Managing reverse sensitivity noise & vibration effects of rail and road transport in New Zealand

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Abstract

District and Regional Plans in New Zealand are a tool that can assist the functioning of a safe and efficient transport systems and assist in managing the environmental effects generated at transport nodes, and along transport corridors. This paper discusses reverse sensitivity measures intended to address noise and vibration from road and rail sources. The paper discusses whether applying land use restrictions beyond the designation corridor to address reverse sensitivity effects best serves the purpose and principles of the Resource Management Act if there are little or no efforts made by transport agencies to adopt the best practicable option to avoid, remedy or mitigate transport noise or vibration effects. Differences are highlighted between road and rail noise in this regard. The paper discusses the benefits of implementing planning measures that directly address effects of noise and vibration effects of land transport noise on people and communities for health and amenity reasons as a means of also dealing with reverse sensitivity effects on transport systems (if any). Finally, the paper outlines difficulties likely to be experienced by Council's implementing reverse sensitivity rules requested by the country's rail operator and by the state highway agency. Improvements are recommended that engender a balanced approach to managing direct and reverse sensitivity effects, based the relevant guidance from published New Zealand Standards and relevant international Standards.

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1. Introduction

Transportation noise can cause a range of impacts on people and communities from general interference with everyday activities through to more significant health impacts. Action to reduce environmental noise has had a lower priority than many other environmental issues, such as air, biodiversity and water, as noise has previously been regarded as an acceptable result of development [1]. As the impacts of noise are better under- stood transportation noise has now become a key environmental and social issue

Noise emissions are one of the more important impacts of Land Transport alongside other effects such as emissions to air, reduced water quality, landscape impacts, community severance and visual intrusions. Managing land Transport noise in New Zealand has been previously examined [2]. That report contains an evaluation of the total costs of Land Transport noise in New Zealand which has a value between 0.25% and 3.1% of GDP [2]. This estimate of the cost of Land Transport noise in New Zealand indicates the increasing impor- tance of Land Transport noise in terms of outcome for the environment.

2. Effects of transport noise

The impact of noise on human health have been widely researched [3,4,5 & 6]. Noise affects people in different ways and creates various reactions depending on the level of noise and the activities individuals are engaged in.

Noise in the environment, including from transport systems, creates stress-type responses in humans. No significant impacts on health are thought to occur at noise levels under 40 dBA during the day or 20 dBA at night. The effects rise with the level of noise and length of exposure. It is widely accepted that noise above 65 dBA is highly undesirable.

Sleep disturbance is a common complaint from people affected by noise. Sleep deprivation can have cumulative effects due to impairment of the rest and recovery functions of sleep [4].

3. Land use planning and noise

In New Zealand, land use planning is primarily implemented through the Resource Management Act, 1991 (RMA).

Part IV of the Act mandates territorial local authorities (Councils), through District Plans, to ensure the noise environment is managed in a sustainable manner and that adverse effects of noise generating activities are avoided, remedied or mitigated. The District Plan is therefore a key instrument for the control of adverse environmental effects, including noise.

Apart from District Plans, Council can control noise effects through such methods as:

- Conditions attached to resource consents or designations;

- Enforcement proceedings including: Abatement notices, enforcement orders and; excessive noise direction notices.

Apart from Council's, other key players in the management of the effects of transport noise include:

- The noise producers (RMA S16. Imposes a general duty on all landowners to avoid unreasonable noise);
- The receivers of noise (Developers and builders and designers are free to adopt methods that reduce noise received from transport corridors, although this on its own would not be likely to be a successful policy measure).

The over-riding requirement is for the noise-maker(s) to recognise the general duty to avoid unreasonable noise.

4. Mangaing land transport noise

4.1 Noise from road traffic

For road vehicles, the New Zealand Transport Agency (NZTA) determines certification requirements for new vehicles, including noise emissions. These requirements are based on 'type approval' testing for each vehicle model released in New Zealand. The allowable noise limit is based on a drive-by noise test (ISO 362). Land Transport (Road User) Rule 2004 provides for on-road enforcement of noise from vehicles in use. The police have a role enforcing these in-service vehicle noise requirements. Regarding exhaust noise, the requirement is for the vehicle to be "less than, or similar to" the noise output from the vehicle's original exhaust system at the time of the vehicle's manufacture". If necessary, the vehicle may be required to undergo a stationary exhaust noise test using a measurement pro- cedure based on ISO 5130 in order to prove a vehicle's exhaust noise levels are acceptable. Land Transport (Road User) Rule 2004 makes it illegal to operate a vehicle in a noisy manner, including noise from audio systems installed in vehicles.

Overall, New Zealand has a comprehensive suite of road vehicle noise controls that govern the output of new vehicles, the noise output of vehicles "in service" and controls over persons operating vehicles on a public road.

In addition, noise from land transport noise is controlled from new or altered roads via design measures through the application of NZ Standard NZS 6806:2010 Acoustics – Traffic Noise – Noise from New & Altered Roads. This Standard is often referred to within planning proceedings when designations are sought for new or altered roads as this Standard is only relevant to those situations.

There is no similar Standard applying to noise from existing roads. The 2008 Transit New Zealand Environmental Plan [7] and previous Transit documents recognise that outdoor noise levels above 65 dB LAeq(24 hr) are unacceptable. Section 2.1 of that Plan notes that if noise levels are above this threshold a noise improvement programme is available to fund retro-fitting of road noise mitigation. The fund for this is limited however and very few roading projects have been initiated to reduce noise from the existing network.

In addition, NZTA have developed "reverse sensitivity" noise guidelines to assist with managing noise from the existing state highway network. Developers and land owners seeking access to the state highway network are commonly requested by NZTA in return to agree to reverse sensitivity clauses where the development involves establishing noise sensitive activities such as residential subdivisions or apartments near state highway. An example of such a clause is set out as follows:

> The design and construction of the development shall;
>
> (a) Ensure that the following criterion is met in relation to noise from traffic on the road allowing for increases in noise arising from increased traffic growth during a period up to the year 2014 (Noise Performance Criterion);
>
> i. Noise from traffic on the road shall not exceed 35 dBA Leq(24 hour) in any bedroom and 40 dBA Leq(24 hour) in other Habitable Rooms (AS/NZ 2107:2000) within any Building.

Comments and observations on this approach to dealing with reverse sensitivity noise effects of the state highway network are discussed below.

4.2 Noise from rail activities

KiwiRail Holdings Limited (KiwiRail) is the State Owned Enterprise responsible for the management and operation of the national railway network. This includes managing railway infrastructure and land, as well as rail freight and passenger services within New Zealand. KiwiRail Holdings Limited is also the Requiring Authority for land designated "Railway Purposes" in District Plans throughout New Zealand. KiwiRail Network (ONTRACK) owns and manages New Zealand's rail network on behalf of the Crown, maintaining 4,000 kms of railway track, bridges and tunnels

KiwiRail operates around 100 diesel-electric locomotives, 22 electric locomotives, 3 railcars, and 103 shunting locomotives (Wikipeadia). There are also 19 diesel multiple units in Auckland operated by Auckland Transport and 71 electric multiple units owned by the Greater Wellington Regional Council. The author understands around 57 electric multiple units under construction for Auckland Transport.

The author has been unable to identify any rules or guidelines relevant to the control of noise from locomotives or rail vehicles in New Zealand. An ISO Standard (ISO 3095:20051) is available to guide on the procedures for obtaining reproducible noise levels emitted by all kinds of vehicles operating on rails, however there are no relevant rail noise limits applying in New Zealand.

KiwiRail has submitted on many District Plans to discourage "sensitive receivers" near rail corridors. This is to address so-called "reverse sensitivity" effects. As an example, the following wording of a reverse sensitivity rule was agreed among the parties to be inserted into the Tauranga District Plan (see *NZ Railways Corporation v Tauranga City Council: ENV-2011-AKL-00072*):

> Rule 4E.2.6 - The Rail Network - Managing Reverse Sensitivity Effects
>
> (a) For noise sensitive activities within the KiwiRail Reverse Sensitivity Plan Area shown on the Plan Maps (Part B):
>
> i. Any new dwelling shall meet an internal rail traffic design sound level of 40 dB LAeq(1hr) inside all habitable rooms except for bedrooms which shall achieve an internal rail traffic design sound level of 35 dB LAeq(1 hr)
>
> ii. All other noise sensitive activities shall meet an internal rail traffic design sound level of 40 dB LAeq(1 hr).

Below we set out observations and comments on the approach advocated by KiwiRail that require Councils and land owners and developers to implement measures ostensibly to protect the operation of the rail network.

5. Reverse sensitivity as an "effect"

Often Council's are asked by road and rail authorities to include within District Plans land use planning measures to address noise and vibration effects to address what are termed "Reverse Sensitivity" effects on the operation of the transport system. The measures sought in respect of both road and rail reverse sensitivity measures involve recommending no noise sensitive development take place within a land corridor adjacent to the transport corridor, with a recommendation for developers and landowners implementing mitigation within a wider "effects" corridor to ensure the levels of noise within habitable rooms in new buildings established within these areas are within what are considered reasonable limits recommended by the World Health Organisation (for example).

Existing case law establishes reverse sensitivity as an "effect" under the RMA. However, our search of the relevant databases has not been able to provide examples where a road or rail corridor has been affected by reverse sensitivity effects such as complaints by individuals or communities living within areas affected by noise from land transport noise.

Although the reverse sensitivity effect is widely touted at planning hearings as being a core concern of road and rail authorities, there are no examples evidencing where this effect has actually negatively impacted on the operation of any part New Zealand's transport system. While there are fears of such an effect, no actual effects of this nature appear to have surfaced.

6. Misuse of AS/NZS 2107:2000

NZTA's Reverse sensitivity guidelines have adopted the Australian and New Zealand internal noise standard AS/NZS 2107:2000 Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors. This Standard is said to have been adopted by NZTA because it is "an accepted industry standard" however there are some technical issues which remain unanswered regarding reliance on this Standard.

KiwiRail's reverse sensitivity guidelines typically seek insulation of buildings establishing within 40 metres from the rail track Dwellings so that rail noise does not exceed 40 dB LAeq(1hr) inside bedrooms or 45 dB LAeq(1hr) in other habitable spaces. The Guidelines seek rail noise levels within all other developments be "no greater than 5 dB above the recommended maximum design guidelines given in NZS 2107-2000".

Both road and rail reverse sensitivity guidelines rely on the recommendations of NZS 2107:2000. However, the author considers this to be a misuse of this Standard.

For example, NZS 2107:2000 refers to noise levels quantified using the Leq unit, however there is no reference within that Standard to the use of LAeq(24hr) or LAeq(1hr) units which have been adopted as the units within road and rail reverse sensitivity guidelines. Section 2 of the Standard specifically states the Standard was not developed to deal with rail noise and yet this Standard is quoted extensively within justifications provided for reverse sensitivity measures address rail noise. The Standard was developed to be used by architects and room designers and does not have a focus on recommending noise standards for land use planning purposes (which seems to be its main use in New Zealand over recent years).

According to enquiries undertaken by the author, no New Zealand transport agencies, environmental authorities or the Ministry of Health were consulted in the development of NZS 2107:2000. The author considers NZS 2107:2000 is being mis-applied to some extent from its original intended use as a guide to architects and building designers. This Standard appears to be currently misused to plug a void. It is clear to most of us involved that what is really needed is a purpose-developed NZ Standard which would be developed among all key stakeholders and would represent a “whole of government” approach, not simply the wishes of the agencies responsible for noise-making activities.

7. Acoustic insulation requirements

Acoustic insulation requirements contained within NZTA and KiwiRail requests for reverse sensitivity protection rely upon compliance with a stipulated limit of road or rail sound measured indoors. In practice, checking compliance on behalf of Council’s or affected parties has proven very problematic. Relying on achieving a stipulated indoor sound level leads to unpredictable outcomes because:

(a) Acousticians and designers are not provided with guidance on expected outdoor sound levels against which to design the acoustic insulation of the building. This will often lead to an inconsistent design approach as different designers may assume (quite legitimately) differing levels of outdoor sound. Rail noise guidelines are said to be based on 65 dB LAeq(1hr) at 12 metres from the closest rail track. KiwiRail’s submission on the Hauraki District Plan KiwiRail proposed that train noise shall be deemed to be 70 dB LAeq(1hr) at 12 metres from the closest rail track. The request to assume a certain outdoor sound levels for the purposes of calculation and design means the actual noise level occurring on the site is never known. This means an objective assessment of noise effects on the (such as Council’s may undertake) cannot realistically be undertaken as no site specific information is provided.

(b) It is unclear how growth in noise levels is taken into account. The objective (to achieve adequately protected indoor environments) may be undermined if growth in noise levels in the long run is not adequately accounted for.

(c) The amount of noise reduction to be achieved by the building design may never be known and cannot therefore be tested or evaluated by Council’s who are charged with implementing District Plans and overseeing enforcement (where required) with resource consent conditions.

(d) Should compliance need to be checked, measuring road or rail noise indoors within insulated rooms brings with it a host of problems. Simply measuring a 24 hour sound level to check traffic noise levels within insulated habitable rooms caused difficulties which have been outlined in evidence to the High Court in Invercargill (*P & J Tompkins v Wensley Developments 2011*). Not only was it not possible to avoid extraneous sounds (such as aircraft noise), but the speed limit was adjusted up- wards and road surface type changed after the insulated apartments were built and before they could be tested. For road noise, deviations in the normal percentage heavy vehicles and effects of a wet road surface can significantly alter measured sound levels within nearby rooms. For rail noise, the following questions arise for Council’s when attempting to assess compliance with KiwiRail’s reverse sensitivity measures:

    During which 1 hour period should compliance measurements be conducted?

    Measure compliance during daytime or night time?

    What about non-rail noise occurring during the measurement period?

It is worth noting that NZS 6806:2010 refers to insulation requirements for protecting against road traffic noise at clause 5.2.3.2 where it states the acoustic insulation performance of buildings should be rated using the ‘standardised level difference’ methods of ISO 717, not based around the “indoor LAeq(24 hr)” approach of the NZTA reverse sensitivity guidelines.

8. An issue of “Equity”?

While concerns raised above are important because it appears acoustic performance based on a received indoor sound level cannot be easily or simply checked by Council as consent authority, a further substantial issue is one of equity - Who would be responsible if a reverse sensitivity insulation rules was proven not have been properly complied with?

Quite clearly in this circumstance, the roading authority and rail agency (who are responsible for managing the transport noise at source) will not be around to assist. The Council would simply be trying to implement and assess compliance with the rule or resource consent condition and could not be blamed for the non-compliance. The building owner or developer would have taken appropriate acoustic advice at the time the building was designed (and all being equal, the builder built the building to specification), however any of the variables (a) to (d) above could easily cause non-compliance so that the owner or developer is left with a non-compliance which was really none of his or her making.

With these experiences in mind, the author considers it is inappropriate for councils and imposes unnecessary costs and risks for the building designer and owner where the outcome is based on the uncertain result of an indoor sound level measurement to determine the effectiveness of acoustic insulation.

There appears an inherent inequity in a system that enables the noise-making agency to request insulation rules based around an uncertain method for managing indoor effects of road or rail noise yet do not share in the technical and design risks in attempting to achieve compliance with the requested standards. This is aside from the difficulties

Councils must face in assessing compliance.

This is in addition to the questionable need for reverse sensitivity setbacks and insulation requirements where there are no known examples in New Zealand where the operation of a road or rail corridor has been adversely affected due to noise or vibration complaints from people living in high noise effects areas.

That is not to say there is no evidence of complaints. Most local authorities at one time or another will have fielded complaints regarding road or rail noise, however any organisation with an "embedded" network emitting noise 24 hours a day can expect to receive complaints and will be obliged to deal with them. The mere receipt and need to investigate complaints is often mistaken as a need to implement reverse sensitivity measures. However this seems to defy logic. The reverse sensitivity measures will not address the generation of noise or vibration complaints per se. It is normal for a transport organisation to have to investigate and report on noise and vibration complaints from time to time. Despite what some officials may say, this is not a policy driver for implementing reverse sensitivity measures

The lack of any operational noise or vibration emission limits coupled with the enabling provisions of the RMA (and inherent powers of any designations held) mean the road or rail agency will always prevail where any complaints or further actions arise. Realistically it is unlikely any individual or community has the ability to shut down or interfere with the operation of a road and rail corridor as often claimed as a rational basis for adopting reverse sensitivity measures within District Plans or resource consent conditions.

Granting rail noise reverse sensitivity measures in District Plans or resource consents worded as often sought within submissions by KiwiRail is particularly iniquitous. This is because this agency appears to make no attempt to manage noise from its rail and locomotive fleet in a manner consistent with the best practicable option requirement of the RMA. Rail noise has a large low-frequency component and can affect wide tracts of land, yet there appear to be no guidelines, rules or regulations in New Zealand requiring this noise to be managed at source.

For road traffic and vehicle noise it is clear a suite of controls are in place in New Zealand that (within reason) ensure cumulative noise from a road is no louder than necessary (setting aside for the moment improvements that could be achieved via introducing a noise-aware re-surfacing policy in residential areas). Rail noise is, and has always been, unfettered at source with KiwiRail continuing to be able to generate as much noise as it likes without impunity it seems

9. Recommended insulation standard

There are inherent advantages in acoustic insulation rules or consent conditions that stipulate the amount of acoustic insulation required of the building. This is achieved by specifying an acoustic rating of the building envelope using methods based on ISO 717-1:20132 such as stipulating Dtr,2m,nTw + Ctr. > 30. This means the building envelope or facade must reduce the outdoor sound level by 30 dB when tested in accordance with the prescribed (normalised) test method. Such an approach is superior in a number of ways because:

(a) Such rules provide greater guidance for architects and engineers to design to, and will result in a more certain outcome; and

(b) The performance standard to be achieved by the building fabric is established at the time the Plan or designation/consent hearing takes place (within a public process and being subject to scrutiny), or at the time the resource consent is decided. This can satisfactorily deal with issues such as how noisy the site is, how future growth in noise is to be taken into account and what sound spectrum to be assumed. Quite clearly, the "one size fits all" approach based on complying with a stated indoor noise limit does not work and leads to an imbalance between those whom benefit from measures that are said to protect road and rail corridors and those that must implement and administer the requested measures.

(c) While the use of an indoor sound level as a design target can be useful when setting the insulation standard to be achieved by the building, the actual process designing to achieve a stated indoor sound limit entails a great number of assumptions and can lead to uncertainty (not to mention the difficulties in determining compliance, as discussed above).

(d) For consent authorities and Council's, rules based on ISO 717-1:2013 are preferred because they can be readily checked using a simple test using a handheld sound level meter. The performance of a building can be estimated by simply measuring the difference between the sound level outdoors and the sound level measured indoors.

A full field test of facade transmission loss using ISO 16283-1:20143 can be conducted where an "evidential" type test result is desired.

10. Discussion and Summary

Council have a duty to manage noise effects in the district. This can often involve deciding upon submissions received that deal with reverse sensitivity noise and vibration effects from road and rail corridors.

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We question whether the need for such methods have ever been properly investigated in a "whole of government" approach that examines the full societal costs and benefits of adopting measures commonly requested. There appears to be no evidence of the operation of any road or rail corridor having been adversely affected by complaints from the public.

The primary need to manage the noise and vibration effects of road and rail activities are surely those based around protecting the health and well-being of exposed populations. It is a curious and disappointing observation that calls to protect the operation of roads and rail corridors due to reverse sensitivity concerns are more commonly raised within RMA proceedings compared to the relatively few submissions received from the Ministry of Health or primary health care agencies regarding the need to protect human health and welfare in these situations.

Councils may also be involved with compliance checking of acoustic insulation of dwellings and habitable rooms established within "noise affected" corridors adjacent to state highways or rail tracks. The above discussion establishes that acoustic insulation performance requirements based around meeting a stated limit of road or rail noise indoors has in practice to be neither practical nor workable. While indoor sound levels are important for ascertaining the appropriate standard of acoustic insulation to be implemented, as above, the actual acoustic performance standard should be based around the units set out within ISO 717:2013.

Setting acoustic insulation standards on a maximum level of road or rail noise to be received indoors is un-certain for Councils to enforce and impose unnecessary costs and risks for the building designer, builder and/or owner.

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Publication Dates and Deadlines

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