BEFORE THE INDEPENDENT COMMISSIONERS

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER a submission by KiwiRail Holdings Ltd ("**KiwiRail**") on Proposed Plan Change 14 ("**PC14**") to the Christchurch District Plan

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

NOISE AND VIBRATION
20 September 2023

Introduction

1.1 My full name is Dr Stephen Gordon Chiles. I have the qualifications and experience as set out in Section 1 of my previous statement of evidence for the Plan Change 5E ("**PC5E**") hearing, dated 3 February 2023, attached to this current statement as **Appendix A**. I adopt that evidence as my evidence for PC14, subject to further clarifications in this statement below.

1.2 I have read the Environment Court's Code of Conduct for Expert Witnesses 2023 and I agree to comply with it. I confirm that the issues addressed in this brief of evidence are within my areas of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

1.3 This statement relates to potential effects of railway noise and vibration on new and altered sensitive activities enabled by the intensification provisions of PC14. I have been engaged by KiwiRail as the requiring authority for the rail network that passes through the Christchurch District.

Noise controls

1.4 KiwiRail made a submission on PC14 seeking land use controls for new and altered sensitive activities within 100 metres of the rail corridor in line with its previous submission on PC5E, including amendments sought through the hearing. I confirm that the matters set out in my previous evidence dated 3 February 2023 still correctly set out my opinions on this issue and are applicable to PC14. I confirm that I consider that controls are necessary to manage the location

and design of sensitive activities near railways, to protect people from adverse health effects and in turn to manage potential reverse sensitivity effects on KiwiRail.

Vibration controls

1.5 PC5E did not include controls for rail vibration affecting new and altered sensitive activities. KiwiRail's submission on PC14 sought for controls to be added for vibration. In a similar manner to noise, rail vibration causes adverse health effects in the vicinity of railways.

1.6 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.

1.7 With respect to vibration, Norwegian Standard NS 8176[1] 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 within 100 metres of 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.

1.8 KiwiRail's submission sought to add new vibration controls for sensitive activities within 60 metres of the rail corridor. The 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.

1.9 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.

[1] 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.

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

1.10 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 the railway corridor in New Zealand, but there is significant variation. Vibration levels exceeding this criterion occur beyond 60 metres from the rail corridor in most cases. For application of land use controls, from a technical perspective it would be preferable to assess all sites within 100 metres or more of the rail corridor. However, KiwiRail limited proposed controls to 60 metres in its submission on a pragmatic basis, also in recognition of the significant variability in vibration levels.

1.11 As outlined in the evidence of Ms Heppelthwaite and Ms Grinlinton-Hancock, I understand KiwiRail now proposes a vibration alert layer in lieu of controls on new and altered sensitive activities. However, I continue to support the inclusion of controls on the basis that I consider they are necessary to manage adverse vibration effects.

Stephen Chiles

20 September 2023

APPENDIX A

Statement of evidence of Stephen Chiles on the Proposed Plan Change 5E to the Christchurch District Plan on behalf of KiwiRail Holdings Limited and Waka Kotahi NZ Transport Agency, dated 3 February 2023

BEFORE INDEPENDENT HEARINGS COMMISSIONERS APPOINTED BY CHRISTCHURCH CITY COUNCIL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of submissions by Waka Kotahi New Zealand Transport Agency (submitter S32) and KiwiRail Holdings Ltd (submitter S27) on Proposed Plan Change 5E to the Christchurch District Plan ("**Plan Change 5E**")

STATEMENT OF EVIDENCE OF STEPHEN GORDON CHILES ON BEHALF OF WAKA KOTAHI NZ TRANSPORT AGENCY AND KIWIRAIL HOLDINGS LIMITED

ROAD AND RAIL NOISE

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 Holdings Ltd ("**KiwiRail**") (railways), Christchurch City Council ("**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.

Code of Conduct

1.5 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.

Scope of evidence

1.6 My statement relates to Plan Change 5E, which proposes to amend the operative rule 6.1.7.2.1. The operative rule currently sets controls for new and altered noise sensitive activities near roads and railways, and Plan Change 5E primarily seeks to improve clarity and efficiency of the rule.

1.7 I have prepared this statement taking into account the functions of KiwiRail and Waka Kotahi as railway and state highway network operators in the Christchurch District. KiwiRail and Waka Kotahi share an interest in and seek similar relief through their submissions supporting Plan Change 5E, subject to three relatively minor wording changes in the case of the KiwiRail submission.

1.8 I was previously engaged by KiwiRail to give evidence to the Independent Hearings Panel in 2016 with respect to the now operative rule 6.1.7.2.1. I attended the Council workshop on Plan Change 5E in 2020 and the meeting of noise experts in October 2022.

1.9 Given that the KiwiRail and Waka Kotahi submissions support Plan Change 5E, and that my opinions are generally aligned with Council's technical advice from Acoustics Engineering Services ("**AES**") appended to the section 42A report, my evidence will be relatively brief. However, I will set out the reasons for my opinions on the fundamental issues. In my evidence I will not address minor nuances between reasoning given by AES and my own reasons, where we reach the same overall position.

1.10 In my opinion, to manage adverse effects on human health, in addition to controls in the operative or notified rule 6.1.7.2.1, it would be appropriate for the Christchurch District Plan to include controls for noise in new outdoor living spaces and vibration inside new habitable spaces. Neither of these matters are addressed in Plan Change 5E or in the submissions by KiwiRail and Waka Kotahi. Therefore, I will not address these matters in my evidence.

1.11 My evidence will address:

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

(b) methods to manage effects on new and altered buildings containing noise sensitive activities near existing infrastructure, as well as reverse sensitivity effects on existing infrastructure arising as a result of such activities;

(c) controls that are included in the operative rule 6.1.7.2.1 and in Plan Change 5E; and

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

1.12 I have prepared my evidence based on my experience assessing and managing future and existing state highway and railway sound, at numerous locations throughout New Zealand.

2. NOISE EFFECTS FROM ROAD AND RAIL INFRASTRUCTURE

2.1 Sound from road and rail networks has the potential to cause adverse health effects on people living nearby. This has been documented by the World Health Organisation ("**WHO**"),[1] including a 2018 publication by WHO Europe ("**2018 WHO Guidelines**"), which sets out guidelines for managing environmental

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

noise.[2] These publications are underpinned by extensive research, and I am not aware of any fundamental disagreement in the acoustics profession with the information regarding road and rail noise effects.

2.2 Research published in 2019 specifically addressed the applicability of international data on road and rail noise annoyance to New Zealand.[3] This included a survey of people living in the vicinity of the North Island Main Trunk line and separately State Highway 1 in South Auckland. The survey was based on the questions and methods set out in the international technical specification ISO/TS 15666,[4] which is the same approach used in most international studies. The research found that international noise response curves are generally applicable for the New Zealand population, although potentially the New Zealand population may be slightly more noise sensitive. I am currently on the steering groups for two other research projects further investigating these issues: "Community response to noise" and "Social cost (health) of land transport noise exposure".[5]

2.3 The 2018 WHO Guidelines note the following adverse effects from road and rail noise: ischaemic heart disease, hypertension, high annoyance and sleep disturbance. Based on the strength of the evidence of adverse effects, WHO makes recommendations to policymakers to reduce road and rail sound exposure to below a range of guideline values. The relief sought by KiwiRail and Waka Kotahi to retain the notified provisions of Plan Change 5E (and the amendments discussed in the evidence of Stuart Pearson) is consistent with this direction, as an integral part of their broader noise management activities. I describe below some of the steps and actions that Waka Kotahi and KiwiRail implement as part of this approach.

3. METHODS TO MANAGE ADVERSE EFFECTS

3.1 I have been involved in different activities undertaken by KiwiRail and Waka Kotahi to manage and reduce road and rail sound where practicable. These include development of quieter road surfaces, installation of noise barriers, rail grinding and tamping, investigation into engine braking noise, and automated monitoring of rolling stock wheel condition. However, even with practicable improvements implemented, the operation of the state highway and railway

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 International Standards Organisation ISO/TS 15666:2003 Acoustics – assessment of noise annoyance by means of social and socio-acoustic surveys.

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

networks can result in adverse noise effects which cannot be completely internalised within their typical designation boundaries.

3.2 As these effects cannot be completely internalised within the corridor, 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 effects on new sensitive activities or alterations to such activities are critical in protecting sensitive activities from effects on health. Such controls, in turn, are fundamental to managing the potential for reverse sensitivity effects on the road and rail networks. The location of incompatible sensitive activities in proximity to road and rail infrastructure can lead to noise effects on, and complaints from, sensitive users.

3.3 If it is not practicable to avoid sensitive activities near road and rail corridors, for new buildings being constructed or existing buildings being altered, it is relatively straight-forward to control internal sound through the building location, design and systems (like acoustic insulation and mechanical ventilation). In most cases, it is practical to achieve acceptable internal sound 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 state highway and railway sound.

3.4 Rules in other district plans commonly control the location and design of noise 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 roads and 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 roads and railways. Other aspects of the controls vary between these plans.

4. NOISE CONTROLS IN THE CHRISTCHURCH DISTRICT PLAN

4.1 The aim of operative rule 6.1.7.2.1 is to reduce road and railway sound inside buildings to provide an internal environment whereby people have reasonable amenity and protection from health effects such as sleep disturbance. Two common ways of achieving this are either to specify internal sound levels directly, or to specify the sound insulation of buildings that should consequently result in those same (or lower) internal levels. There are benefits and drawbacks with either approach.

4.2 The operative rule 6.1.7.2.1 allows the option of using either approach, and further allows for sound insulation to be determined by a performance standard or specific constructions. Technically, it is possible to draft a rule with options to use multiple methods which all result in internal sound levels below a threshold to protect health. However, as set out in the section 32 evaluation, this might not have been achieved with the operative rule 6.1.7.2.1 and the inclusion of multiple methods has reduced clarity in what would be a detailed technical rule even if there was just one method. From my experience reviewing, drafting and applying plan rules to address new and altered buildings exposed to road and rail noise, I consider that use of one primary method to control internal sound levels is preferable. In my opinion this improves clarity and understanding of the rule, which in turn can improve efficiency and robustness of implementation.

4.3 While either approach of specifying internal levels or sound insulation could be applied, on balance, for rail and road noise I recommend specifying internal sound levels as it avoids unnecessary expenditure on building components and allows each building to be built to an appropriate design for its specific site and layout. I consider this to be the most efficient and effective mechanism to manage rail and road noise effects in new and altered buildings. This is the approach taken by Plan Change 5E, which seeks to amend operative rule 6.1.7.2.1 to remove the sound insulation method and rely primarily on specification of internal sound levels.

4.4 Plan Change 5E seeks to retain the existing internal sound levels specified in the operative rule 6.1.7.2.1. The rule sets maximum road and rail noise levels to be met in bedrooms of 40 dB $L_{Aeq(24h)}$ and 35 dB $L_{Aeq(1h)}$ respectively. The WHO 2018 Guidelines recommend a criterion of 44 dB L_{night} but applied outside buildings and averaged over the night period for a year. This WHO value assumes windows may be open, resulting in internal sound levels of around 30 dB. The respective averaging time periods for the $L_{Aeq(24h)}$, $L_{Aeq(1h)}$ and L_{night} need to be accounted for when comparing values. When adjusting to comparable time periods, the road and rail noise criteria for bedrooms in rule 6.1.7.2.1 are slightly higher (more lenient) than the 44 dB L_{night} WHO recommendation by around 5 dB. I consider this a pragmatic approach for rule 6.1.7.2.1 to address the most significant adverse health effects, without imposing significant constraints on development of noise sensitive activities. Likewise, I consider the indoor criteria in rule 6.1.7.2.1 for other spaces, of 40 dB $L_{Aeq(24h)}$ and 40 dB $L_{Aeq(1h)}$ for road and rail noise respectively, to be pragmatic values.

4.5 The operative and proposed rule 6.1.7.2.1 include two secondary compliance methods to avoid detailed acoustics assessment if external noise levels are below certain thresholds or if the building is at least 50 metres away with screening from roads and railways.

4.6 The operative rule 6.1.7.2.1 includes a requirement for a ventilation system where windows are required to be closed to achieve indoor road and rail noise criteria. I consider this appropriate because if residents do not have adequate thermal comfort with windows closed they may need to open windows, which would compromise the sound insulation and result in excessive indoor noise. Plan Change 5E as notified proposes to alter the requirement for ventilation.

5. RESPONSE TO SECTION 42A REPORT

5.1 The section 42A report generally recommends retention of the notified provisions with some minor amendments. For the reasons set out above, I generally consider the notified provisions should result in an appropriate rule to manage indoor road and rail noise effects. However, I have comments on the economic evaluation and changes to ventilation provisions recommended in the section 42A report.

Economic evaluation

5.2 Appendix 8 of the section 42A report is an economic assessment by Formative. I do not have expertise in economic assessment but do have experience in monetisation of noise for economic assessment. I have investigated this issue for Waka Kotahi several times since being involved in testing of noise benefit-cost ratios when NZS 6806[6] was developed prior to 2010. I was involved in the recent "Domestic Transport Costs and Charges Study" for the Ministry of Transport,[7] and, as above, I am on the steering group of a current research project that is designed to investigate this specific issue.

5.3 Formative has monetised noise benefits as 1.2% of property value representing the value of avoiding 1 dB of noise exposure. This is the approach to monetisation of road noise exposure that has been most commonly used in New Zealand, but I am unaware of any evidential link between this approach and noise effects. From my ongoing review of scientific literature, I consider that international best practice has emerged over the last two decades to monetise noise exposure primarily based on the adverse health effects caused by that

6 Standards New Zealand, NZS 6806:2010 Acoustics – Road-traffic noise – new and altered roads

7 https://www.transport.govt.nz/area-of-interest/freight-and-logistics/transport-costs-charges/

exposure. The recent work and current research I have been involved in monetises noise using standardised costs of adverse health impacts it causes.

5.4 In my experience, monetisation based on costs of adverse health effects is likely to have shown greater benefits of maintaining land use controls in the district plan. However, this would be unlikely to alter the overall conclusions drawn from the Formative analysis.

5.5 The economic analysis includes "alternative protection options" in its assessment. Two of these options are provision of noise barriers and changing road surfaces. In my opinion, both of these mitigation measures are flawed as options in this context as they would not result in road and rail sound levels inside all new and altered buildings below acceptable thresholds to protect health, as I have discussed above. As such, I consider it potentially misleading to include these measures in the economic analysis as "options" when technically they are not valid as options. This limitation is acknowledged in the section 42A report.

Ventilation

5.6 In terms of noise effects, the requirement for ventilation and/or temperature controls is a consequential measure if windows need to be kept closed for sound insulation. I do not have expertise in mechanical engineering, but I have sought and commissioned advice for Waka Kotahi several times seeking to establish appropriate parameters for ventilation and temperature controls, because this does not appear to be adequately addressed in a standard, guide or regulations. The issues are summarised in a 2020 review by AES for Waka Kotahi.[8]

5.7 The notified provisions in Plan Change 5E reduced the ventilation air flow requirements from the operative rule 6.1.7.2.1. This is contrary to advice I have previously received on appropriate ventilation systems in this scenario.[9] In Appendix 9 to the section 42A report, Chris D'Arth advises that air conditioning could be specified to provide cooling. The section 42A report has followed this advice and recommends a requirement for air conditioning units. However, the recommended provision does not specify any temperature parameters to be achieved by air conditioning units. Therefore, any air conditioning unit could comply with the rule even if it does not provide adequate thermal comfort in all spaces. Based on my previous investigation of this issue for Waka Kotahi I

8 Acoustic Engineering Services, NZTA Ventilation specification review, 30 June 2020

9 Beca, Ventilation systems installed for road-traffic noise mitigation, 26 June 2014

understand that specifying an inside temperature range to be achieved by air conditioning may address this issue.

6. CONCLUSION

6.1 Sound from road and 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.

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

6.3 Adverse effects on new and altered buildings for sensitive activities can be avoided and managed through well understood controls in district plans. In my opinion, it is critical that the Christchurch District Plan maintains land use controls to manage the location and design of sensitive activities near road and rail corridors, to protect these users from adverse health effects and in turn to manage potential reverse sensitivity effects on KiwiRail and Waka Kotahi.

6.4 In my opinion the notified provisions in Plan Change 5E should improve the clarity and efficiency of the operative rule 6.1.7.2.1. The section 42A report recommends generally minor changes to the notified provisions. I have identified a potential issue where further specificity may be warranted with respect to the proposed requirement for air conditioning units.

Stephen Chiles
3 February 2023