levels remain "acute".

Strengths

The least total number of residences (of the three options assessed in this working paper) would be affected since traffic noise would be confined to the one corridor. Only those residences already affected by traffic noise would be subjected to increases in traffic noise.

Weaknesses

Noise levels, even with mitigation are unlikely to be controlled to below the *Base Criteria*. There is little or no opportunity to plan buffer zones since all receivers already exist.

Opportunities

Barriers could be provided to mitigate noise where necessary. At most receivers, noise could be reduced to lower than current noise levels. The visual impact of barriers could be reduced by lowering the longitudinal gradeline of the Highway, if possible, at suitable locations. This has the potential to reduce barrier height.

Threats

The height of barriers in some areas may not satisfy urban design requirements and community expectations.

5. CONCLUSIONS

This report has provided a review of the impacts of road traffic noise generated by three potential bypass options identified by the Coffs Harbour Highway Planning Strategy.

Existing noise levels at the closest residential receivers along the existing highway are already above the DEC *Base Criteria* for Redeveloped Roads. For the Existing Highway Upgrade option, noise mitigation could be provided to ensure noise levels for the vast majority of residences could be controlled to levels below that prior to the commencement of construction. However, there may be some areas where barrier heights may not satisfy urban design requirements.

For the Inner Bypass options, road traffic noise would be introduced to areas that are currently subjected to little or no road traffic noise. For the Inner Bypass there are already a relatively high number of residences where the DEC *Base Criteria* for new roads would be exceeded without noise mitigation. Clearly, the Inner North 1 and Inner South 1 would affect more residences in the areas already developed.

Noise mitigation in the form of barriers may not satisfy urban design requirements for the rural residential areas adjacent to the Inner Bypass route. Consideration should be given to adjust the vertical alignment, where feasible, to allow the cuts to be deeper. This possibly has three benefits; firstly the cuts may be deep enough to provide shielding without the need for any additional noise mitigation; secondly if additional mounding or a noise wall is required the height above natural surface level is reduced and thirdly the deeper cuts (and presumably lower fill sections between) would generate more spoil material to be able to provide shielding in the form of earth mounding (rather than walls) which may better suit the rural surroundings if the space is available.

Noise control and future land use planning to limit residential development adjacent to the road corridor could dramatically reduce the number of residences where noise levels exceed the *Base Criteria*, however, immediate action is required.

Quality Assurance
Wilkinson Murray Pty Limited is committed to and has implemented AS/NZS ISO 9001 : 1994 "Quality Systems - Model for quality assurance in design, development, production, installation and servicing". This management system has been externally certified and Certificate No. QEC 13457 has been issued.
AAAC
This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Version	Date	Status	Prepared by	Checked by
A	26 June 2003	Draft	Neil Gross	Rob Bullen
B	10 September 2003	Draft	Neil Gross	Rob Bullen
C	15 January 2004	Final	Neil Gross	Rob Bullen

APPENDIX A

NOISE DESCRIPTORS

NOISE DESCRIPTORS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}). The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1}. The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10}. The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

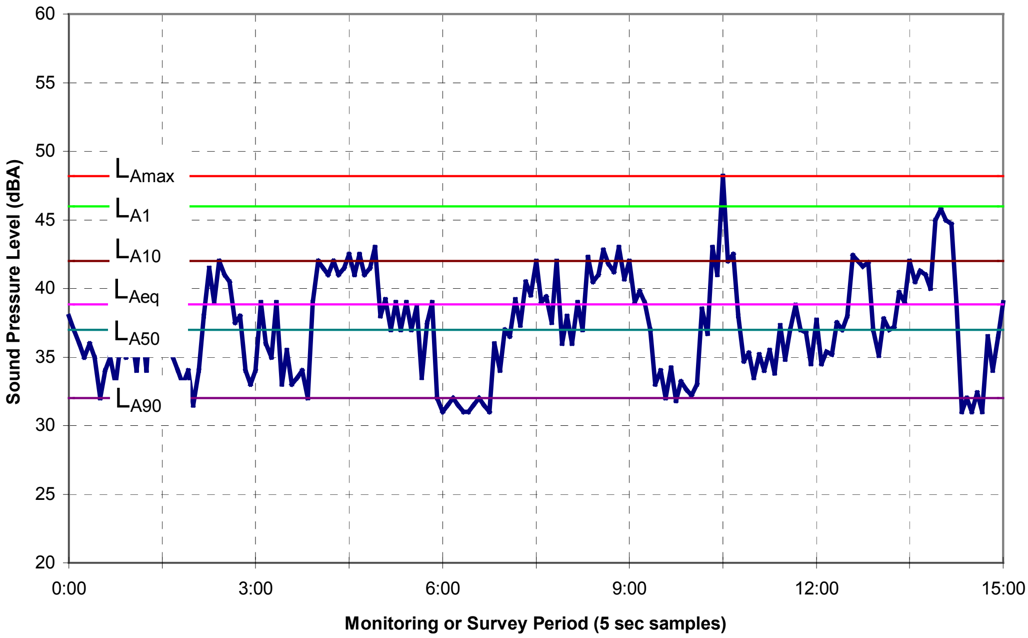
L_{Aeq}. The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

L_{A50}. The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

L_{A90}. The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

ABL. The Assessment Background Level is the single figure background level representing each assessment period (day, evening and night) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL. The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period, day, evening and night.


60
55
50
45
40
35
30
25
20
Sound Pressure Level (dBA)
L_Amax
L_A1
L_A10
L_Aeq
L_A50
L_A90
0:00
3:00
6:00
9:00
12:00
15:00
Monitoring or Survey Period (5 sec samples)