ACOUSTICS 2025
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A Review of the SPP 5.4 Noise Exposure Forecast Table

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ABSTRACT

In Western Australia, approval of noise-sensitive development near transport infrastructure generally follows State Planning Policy 5.4 (SPP 5.4). Table 2 of the SPP 5.4 Implementation Guidelines presents the Noise Exposure Forecast (NEF) table, which provides a simplified method for estimating the level of transport noise exposure without requiring detailed modelling during early planning stages. However, limited detail is available on how conservative the NEF table is compared to actual noise levels. This paper reviews the performance of the NEF table by comparing its predictions to modelled levels and field measurements across the Perth metropolitan area. Results indicate that the NEF table is not always conservative as a preliminary screening assessment for the assessed scenarios. Recommendations have been provided to increase transparency and consistency.

1 INTRODUCTION

In Western Australia, State Planning Policy 5.4 (SPP 5.4, the Policy) applies to proposed noise-sensitive land use within the policy's specified trigger distances, and to proposed new or major upgrades of roads and railways (Department of Planning, Lands and Heritage 2019a). When a lot is within the trigger distance, proponents may either conduct a preliminary screening assessment using Table 2: Noise Exposure Forecast (NEF table) from the SPP 5.4 Implementation Guidelines (SPP 5.4 Guidelines), or commission a site-specific noise management plan.

The NEF table provides a pragmatic, low-cost approach suitable for early planning (e.g. lot subdivision), while site-specific modelling is typically reserved for larger proposals (Department of Planning, Lands and Heritage 2019b). Anecdotal feedback around this table since its implementation in 2019 is that it is reasonably easy to follow but unclear as to the underlying assumptions, preventing its adaptation in more detailed studies.

For the NEF table to be effective, it needs to be easy to follow. It should also be sufficiently conservative to ensure triggering of the policy on developments that require mitigation with minimal 'false positives'. This paper reviews the performance of the NEF table for a 'Strategic major traffic route' and 'Passenger railway' by comparing its predictions with model and field data obtained in accordance with the same guideline, with the objective of identifying where discrepancies might arise and what practical steps could be taken to address that.

2 NEF TABLE BASIS AND ASSUMPTIONS

Figure 1 shows the NEF table as extracted from the SPP 5.4 Guidelines. The NEF table categorises road and rail corridors based on their classification, with road corridors further differentiated by the number of lanes. Each category includes corresponding forecast noise levels for lot distances from the transport corridor.

The values in this table were derived from Appendix 3 of Attachment 2 (Implementation Guidelines) of the May 2009 version of SPP 5.4 (Department for Planning and Infrastructure 2009), supported by a relatively small campaign of local traffic data measurements commissioned around 2013. However, the 2019 table is markedly different in that it is simplified to provide an estimate using only the number of lanes and distance from each asset. The number of lanes provide a substitute for traffic volume, on the basis that there are practical limits to daily capacity per lane.

Transport Corridor Classification		Number of lanes (both directions), including bus/priority lanes and entrance/ exit ramps	Forecast noise exposure category based on lot distance(m) from edge of nearest main road carriageway (not entrance/exit ramps)																				
		adjacent	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	175	200	225	250	275	300
Strategic freight/major traffic route • 500 or more Class 7-12 Austroads vehicles per day, or • 50,000+ vehicles per day		2 to 4 lanes	72	68	66	65	63	62	61	61	60	59	59	58	57	57	56	55	54	53	52	51	50
		5 to 6 lanes	74	70	68	66	65	64	63	62	61	61	60	59	59	58	58	57	56	55	54	53	52
		7 to 8 lanes	76	72	69	68	66	65	64	64	63	62	62	61	60	60	59	58	57	56	55	54	53
		9 to 10 lanes	77	73	70	69	67	66	65	65	64	63	63	62	61	61	60	59	58	57	56	55	54
		10 or more lanes	78	74	71	70	68	67	66	66	65	64	64	63	62	62	61	60	59	58	57	56	56
Other significant freight / traffic routes • Any actual or planned future State Administered Road • Local Government Roads Carrying 100 or more Class 7 – 12 Austroads vehicles/day • 25,000+ vehicles per days vehicles/day	Urban Region Scheme areas 60-80 km/hr	1 to 2 lanes	67	64	62	61	60	59	58	57	56	56	55	54	54	53	53	52	51	50	49	48	47
		3 to 6 lanes	69	66	64	63	62	61	60	59	58	58	57	56	56	55	55	54	53	52	51	50	49
	Urban Region Scheme areas 100+ km/hr	1 to 2 lanes	70	67	65	64	63	62	61	60	59	59	58	57	57	56	56	55	54	53	52	51	50
		3 to 6 lanes	74	70	68	66	65	64	63	62	61	61	60	60	59	59	58	57	56	55	54	53	52
	Rural areas 60-80 km/hr	1 to 2 lanes	62	59	57	56	55	54	53	52	51	51	50	49	49	48	48	46	45	44	43	42	41
		3 to 4 lanes	66	63	61	60	59	58	56	56	55	54	53	53	52	52	51	50	49	48	47	46	45
	Rural areas 100+ km/hr	1 to 2 lanes	67	64	62	61	60	59	58	57	56	55	54	54	53	53	52	51	50	49	48	47	46
		3 to 4 lanes	69	66	64	63	62	61	60	59	58	57	56	56	55	55	54	53	52	51	50	49	48

Railway Transport Corridor Classification		Forecast period average noise level and exposure category based on distance from nearest rail centreline (m)																
	adjacent	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	175	200
Passenger railways	Fremantle, Midland and Thornlie main lines only	68	64	62	60	59	58	56	56	55	54	53	52	52	51	51	49	48
	All other metro passenger rail lines, and where multiple metro rail services share the same transport corridor	70	66	64	62	61	60	58	57	56	56	55	54	54	53	52	51	50
Freight railways, up to 1 movement per hour		72	68	65	63*	62*	60*	59*	58*	57*	57*	56	55	55	54	53	52	51

Source (State Planning Policy 5.4 Implementation Guidelines, 2019)
Figure 1: Noise exposure forecast (NEF) table

The SPP 5.4 Guidelines states the following regarding the NEF table:

> *The noise exposure forecast table is based on conservative estimates of future noise levels which have been informed from field data obtained across a broader number of sites and been verified by a professional acoustic engineer.*
>
> *[..]*
>
> *The noise levels in noise exposure forecast table are based on a number of assumptions including:*
>
> - *Level and open ground between the noise source and the receiver and neutral weather effects;*
> - *All values include a +2.5 dB façade correction, typical ground absorption, some scattering from buildings in line with measured data for urban and rural scenarios; and include in-built cumulative noise factors for urban areas;*
> - *Development building outline is within 10 metres of the lot boundary facing transport corridor;*
> - *Number of road lanes roughly scale with traffic volume (at up to ~18,000/vehicle per day for a 2 lane road);*
> - *Railway noise levels are based on level straight track with adjustments included for future growth over 20 years in line with historical averages;*
> - *For railway noise levels 3 dB per doubling of traffic per hour can be added if higher noise levels may be expected near tight curves and turnouts.*

Additionally, a 4 dB reduction can be applied where 'screened' development exists, which is generally defined in the Guidelines as where there is no reasonable direct line of sight between the transport corridor and assessed premises, due to say a highway noise wall or another building.

With low levels of detail as inputs, the NEF table should generally indicate noise levels above those typically observed in practice. However, the NEF table does not state its assumptions around other key factors, such as vehicle speeds, heavy vehicle percentages and road surface type. These omissions could contribute to differences between the NEF table and actual measured levels.

3 MODEL CONFIGURATION

Predicted noise levels from production grade transport noise models are compared with the NEF table for a 'Strategic major traffic route' and 'Passenger railway'. These models were created in SoundPLAN and set up in accordance with the methodology outlined in the SPP 5.4 Guidelines. They contain 3D terrain data, buildings, walls, neutral weather conditions, and receivers at 1 metre from each building façade. Volumes included for future growth over 20 years, consistent with the NEF table. The following subsections provide further information on each model.

3.1 Road

A model was developed to represent existing noise emissions from a proposed highway upgrade (a major traffic route under the NEF table).

The model uses the CoRTN algorithm (Department of Transport and Welsh Office 1988), which is still widely used in Australia and referenced by state road authorities in SPP 5.4 and Transport for NSW (2025). L_{A10} noise levels were converted to L_{Aeq} by selecting the -3 dB method in SoundPLAN, as suggested by Kean (2008), and then adding 0.8 dB to reach a difference of -2.2 dB per SPP 5.4 guidelines.

Each road lane, including both mainlines, ramps, and overpasses, were modelled as individual links. The 'three strings' approach was also used, whereby three road strings of different heights are used to represent passenger vehicles (+0.5 m) and heavy vehicle engines (+1.5 m) and exhausts (+3.6 m). Noise level corrections of -0.8 dB and -8 dB were also applied to heavy vehicle engines and exhausts respectively.

Road volumes were derived from a transport model supplied. For the mainline, volumes were modelled at more than double that assumed by the NEF table (9,000 vehicles per day per lane), with approximately 90% of the 24-hour volume during the day period, and with heavy vehicle percentages ranging from 5% to 10%. To be consistent with stated volume assumption in the NEF table, a -3 dB reduction was applied to the modelled levels to represent a halving in volumes.

Road surfaces were modelled as open graded asphalt (OGA) for mainlines, and dense graded asphalt (DGA) for the ramps and overpasses, with a -2.5 dB and 0 dB adjustment respectively. Road speeds were generally 100 km/h on the mainlines, gradually reducing to around 70 km/h for the ramps and overpasses.

The model was validated (source levels adjusted to minimise the median measurement error) using field data obtained at the nearest residences in accordance with the SPP 5.4 Guidelines, all generally within 50 metres from the nearest edge of carriageway.

To compare the levels with the NEF table, modelled levels were split into three different lane categories under the strategic freight/major traffic route: 2 to 4, 5 to 6, and 7 to 8 lanes. These lanes include both mainlines and ramps.

3.2 Rail

The rail model uses the Nord 2000 algorithm, which was found to fit measured data across Perth most closely at distances up to 130 m under the settings detailed in Liu and Zoontjens (2024).

Reference noise emission values were developed based on historical noise measurements of train passbys undertaken by SLR Consulting Australia at multiple locations across Perth.

Modelled levels presented are from the future scenario (within the next 20 years), with train volumes based on scheduled timetables supplied.

The trackform was modelled as ballasted track. Rail speeds were modelled with a maximum speed of 130 km/h. No curving noise corrections were applied as the track was relatively straight (no curves with less than 500 metres radius).

Effects of nearby building reflections were directly calculated instead of a default façade correction (+2.5 dB).

4 MODELLED LEVELS

4.1 Road

Figure 2, Figure 3 and Figure 4 present modelled road noise levels and NEF table versus distance for three lane categories. From these figures it can be seen that

- For roads with 2 to 4 lanes,
  - At distances up to 100 metres, the median road noise modelled levels are under the NEF table results.
  - Beyond 100 metres, the median modelled levels are above the NEF table results (with 4 dB screening) by up to 3 dB.
- In the 5 to 6 lanes and 7 to 8 lanes plots, most of the modelled levels are under the NEF table results.
- In all three plots, modelled levels at 20 to 30 metres are lower than that at 40 to 60 metres. This is attributable to receivers being located in the shadow zone created by highway noise walls.

- At increasing distances, categories with fewer lanes show comparable or higher modelled levels than those with more lanes, which is attributed to differences in screening effectiveness (e.g. higher noise walls along 7 to 8 lane sections).

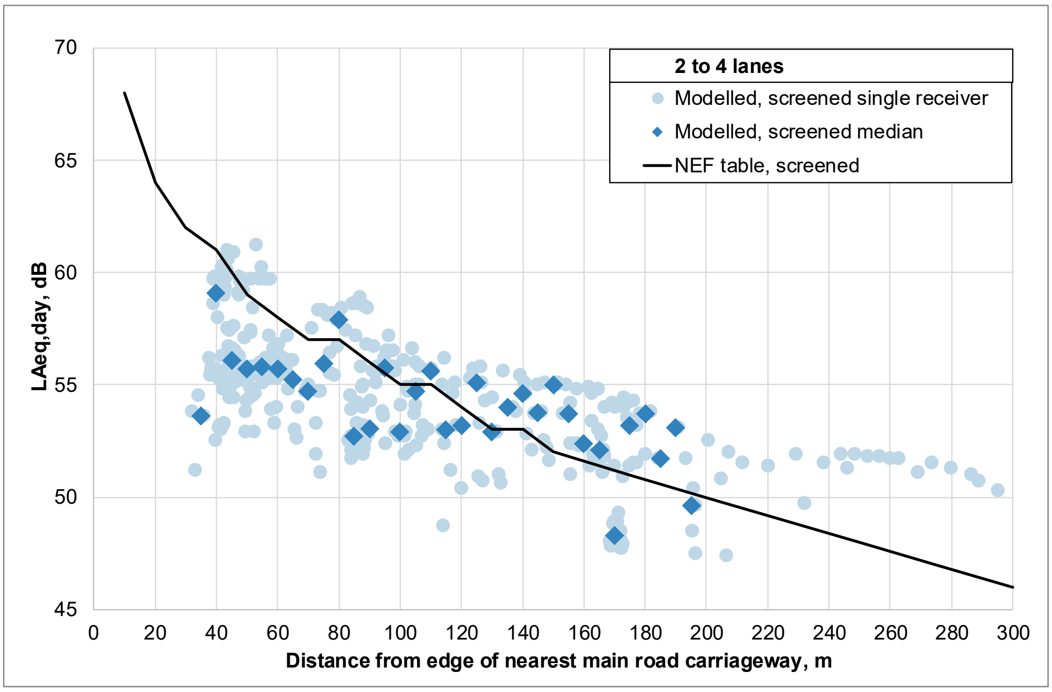

Figure 2: Modelled road noise levels and NEF table versus distance, 2 to 4 lanes

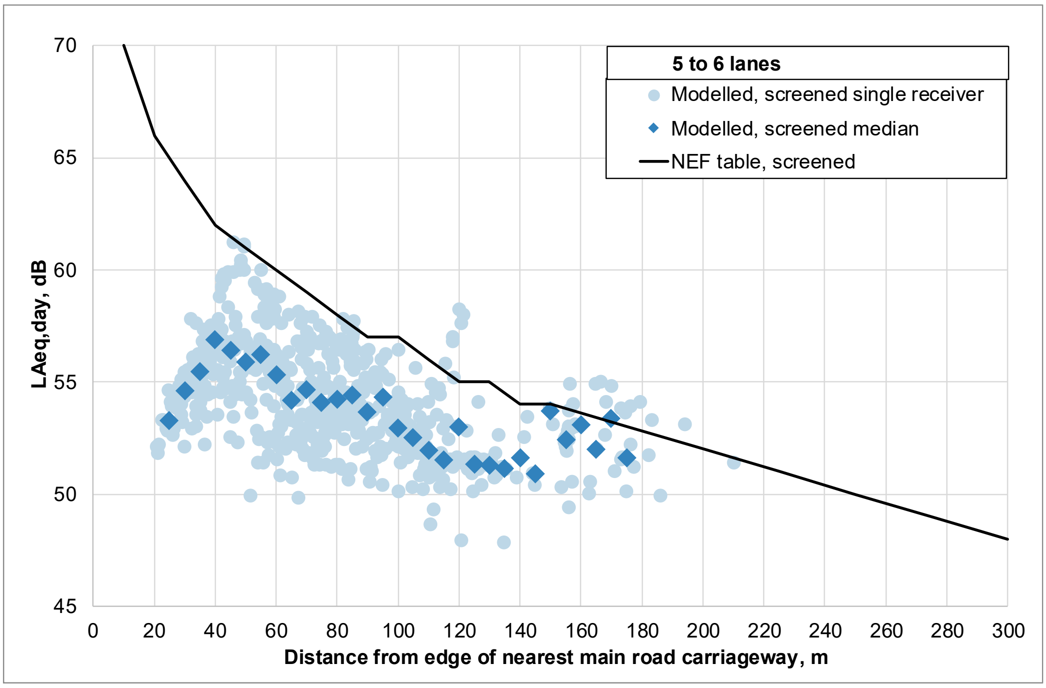

Figure 3: Modelled road noise levels and NEF table versus distance, 5 to 6 lanes

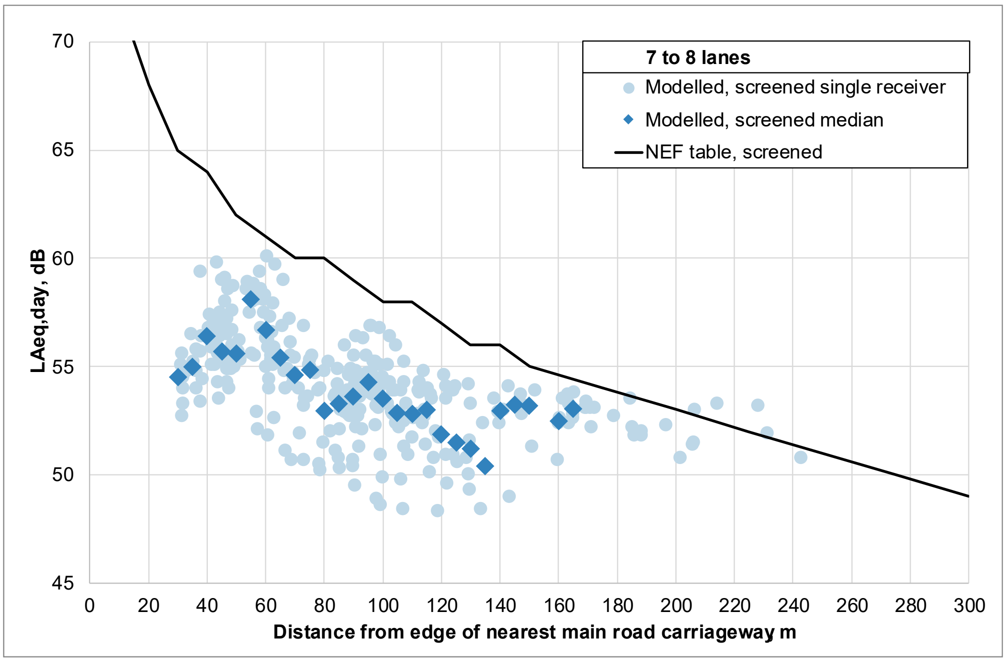

Figure 4: Modelled road noise levels and NEF table versus distance, 7 to 8 lanes

4.2 Rail

Figure 5 presents a comparison of modelled and the NEF table noise levels for metro passenger rail lines. The figure indicates that there is reasonably good agreement with median results.

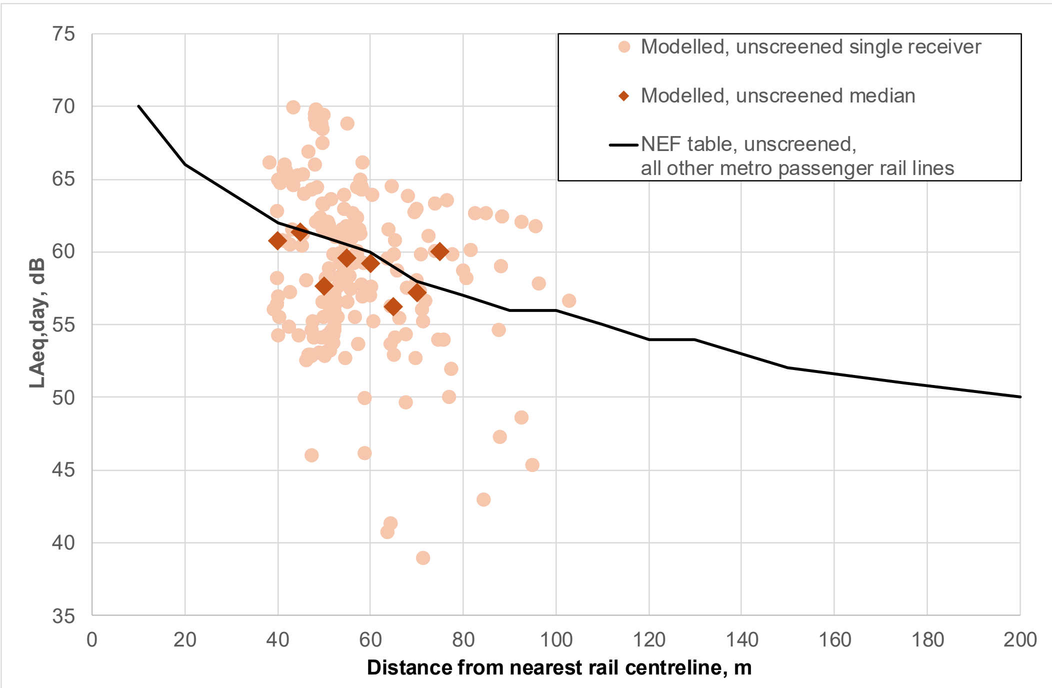

Figure 5: Modelled and NEF table rail noise levels versus distance

5 MEASURED RAIL LEVELS

Figure 6 presents a comparison between measured rail noise levels and NEF table versus distance.

The data plotted consists of outdoor rail noise measurements across the Perth passenger rail network under various conditions. These measurements include unscreened and screened data, are presented against the un-screened NEF table levels.

The figure shows that the median measured noise levels are usually lower than that indicated in the NEF table.

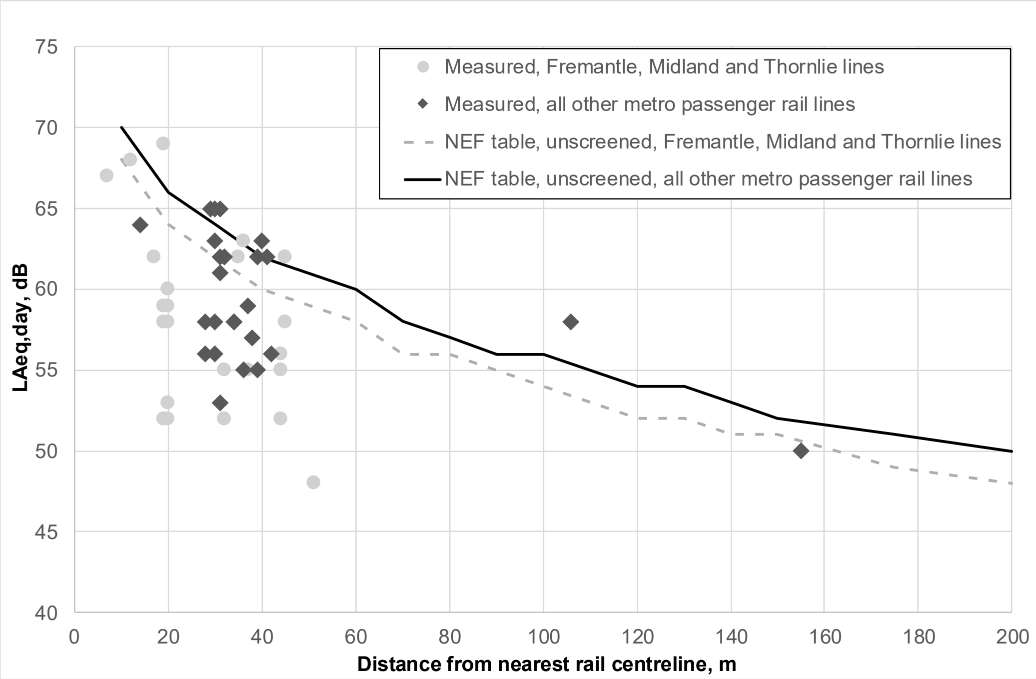

Figure 6: Measured rail noise levels and NEF table versus distance

6 DISCUSSION

The comparisons indicate that the NEF table is not necessarily conservative against typical modelled levels. The following discusses likely factors contributing to potential differences in practice:

- **Road**
  - **Traffic volumes**. In the experience of the authors, design traffic volumes for new road designs tend to approach a limit of around 18,500 vehicles per day per lane. This is understood to be around double the rate stated in the NEF of 18,000 vehicles per day for a two-lane road, which is presumably 9,000 per day per direction.
  - **Vehicle speeds**. The NEF table does not specify speeds used for major traffic routes. The modelled road speeds of up to 100 km/h may be above that used in the NEF table.
  - **Heavy vehicle percentages**. The NEF table only states that major traffic routes should have 500 or more Class 7-12 Austroad vehicles per day (Figure 1). For a 4-lane road with 9,000 vehicles per lane per day, the modelled 5% to 10% heavy vehicles is significantly higher and in the order of 1,800 to 3,600 vehicles, noting that this includes Class 3-12 Austroad vehicles.
  - **Road surface condition.** Though the NEF table also does not specify road surface type, it is unlikely to be a contributing factor as the model uses OGA on the mainlines, which is a low-noise surface.
- **Railways**
  - **Vehicle speeds.** The NEF table does not specify speeds used for railways. The modelled rail speeds of up to 130 km/h may be above that used in the NEF table.
  - **Rail condition.** Rail condition in different track sections could also explain the large variation in measured noise levels.

7 PRACTICAL IMPLICATIONS AND RECOMMENDATIONS

The findings indicate that the NEF table is reasonably conservative for the transport assets assessed. However, for strategic roads with less than 4 lanes there is the possibility of increased volumes above that assumed in the NEF, possibly leading to cases where mitigation measures would be justified but not triggered at a screening level.

The following recommendations arise from this review:

- **Increase transparency of assumptions.** The NEF table should increase the detail it provides around traffic and operational assumptions it uses (e.g. reference vehicle speeds, heavy vehicle percentages, and assumed road surfaces). This will help users understand when the table will be conservative and when it may under-predict. This could however increase the risk of confusion and misinterpretation by the general public in its use.

- **Introduce conditional flags**. Where local conditions may result in higher noise levels than the NEF table assumptions (e.g. higher vehicle speeds or heavy vehicle percentages), recommend early site-specific modelling rather than relying on the NEF table alone.
- **Increase local measurement data at distances more than 100 metres**. The model used to inform the NEF is understood to be based on CoRTN and validated with measurements within the urban environment at various distances up to 100 metres. The effect of the 4 dB screening adjustment may not be appropriate at further distances where noise walls and intermediate structures are less effective.

8 LIMITATIONS AND FUTURE WORK

This review compares a sample of predicted levels from one road model and one rail model. It is planned to include more detailed models. Additional measurements of significant road traffic routes and railways could also be included in a future study.

9 CONCLUSION

This study compared noise levels from the SPP 5.4 NEF table against samples of modelled and measured noise levels. Results indicate that the NEF table may not be sufficiently conservative for preliminary screening. Differences are likely due to higher local vehicle speeds, traffic volumes, and heavy vehicle percentages than those assumed.

It is recommended that the NEF table is reviewed to document its assumptions and include conditional triggers where site-specific modelling may be warranted. Further studies across additional corridors and conditions are suggested.

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