BEFORE THE INDEPENDENT COMMISSIONERS

IN THE MATTER	of the Resource Management Act 1991 ("**RMA**")
AND	
IN THE MATTER	of a submission by KiwiRail Holdings Limited (**"KiwiRail"**) (submitter 30 and FS 71) on Plan Change 92 (**"PC92"**) to the Operative Western Bay of Plenty District Plan (**"ODP"**)

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

RAIL 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, 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.

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 PC92, 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 the requiring authority for the East Coast Main Trunk line (**"ECMT"**) that passes through the Western Bay of Plenty District.

3.2 KiwiRail made a submission (30) on PC92 seeking rules to manage adverse effects caused by new and altered buildings containing noise sensitive activities establishing near existing railway corridors. The purpose of the provisions sought is to protect the health of occupants of new and altered buildings, and in turn to avoid or mitigate potential reverse sensitivity effects on KiwiRail's operation of the ECMT.

3.3 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) controls that are included in the ODP;

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

(e) the recommendations in the section 42A report 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.

Rail noise effects

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 rail noise annoyance to New Zealand.[3] This included a survey of 244 people living in the vicinity of the North Island Main Trunk line in South 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]

4.4 From preceding studies, the 2018 WHO Guidelines found evidence that railway sound cause 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 submission on PC92 by KiwiRail to include land use controls for new and altered sensitive activities near rail corridors 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 implement as part of this management approach.

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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/.

Rail vibration effects

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 rail vibration, such as annoyance and sleep disturbance, 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, including into the combination of noise and vibration given that both can cause the same adverse health effects.

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 the existing rail network. 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 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 with 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 that can cause disturbance to activities in proximity to the rail corridor.

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 nearby. 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 both health impacts on those located near the rail network, and reverse sensitivity effects on the rail network itself.

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

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. For new houses near existing railways, examples of second-generation operative district plans containing controls include: Christchurch, Dunedin, Tauranga, Hamilton, Palmerston North, Whangarei and Hutt City. In all these example plans there are requirements to achieve reasonable internal noise levels in sensitive spaces near railways. Other aspects of the controls vary between these plans.

6. EXISTING RULES IN THE ODP

6.1 Rule 4C.1.3.2.c in the ODP sets internal noise limits in residential units and offices which apply district-wide in all cases where these buildings are permitted or controlled activities. Ms Heppelthwaite sets out various issues with the application of this rule in her evidence. In addition to those matters, I have the following comments.

6.2 The ODP rule requires an acoustic design certificate to be provided at the time of building consent. I am not aware of any similar district-wide rule in other districts, and this rule appears to impose an unwarranted cost in that it requires all houses to have acoustic design certificates regardless of their individual noise environment. I am unaware of how this rule is implemented in practice and whether in reality all houses and offices do have acoustic design certificates (prepared by a suitably qualified and experienced person) submitted with building consents.

6.3 The table in rule 4C.1.3.2.c.i sets internal noise limits without specifying the basis for external noise exposure to be used in the design. In my opinion, it is not practical to set internal noise limits as absolute criteria to be met at all times under all circumstances. In practice, the lack of specificity in the ODP rule will result in variable outcomes as different assumptions can be made for external noise exposure.

6.4 The noise limits in rule 4C.1.3.2.c.i apply to the ‘LAeq’ metric, and in accordance with the assessment standard specified in rule 4C.1.3.4, this would use a 15-minute averaging period. This would result in noise limits being relatively stringent for short-duration rail noise events.

6.5 Rule 4C.1.3.2.c.ii requires alternative means of ventilation where windows need to be closed to achieve indoor noise limits. However, there are no air change or temperature parameters specified beyond Building Code minima. Therefore, windows might need to be opened for occupants to be comfortable, which would compromise the sound insulation and could result in excessive indoor noise.

6.6 The ODP does not include any explicit controls for new and altered buildings affected by railway vibration.

7. RELIEF SOUGHT

7.1 KiwiRail's submission sought to add new land use controls for sensitive activities near rail corridors. Conceptually, the provisions proposed by KiwiRail are similar to ODP rule 4C.1.3.2.c, but they are more comprehensive and address the issues with the ODP rule that I have identified above.

Activities to be protected

7.2 KiwiRail's proposed provisions protect all identified noise sensitive activities (including residential, education, health and cultural activities) and not just offices and residential units. There can be adverse impacts on all types of noise sensitive activity and in my opinion, it is appropriate for provisions to manage noise and vibration effects on all the activities set out in KiwiRail's submission.

7.3 KiwiRail's proposed provisions apply to new and altered buildings. The ODP rule 4C.1.3.2.c is unclear whether it applies to altered buildings. When buildings are being altered, such as extensions or conversions for habitable spaces, I consider it appropriate to design to achieve the same indoor noise criteria to protect health as for new buildings. Extensions or conversions mean that additional people may be subject to adverse health and amenity effects. During construction of both new and altered buildings is the most efficient and effective time to incorporate appropriate noise controls.

Extent of rail noise controls

7.4 KiwiRail's proposed provisions for rail noise apply within 100 metres of railways, focussing land use controls on areas most likely to be affected by noise. 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] More recent (unpublished) measurements for various

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

New Zealand train types confirm these sound levels are in a realistic range. These levels are consistent with KiwiRail's proposed provisions.

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 $L_{Aeq(1h)}$

7.5 In the Marshall Day Acoustics report which generated the above levels, it was not set out as applying in settings which actually experienced two freight train movements per hour across a day. Instead, the intention of the average is to provide an approximation of both the effects of a single event, and a generalised average of noise from the corridor. The report considered a single measurement would enable simpler application of the rule framework by landowners (compared to an average and maximum approach which was considered to add extra complication without significant benefits in effects management given the variability of single trains passing by). In my opinion, the 15-minute average in the ODP rule 4C.1.3.2.c does not provide this balance.

7.6 Based on these indicative external levels, I consider that as included in KiwiRail's proposed provisions, controls should apply over at least 100 metres from the ECMT in the Western Bay of Plenty District, because where external rail noise exposure is over 55 dB $L_{Aeq(1h)}$ it is likely that recommended indoor criteria would be exceeded.

Indoor rail noise criteria

7.7 KiwiRail's proposed provisions include indoor noise design levels for all types of noise sensitive activity. These criteria are in terms of the $L_{Aeq(1h)}$ parameter and relate to specified assumptions of external rail noise.

Rail vibration controls

7.8 KiwiRail's proposed provisions include a maximum rail vibration criterion of 0.3 mm/s $v_{w,95}$ inside buildings for sensitive activities. This criterion corresponds to exposure where about 20% of people would be expected to be highly or moderately annoyed by vibration. 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.

7.9 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
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

7.10 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 (including from the ECMT), but there is significant variation. Vibration levels exceeding this criterion occur beyond 60 metres from the track in most cases.

7.11 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.

7.12 The KiwiRail submission seeks an option in the proposed vibration provisions to use a construction specification for a vibration isolation bearing. This can be applied for simple buildings (ie 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 $v_{w,95}$.

8. SECTION 42A REPORT

8.1 The section 42A report does not include separate comment by an acoustics specialist. It recommends rejecting the provisions proposed by KiwiRail that I have discussed above. I will comment on the technical matters raised in the section 42A report.

Effectiveness of a 10-metre setback

8.2 The section 42A report discusses a 10-metre building setback from railway corridors. I have set out above how noise and vibration effects from rail corridors extend substantially further than 10 metres. As such, a 10-metre setback does not control most of the potential adverse rail noise and vibration effects on new and altered sensitive activities. As set out in the evidence of Ms Heppelthwaite, the primary purpose of the 10-metre yard setback is to provide for building maintenance to be undertaken in a safe manner, not to protect occupiers from noise or vibration effects.[7]

Extent of controls

8.3 The section 42A report questions the extent of noise and vibration controls proposed by KiwiRail (100 and 60 metres from the rail corridor respectively). I have set out the technical basis for these distances above in my evidence. In my opinion, these distances are appropriate to identify sites most likely to be affected, with actual design measures for individual buildings then being determined through site specific assessment as required by the proposed rules. The rules proposed by KiwiRail allow flexibility to account for site-specific variations. For example, in the event that a new noise sensitive activity is located over 50 metres from the rail corridor and a

7 Statement of Evidence of Catherine Heppelthwaite dated 25 August 2023 at [10.7].

noise barrier blocks line-of-sight, then design measures are not needed. This contrasts with ODP rule 4C.1.3.2.c, which has indiscriminate application to all noise environments regardless of risk of adverse health effects.

Complaints

8.4 The section 42A report questions the nature of existing rail noise and vibration complaints in Ōmokoroa and Te Puke. In terms of adverse health effects, in my opinion existing complaints are irrelevant. The criteria I have set out in my evidence relate to adverse public health effects arising from certain levels of noise and vibration exposure. These effects can occur independently of any complaints, and complaints are not a reliable indicator of adverse public health effects. For example, research has shown that large numbers of people have sleep disturbed or are annoyed by environmental noise but there are not corresponding complaints. Adverse health effects generally arise from long-term exposure to environmental noise, rather than short-term specific identifiable events that might be more likely to be subject to complaint. In essence, adverse health effects can accumulate without people being explicitly aware of them at the time, and not necessarily being aware of the link to a particular source. In instances where people are aware of the source, they also might not complain if they perceive that it is unlikely to result in the noise being reduced in practice.

ODP rule 4C.1.3.2.c

8.5 The section 42A report highlights that ODP rule 4C.1.3.2.c already provides protection from rail noise. I have discussed substantial shortcomings of ODP rule 4C.1.3.2.c in my evidence and for those reasons, in my opinion it is inadequate to provide protection from rail noise. In terms of the plan structure, KiwiRail's proposed provisions could potentially be incorporated into a revision of ODP rule 4C.1.3.2.c if it were redrafted to address the issues I have identified.

Cost

8.6 The section 42A report notes that vibration controls would add cost to buildings. I agree that KiwiRail's proposed controls will often result in increased cost. However, in terms of adverse health effects, those costs are warranted in areas affected by rail noise and vibration, compared to say locations remote from significant noise and vibration sources.

9. CONCLUSIONS

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

9.2 KiwiRail continuously works to reduce existing noise and vibration exposure and to manage the effects of its 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.

9.3 Adverse effects on new and altered buildings for sensitive activities can be avoided and managed through well understood controls in district plans. KiwiRail made submissions on PC92 seeking provisions implementing such controls. I consider that the relief sought by KiwiRail as refined in Appendix A to the evidence of Catherine Heppelthwaite appropriately address these issues.

Stephen Chiles
25 August 2023