BEFORE INDEPENDENT COMMISSIONERS

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER a submission by KiwiRail Holdings Ltd (**"KiwiRail"**) (submitter s094) on Proposed Plan Change 2 (**"PC2"**) to the Operative Kāpiti Coast District Plan (**"ODP"**)

STATEMENT OF EVIDENCE OF STEPHEN CHILES ON BEHALF OF KIWIRAIL HOLDINGS LIMITED

NOISE AND VIBRATION

1. INTRODUCTION

1.1 My full name is Dr Stephen Gordon Chiles. I have the qualifications of Doctor of Philosophy in Acoustics from the University of Bath and Bachelor of Engineering in Electroacoustics from the University of Salford, UK. I am a Chartered Professional Engineer and Fellow of the UK Institute of Acoustics.

1.2 I am self-employed as an acoustician through my company Chiles Ltd. I have been employed in acoustics since 1996, as a research officer at the University of Bath, a principal environmental specialist for Waka Kotahi NZ Transport Agency (**"Waka Kotahi"**), and a consultant for Arup, WSP, and URS, Marshall Day Acoustics and Fleming & Barron. I am contracted as the principal advisor to provide the Environmental Noise Analysis and Advice Service to the Ministry of Health and Te Whatu Ora - Health New Zealand.

1.3 I have been involved in many situations relating to noise effects on new or altered sensitive activities around existing infrastructure. I was an Independent Commissioner for plan changes for Queenstown and Wanaka Airports and a plan variation for Port Nelson, which dealt particularly with noise effects. I have previously been engaged to advise Waka Kotahi and Auckland Transport (roads), KiwiRail (railways), Christchurch City Council (airport) and Environment Canterbury (port) on reverse sensitivity noise issues. I have presented acoustics evidence for Waka Kotahi and KiwiRail on numerous plan changes and plan reviews. I previously drafted potential environmental noise provisions for Clause G6 of the New Zealand Building Code for the Ministry of Business, Innovation and Employment.

1.4 I am convenor of the New Zealand reference group for "ISO" acoustics standards and a member of the joint Australian and New Zealand committee responsible for acoustics standards. I was Chair of the 2012 New Zealand acoustics standards review, Chair for the 2010 wind farm noise standard, and a member for the 2008 general environmental noise standards.

2. CODE OF CONDUCT

2.1 I confirm that I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023. I have complied with the Code of Conduct in preparing this evidence and will continue to comply with it while giving oral evidence at the hearing. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

3. SCOPE OF EVIDENCE

3.1 My statement relates to PC2, and in particular to potential effects of railway noise and vibration on new and altered sensitive activities enabled by intensification provisions. I have prepared this statement for KiwiRail as transport network utility operator for the North Island Main Trunk line ("**NIMT**") that passes through the Kāpiti Coast District.

3.2 I was previously engaged by KiwiRail to give evidence in 2016 to the hearings panel for the now operative rule NOISE-R14.

3.3 KiwiRail made a submission (s094) on PC2 including seeking:

(a) amendment of NOISE-R14 to apply land use controls to new and altered sensitive activities within 100 metres of rail corridors, rather than 40 metres in the ODP; and

(b) addition of land use controls for vibration where new or altered buildings for sensitive activities are within 60 metres of a rail corridor.

3.4 The purpose of these provisions is to protect the health and amenity of occupants of those buildings, and to avoid or mitigate potential reverse sensitivity effects on KiwiRail's operations on the NIMT.

3.5 Andrew Banks discusses these aspects of the KiwiRail submission in paragraphs [302] to [310] of the Council Officers' Planning Evidence. He recommends rejection of the relief sought in part citing lack of evidence and also discussing complexity of vibration controls. Mr Banks does not report having received any expert acoustics advice in reaching his position on these matters and no acoustics evidence has been filed by the Council.

3.6 My evidence will address:

(a) noise and vibration effects arising from rail infrastructure;

(b) methods to manage adverse effects on new and altered buildings containing sensitive activities near existing infrastructure;

(c) the appropriateness of the relief sought by KiwiRail from an acoustics and public health perspective; and

(d) the recommendations in the Council Officers' Planning Evidence in relation to the relief sought by KiwiRail.

4. NOISE AND VIBRATION EFFECTS FROM RAIL INFRASTRUCTURE

4.1 Sound and vibration from rail networks have the potential to cause adverse health effects on people living nearby.

Noise effects from rail networks

4.2 In respect of noise, this has been documented by authoritative bodies such as the World Health Organisation (**"WHO"**),[1] including a 2018 publication by WHO Europe ("**2018 WHO Guidelines**"), which sets out guidelines for managing environmental noise.[2] These publications are underpinned by extensive research. I am not aware of any fundamental disagreement in the acoustics profession with the information published by WHO regarding rail noise effects.

4.3 Research published in 2019 specifically addressed the applicability of international data on noise annoyance to New Zealand.[3] For rail noise, this research was based on a survey of 244 people living in the vicinity of the NIMT in Auckland, using the same general methodology as most international studies. The research found that international noise annoyance response curves are generally applicable for the New Zealand population. I am currently on the steering groups for two other research projects further investigating these issues: "Community response to noise" and "Social (health) cost of land transport noise exposure in New Zealand".[4]

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1 World Health Organisation, Guidelines for community noise, 1999; World Health Organisation, Burden of disease from environmental noise, 2011.

2 World Health Organisation, Environmental noise guidelines for the European region, 2018.

3 Humpheson D. and Wareing R., 2019. Evidential basis for community response to land transport noise, Waka Kotahi Research Report 656. https://nzta.govt.nz/resources/research/reports/656/

4 https://www.nzta.govt.nz/planning-and-investment/research-programme/current-research-activity/active-research-projects/

4.4 From preceding studies, the 2018 WHO Guidelines found evidence that railway sound causes adverse health effects in that it increases the risk of annoyance and sleep disturbance in the population. Various other potential health effects were examined but evidence was not available to determine a relationship for them with railway sound. Based on the information available the 2018 WHO Guidelines made "strong" recommendations that external railway sound levels should be reduced below guideline values. The relief sought by KiwiRail to retain the notified provisions in the Proposed Plan is consistent with this direction, as an integral part of its broader noise management activities. I describe below some of the steps and actions that KiwiRail implements as part of this management approach.

Vibration effects from rail networks

4.5 Internationally, there has been less research into transportation vibration effects on people compared to research on transportation sound effects. However, the evidence that does exist on adverse health effects caused by railway vibration indicates they are material, and as such in my opinion the relative paucity of research is not an indicator of the degree of effects. There is international research ongoing in this area. Research is also investigating health effects arising from the combination of railway sound and vibration.

4.6 With respect to vibration, Norwegian Standard NS 8176[5] provides a summary of annoyance and disturbance relationships associated with vibration from land-based transport. These relationships show that adverse effects occur at vibration exposures typically found around existing rail networks. This primary issue relates to people in dwellings being disturbed due to feeling vibration, but there is also an interrelated issue that the same vibration can cause buildings to radiate noise inside.

5. METHODS TO MANAGE ADVERSE EFFECTS

5.1 I have been involved in different activities undertaken by KiwiRail to manage and reduce this sound and vibration where practicable. These include installation of ballast mat, rail grinding and tamping, ballast cleaning and replacement, and automated monitoring of rolling stock wheel condition. However, even with practicable improvements implemented, the operation of the railway network can result in adverse effects which cannot be completely internalised within its typical designation boundaries, such as noise and vibration. These effects commonly occur within the railway network subject to normal maintenance and cannot be solely attributed to defects in track or rolling stock. In particular, vibration varies significantly depending on ground conditions and localised features such as buried services and structures. Even with "good" ground, track and rolling stock conditions there is still inherent vibration from railways that can cause disturbance to activities in proximity to the rail corridor.

5 Norwegian Standard NS 8176:2017 Vibration and shock - Measurement of vibration in buildings from landbased transport and guidance to evaluation of its effects on human beings.

5.2 As these effects cannot be completely internalised within the corridor, in my opinion there must be appropriate land use controls in place to manage sensitive development near these transport corridors. Land use controls to avoid or manage adverse noise and vibration effects on new sensitive activities or alterations to such activities are critical in protecting sensitive activities from adverse noise and vibration effects. Such controls, in turn, are fundamental to managing the potential for reverse sensitivity effects on the rail network. The location of incompatible sensitive activities in proximity to rail infrastructure can lead to noise and vibration effects on, and complaints from, sensitive users.

5.3 If it is not practicable to avoid sensitive activities near the rail corridor, for new buildings being constructed, or existing buildings being altered, it is relatively straight-forward to control internal sound and vibration through the building location, design and systems (like acoustic insulation and mechanical ventilation). In most cases, it is practical to achieve acceptable internal sound and vibration levels using such measures. Thus, with careful design of building location, orientation and materials, future occupants of the building can be protected from the most significant adverse effects associated with railway sound and vibration.

5.4 Rules in district plans commonly control the location and design of sensitive activities such as housing, where such activities seek to locate near existing sound sources such as roads, railways, airports, ports, quarries, industrial sites, industrial and business zones, gun clubs and motorsport facilities. Rule NOISE-R14 in the ODP includes land use controls for new and altered buildings containing sensitive activities, but only addressing noise and not vibration and only applying to buildings within 40 metres of rail corridors.

6. RELIEF SOUGHT

Distance for application of NOISE-R14

6.1 KiwiRail's submission seeks to increase the distance for application of rule NOISE-R14 to extend 100 metres from rail corridors. In my opinion, for the reasons set out below, the current distance of 40 metres is inadequate to protect new and altered noise sensitive activities from adverse health effects, and 100 metres is a more appropriate distance.

6.2 NOISE-R14 in the ODP currently includes a provision that if outdoor rail noise levels are less than 55 dB $L_{Aeq(1h)}$ then no treatment of new and altered buildings is required. For noise exposures above this value sound insulation requirements apply. With windows ajar for ventilation, an outdoor level of 55 dB $L_{Aeq(1h)}$ would typically be in the order of 40 dB $L_{Aeq(1h)}$ inside a space. This indoor level is still above guidelines for sleeping spaces (e.g. 35 dB) but may be reasonable in other habitable spaces. Nevertheless, I will address the question of the appropriate distance for application of NOISE-R14 based on the ODP already adopting 55 dB $L_{Aeq(1h)}$ as a level above which treatment is necessary to address adverse health effects.

6.3 Railway sound levels are dependent on train types/condition, traffic volumes, speeds, track geometry/condition, terrain and various other factors. There will be variation in noise exposure along the length of the NIMT in the Kāpiti Coast District. However, the following table provides an illustration of typical railway sound levels based on an assumption of approximately two freight train movements in a one-hour period, in a flat area without screening. This is based on data summarised by Marshall Day Acoustics. [6] I am familiar with more recent (unpublished) measurements for various New Zealand train types, which confirm these sound levels are in a realistic range.

Distance from track	Sound level
10 metres	71 dB $L_{Aeq(1h)}$
20 metres	68 dB $L_{Aeq(1h)}$
30 metres	66 dB $L_{Aeq(1h)}$
40 metres	64 dB $L_{Aeq(1h)}$
50 metres	62 dB $L_{Aeq(1h)}$
60 metres	60 dB $L_{Aeq(1h)}$
70 metres	59 dB $L_{Aeq(1h)}$
80 metres	58 dB $L_{Aeq(1h)}$
90 metres	56 dB $L_{Aeq(1h)}$
100 metres	56 dB $L_{Aeq(1h)}$

6.4 I understand from KiwiRail that the NIMT through the Kāpiti Coast District is an important part of the freight network, and allowance for two freight movements (in addition to passenger services) in a one-hour period is an appropriate assumption to allow for reasonable use of the existing line. I therefore consider that the indicative levels in the table above should be used to evaluate where land use controls should apply in this instance.

6.5 In the table, rail noise exposures above 55 dB $L_{Aeq(1h)}$ occur for a significant distance beyond 40 metres from the rail corridor. As such, in my opinion this represents a contradiction in the operative rule NOISE-R14, in that it includes 55 dB $L_{Aeq(1h)}$ as a threshold above which building treatment is required, but it limits application of the rule by a seemingly arbitrary distance such that it misses substantial areas where this threshold is exceeded. It can be seen from the table that application of the rule to all areas within 100 metres of the rail corridor would cover most areas likely to be exposed above 55 dB $L_{Aeq(1h)}$. In my opinion this is necessary to manage potential adverse health effects on people in new and altered buildings.

Vibration controls

6.6 KiwiRail's submission seeks for inclusion of a new rule managing indoor vibration in new and altered buildings containing sensitive activities. The proposed rule applies within 60 metres of a rail corridor and compliance can either be achieved by demonstrating vibration does not exceed 0.3 mm/s $v_{w,95}$, or by constructing simple building types with a vibration isolation bearing. I will

6 Marshall Day Acoustics, *Ontrack rail noise criteria reverse sensitivity guidelines*, 22/10/09

address each aspect of this rule: the 0.3 mm/s criterion, the 60 metre distance, and the construction specification.

6.7 NS 8176 defines four categories of vibration exposure in residential buildings, with Class A representing the best vibration conditions and Class D (or below) representing the worst. The Class C criterion has previously been applied in New Zealand for habitable spaces in new buildings. This corresponds to a vibration level at which about 20% of people would be expected to be highly or moderately annoyed by vibration. The Class C criterion is defined as a "statistical maximum value of weighted velocity" ($v_{w,95}$) of 0.3 mm/s. I consider 0.3 mm/s $v_{w,95}$ to be a minimum standard that should be achieved in new buildings near railways for reasonable protection from adverse health effects.

6.8 Railway vibration is generally subject to greater variability between locations than noise, due to complex interactions between localised track/ground conditions and buildings. As an indication, the following table summarises various railway vibration measurements (and associated predictions) in New Zealand from a range of sources, generally ordered from lowest to greatest magnitude (other than the first row which uses the ppv metric rather than $v_{w,95}$). Where the data relates to a private development or complaint, a generic source reference is given. Not all measured values are directly comparable due to issues such as differences in measurement positions (ground/building) that would require adjustments.

Data source	Vibration levels
Marshall Day Acoustics, *Ontrack rail noise criteria reverse sensitivity guidelines*, 22/10/09 *(secondary reporting of Marshall Day Acoustics 2006 assessment for Marsden Point)*	Based on measurements: 2 to 3 mm/s ppv at 30m 0.5 to 1 mm/s ppv at 60m
AECOM, *Bayfair to Bayview – Rail Relocation Post Construction Noise and Vibration Monitoring*, 6/3/17	Measured: 0.56 mm/s $v_{w,95}$ at 7m From measurement and distance correction: 0.19 mm/s $v_{w,95}$ at 100m 0.26 mm/s $v_{w,95}$ at 50m 0.37 mm/s $v_{w,95}$ at 25m
Marshall Day Acoustics, *Wiri to Quay Park third main rail line noise and vibration assessment*, 10/7/20	Measured: 0.6 mm/s $v_{w,95}$ at 9.5m
URS, *Maunganui-Girven Road Intersection -Rail Vibration Assessment*, 14/4/14	Measured: 26.5 mm/s^2 $a_{w,95}$ at 17m *(this $a_{w,95}$ value has different units and is not directly comparable to a $v_{w,95}$ value)* From measurement and distance correction: 0.34 mm/s $v_{w,95}$ at 100m 0.47 mm/s $v_{w,95}$ at 50m 0.67 mm/s $v_{w,95}$ at 25m
URS, *Operational noise and vibration assessment Peka Peka to North Ōtaki Expressway Project*, 12/2/13	Measured: 0.58 mm/s $v_{w,95}$ at 60m
Marshall Day Acoustics, *assessment in relation to a complaint near Hamilton*, 28/11/12	Measured (on a deck structure): 0.42 mm/s $v_{w,95}$ at 140m

Data source	Vibration levels
Marshall Day Acoustics, *assessment for development in Napier*, 6/2/20	Measured: 1.2 mm/s $v_{w,95}$ at 10m
URS, *Ground-borne vibration measurements at Hornby, Christchurch,* 12/9/14	Measured before renewal: 2.2/2.9 mm/s $v_{w,95}$ at 8.4m Measured after renewal: 0.5/0.4 mm/s $v_{w,95}$ at 8.4m

6.9 The data in the above table illustrates the significant variation that is inherent in railway vibration. With respect to the criterion of 0.3 mm/s $v_{w,95}$, the measurement data shows that this criterion can routinely be exceeded at over 100 metres from railway tracks in New Zealand, but there is significant variation. Vibration levels exceeding this criterion occur beyond 60 metres from the track in most cases, including an example in the table that was by the NIMT in Ōtaki.

6.10 For application of land use controls, from a technical perspective it would be preferable to assess all sites within 100 metres or more of rail corridors. However, KiwiRail has limited proposed controls to 60 metres in its submission on a pragmatic basis, also in recognition of the significant variability in vibration levels.

6.11 The final part of the proposed rule is the option to use a construction specification for a vibration isolation bearing. This can be applied for simple buildings (i.e. single-storey framed residential buildings) as an alternative to conducting a site/building specific assessment. From a technical perspective, I recommend a site-specific assessment in all instances due to the variability of vibration and building designs. As such, I consider the construction specification part of the proposed rule could be omitted. However, if a compliance option is desired that does not require site-specific assessment, then the construction specification should provide reasonable vibration isolation such that vibration inside most buildings is likely to be less than 0.3 mm/s $v_{w,95}$.

7. COUNCIL OFFICERS' PLANNING EVIDENCE

7.1 In paragraph [306] of his evidence Mr Banks states that it is not clear why application of NOISE-R14 should extend to 100 metres from rail corridors. I have set out the technical reasons above as to why I consider that controls to at least this distance are necessary to manage adverse health effects.

7.2 Also in paragraph [306], Mr Banks poses six questions (a) to (f) relating to vibration controls. I will respond to his questions (a) to (d) and (f) which have aspects within my technical expertise:

(a) Vibration is measured with specific instrumentation. Sensors are attached to the ground or a structure and levels recorded by a connected or integral meter. Predictions can then be made as to vibration inside a proposed new building on the site. Vibration is a branch of acoustics, and also overlaps with structural/geotechnical engineering. There are various acoustics engineers and some structural/geotechnical engineers in New Zealand who conduct vibration measurements and analysis.

(b) The meaning of the criterion 0.3 mm/s $v_{w,95}$ should be clear to specialists making assessments under the rule. Further specificity could be provided by making reference to NS 8176.

(c) The design solution needed to comply with the proposed rule will vary between sites and buildings. For all sites there are methods available to meet the vibration criterion. However, the cost and complexity of methods will vary, with some sites/buildings requiring only standard construction types and others requiring extensive treatment such as vibration isolation bearings. Mr Banks considers such solutions novel in a New Zealand residential context. I agree that while more common internationally, in my experience railway vibration isolation has been rare in New Zealand. However, in the context of planning provisions allowing for intensification of sensitive activities on sites subject to railway vibration, technically there is no reason why building designs cannot adapt to provide healthy living environments.

(d) Mr Banks questions whether the rule would lead to unreasonable design, construction and ongoing maintenance costs for building owners. The question extends beyond my technical expertise, but I note there should be no ongoing maintenance costs, or ongoing monitoring required as raised by Mr Banks in paragraph [307]. Considering the question from the perspective of technical effects; if building owners/occupants were exposed to vibration above the criterion then I would consider that poses an unreasonable risk of adverse health effects. Such effects can be avoided by building on sites not exposed to vibration or by building on sites with appropriate vibration controls.

(f) Vibration isolation of buildings is most commonly at the foundations, such as with vibration bearings on pile caps or full surface vibration bearings under the floor slab. Above the vibration bearings there are generally no constraints on the building construction, and I am unaware of factors that might affect compliance with other building requirements.

8. CONCLUSIONS

8.1 Sound and vibration from rail corridors can give rise to adverse health and amenity effects on sensitive land uses located nearby. The research and guidelines relating to these effects are widely accepted internationally and applied in New Zealand.

8.2 KiwiRail continuously works to reduce existing sound and vibration exposure and to manage the effects of their operations on existing sensitive activities. However, due to the nature of its operations, KiwiRail (as with many large infrastructure providers) is unable to internalise all noise and vibration effects associated with its activities.

8.3 Adverse effects on new and altered to buildings for sensitive activities can be avoided and managed through well understood controls in district plans. The ODP includes controls for railway noise but only within 40 metres of rail corridors.

8.4 I consider that to manage adverse health effects on sensitive activities in new and altered buildings near the existing NIMT, the distance for application of noise controls should be extended to 100 metres, and vibration controls should be implemented at least requiring compliance with a criterion of 0.3 mm/s $v_{w,95}$ within 60 metres of rail corridors.

Stephen Chiles
10 March 2023