IN THE MATTER of the Resource Management Act 1991 ("**RMA**")

AND

IN THE MATTER of submissions by NZ Transport Agency Waka Kotahi (submitter 450) on the Noise Chapter of Te Tai o Poutini Proposed Plan

STATEMENT OF EVIDENCE OF STEPHEN CHILES
ON BEHALF OF NZ TRANSPORT AGENCY WAKA KOTAHI

ROAD-TRAFFIC NOISE

6 August 2024

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 NZ Transport Agency Waka Kotahi ("**NZTA**"), and a consultant for Arup, WSP, 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 NZTA and Auckland Transport (roads), KiwiRail (railways), Christchurch City Council (airport) and Environment Canterbury (port) on reverse sensitivity noise issues. 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 committees 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 the noise chapter of the proposed Te Tai o Poutini Plan ("**TTPP**"), and primarily to rule NOISE-R3. I have prepared this statement on behalf of NZTA in relation to its function as the state highway network operator.

1.7 I have been separately engaged by KiwiRail and the National Public Health Service with respect to their submissions on TTPP and will be providing separate evidence for those parties.

1.8 NZTA submitted on TTPP supporting new provisions to manage adverse effects caused by new buildings containing sensitive activities establishing near existing state highway corridors. The purpose of these provisions is to protect the health and amenity of occupants of those buildings.

1.9 My evidence will address:

(a) noise effects arising from roads;

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

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

(d) the evidence of Stephen Peakall for the West Coast Regional Council dated 19 July 2024 and the Section 42A report prepared by Ruth Evans, in relation to recommendations on the relief sought by NZTA.

2. NOISE EFFECTS FROM ROADS

2.1 Sound from road networks has the potential to cause adverse health effects on people living nearby. 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 WHO 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 road noise effects.

[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.

2.2 Research published in 2019 specifically addressed the applicability of international data on road noise annoyance to New Zealand.[3] This included a survey of people living in the vicinity of State Highway 1 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 have been on the steering groups for two other research projects, currently awaiting publication, further investigating these issues: "Community response to noise" and "Social (health) cost of land transport noise exposure in New Zealand".[4]

2.3 From preceding studies, the 2018 WHO Guidelines found evidence that road noise causes adverse health effects in that they increase the risk of ischaemic heart disease, hypertension, annoyance and sleep disturbance in the population. Various other potential health effects were examined but evidence was not available to determine a relationship with road noise. Based on the information available the 2018 WHO Guidelines made 'strong' recommendations that external road sound levels should be reduced below guideline values. The relief sought by NZTA on TTPP 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 NZTA implements as part of this management approach.

2.4 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 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.

2.5 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 road networks. This primary issue relates to people in dwellings being disturbed due to feeling

[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/

[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.

vibration, but there is also an interrelated issue that the same vibration can cause buildings to radiate noise inside.

3. METHODS TO MANAGE ADVERSE EFFECTS

3.1 I have been involved in numerous different activities undertaken by NZTA to manage and reduce sound from state highways where practicable. These include development of quieter road surfaces, investigation into engine braking noise and installation of noise barriers. For new or altered roads, NZTA seeks to apply NZ 6806,[6] which provides guidance on the assessment of noise, recommended noise criteria and potential mitigation measures. However, practicable improvements are often constrained, and operation of the state highway network results in noise effects that cannot be internalised.

3.2 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 road corridors. Land use controls to avoid or manage noise effects on new sensitive activities or alterations to such activities are critical in protecting sensitive activities from adverse health impacts.

3.3 For new buildings being constructed, or existing buildings being altered, near to state highways, 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 state highway noise.

3.4 Rules in other district plans commonly control the location and design of sensitive activities, 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, 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. Other aspects of the controls vary between these plans. The notified TTPP includes similar controls in proposed NOISE-R3.

[6] New Zealand Standard NZS 6806:2010 Acoustics – Road-traffic noise – new and altered roads

4. RELIEF SOUGHT

4.1 NZTA submitted in support of NOISE-R3 and associated provisions, seeking for them to be retained in TTPP. In my opinion, the proposed NOISE-R3 and the relief sought by NZTA to retain the rule, should result in new buildings near state highways that provide people with acceptable indoor living conditions. This should manage adverse health effects experienced by those people to a reasonable degree.

4.2 The proposed NOISE-R3 does not address noise in altered buildings, and in my opinion, this is an omission that would result in inadequate control of adverse effects in those instances.

4.3 In its submission NZTA sought for fixed distances from highways in the notified NOISE-R3 to be replaced with a modelled overlay if that became available in time. In other several other districts NZTA has used national noise modelling to better define an area around highways where buildings are likely to require treatment to manage noise effects. I have been involved in this exercise and have set out the process used to develop overlays in the memorandum attached to my evidence as Appendix A. In general, I consider that overlays can have a benefit in targeting controls on the most affected areas.

4.4 Using the methodology set out in Appendix A, a proposed overlay has been produced for TTPP and has recently been provided to Council by Mr Pearson.

4.5 NZTA submitted that vibration controls should be limited to 20 metres from roads, which I consider appropriate based on typical vibration levels near state highways.

5. RESPONSE TO SECTION 42A REPORT

5.1 Mr Peakall and Ms Evans generally agree with the technical basis and need for the controls in NOISE-R3 for buildings for sensitive activities near highways. In principle, they also support the use of an overlay in place of fixed distances.

5.2 Ms Evans has recommended deleting notified NOISE-R3.1.b.ii, but does not explain why. Neither is this point addressed by Mr Peakall. In Appendix A, I have explained the technical basis for adding a 3 dB allowance. I consider this to be an important provision for NOISE-R3 to be effective and result in adequate protection. I recommend that NOISE-R3.1.b.ii be retained as notified.

5.3 Mr Peakall, and in turn Ms Evans, have recommended addition of a new appendix NOISE-APP1, setting out construction details that can be used as an

option to result in compliance with noise and vibration limits. Such tables are commonly used in other plans to provide alternative compliance pathways. In my experience, in practice such tables often don't provide the 'simple' option intended as minor deviations from specified constructions invalidate the approach. However, if the constructions are suitably conservative, they can provide a useful option in some instances.

5.4 I have not reviewed the details of NOISE-APP1, but I note there appears to be a significant omission that no ventilation is specified. If NOISE-APP1 is retained then it should specify that ventilation is to be provided in accordance with NOISE-R3.1.f.

5.5 A minor issue is that Mr Peakall, and in turn Ms Evans, have amended NOISE-R3.1.f.v to state a noise limit applies "at least" 1m away from any grille or diffuser. In my opinion, the noise limit should be specified at 1m to ensure it is achieved at all potentially occupied locations. The wording recommended by Ms Evans provides a loophole that would result in excessive noise from the ventilation system. I recommend retaining NOISE-R3.1.f.v as notified.

6. CONCLUSION

6.1 Noise from state highways 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 NZTA continuously works to reduce existing sound exposure and to manage the effects of its operations on existing sensitive activities. However, due to the nature of its operations, NZTA (as with many large infrastructure providers) is unable to internalise all noise effects.

6.3 Adverse effects on buildings for sensitive activities can be avoided and managed through well understood controls in district plans. NZTA submitted on TTPP for such controls in the notified version to be retained, with specified distances replaced by an overlay. I consider the relief sought by NZTA appropriate to address these issues.

Stephen Chiles
6 August 2024

Appendix A

Chiles Ltd Memorandum
State highway noise control boundary overlay, 23 March 2023

Chiles Ltd

MEMORANDUM

From: Stephen Chiles

To: Mike Wood, Waka Kotahi

Date: 23 March 2023

Subject: State highway noise control boundary overlay

Introduction

This memorandum sets out details of how Waka Kotahi has prepared a draft noise control boundary overlay for the national state highway network based on noise modelling, and the checks and amendments required before implementation of that overlay in each district. Comments are also made on the limitations of using such as overlay based on modelling.

Calculation of noise contours

The proposed noise control boundary overlays are based on national road-traffic noise modelling by AECOM. That modelling work was undertaken as part of a broader research project "*Social cost (health) of land transport noise exposure*". In this formal research programme, the work was subject to internal review, steering group review and independent peer review. At the time of preparing this memorandum the final research report from that project has not been published but is understood to be complete and undergoing final editorial review. The research report will be available on the Waka Kotahi website once finalised/published.

The following table sets out the modelling details understood to have been used by AECOM. These details should be confirmed in the research report although there might be some minor variations.

Table 1 – AECOM noise modelling details (subject to confirmation by research report)

Primary modeller	Lee Evans, AECOM
Software	SoundPLAN v8.2
Calculation algorithm	UK Calculation of Road Traffic Noise
Calculation area	600 metres either side of all highway and arterial centrelines
Parameter	$L_{Aeq(24h)}$ (taken as $L_{A10(18h)}$ – 3 dB)
Sound contour grid	Free-field, 10 m spacing, 1.5 m high
Ground absorption	Urban environments – 0.6 Rural environments – 1
Date of input datasets	2021 (generally reflecting 2020/21 conditions)
Road centrelines	CoreLogic National Road Centreline dataset (x/y) DEM (z)
Traffic volumes (AADT)	CoreLogic National Road Centreline dataset 24h traffic data entered in CRTN as 18h traffic
Heavy vehicles (%HV)	CoreLogic National Road Centreline dataset
Speed	CoreLogic National Road Centreline dataset Posted speed limit

Road surface	Surface types as recorded in Waka Kotahi RAMM database Surface corrections in accordance with Waka Kotahi *Guide to state highway road surface noise*, including a -2 dB correction from CRTN to a reference AC-10 surface.
Bridge locations	CoreLogic National Road Centreline dataset Height interpolated from start and end points
Terrain	LIDAR where available NZ School of Surveying 15 m nationwide DEM in other areas Data combined in GIS to produce 1 m×1 m DEM for noise model
Building footprints	LINZ NZ Building Outlines dataset
Building heights	Where available, calculated from DSM median height minus DEM median height, otherwise: 6 m residential / 8 m commercial
Noise barriers	None modelled

Of note in this table is that the modelling was for highways and other arterial roads in a combined dataset. This has resulted in 'stubs' and other artefacts in the proposed overlay where there are noise contours due to other arterial roads (not highways) in proximity to a highway (within 100 m).

From the AECOM noise modelling the 54 and 55 dB $L_{Aeq(24h)}$ contours (polygons extending around highways and other arterial roads) have been used for subsequent GIS processing. The distance of the contours (and subsequent overlay) from a highway depends on numerous factors included in the modelling, with key parameters being:

- Traffic volume
- Traffic composition (percentage of heavy vehicles)
- Traffic speed
- Road surface
- Road geometry
- Screening by terrain or buildings
- Relative height of highway and surrounding land

These parameters are constantly changing, which results in the contours being at a variable distance from a highway along its length. Notably, the contours are generally smaller around highways with lower traffic volumes, although that effect is often partly offset by differences in road surfaces with lower volume highways more likely to have noisier chipseal surfaces. For busier highways the contours are often further than 100 metres from the road, but the extent of the noise overlay has been capped at 100 metres by the GIS processing.

GIS processing of noise contours

The proposed noise control boundary overlay has been developed based on the modelled noise contours with some additional GIS processing. This additional processing is to make some allowance for uncertainty in the modelling and to reduce the influence of artefacts due to the modelling method and limitations of input data. At a national level the GIS processing summarised in Table 2 has been undertaken by Waka Kotahi.

Table 2 – national GIS processing details

Primary operator	Stewie He, Waka Kotahi
Software	ArcGIS
Base noise contour	54 dB $L_{Aeq(24h)}$ (representing 57dB with 3 dB allowance)
Smoothing	PAEK method - 50m tolerance - one-sided barrier of 55 dB $L_{Aeq(24h)}$ contour
Overlay limits	- no closer than 25m to a centreline (approximating 20m to an edgeline) - no further than 105m from a centreline (approximating 100m from an edgeline)
Holes	All holes in contour less than 5000m^2 filled
Islands	All islands outside contour less than 1000m^2 removed

The 3 dB allowance made by using the 54 dB $L_{Aeq(24h)}$ contour provides a relatively small degree of tolerance for factors including:

- Inherent modelling uncertainty associated with the calculation algorithm
- Uncertainty associated with input datasets and national modelling without detailed ground truthing and checking at a localised level
- Normal changes in road and traffic conditions such as from routine resurfacing and traffic growth or composition change

In reality, the uncertainty from these factors far exceeds 3 dB, but that has been adopted as a compromise value. For example, just the first factor of calculation method uncertainty is around +/- 2dB close to the road and say double that at greater distances. Without adequate allowance for uncertainty, many buildings that might theoretically comply with the internal noise criterion but would actually exceed it immediately on construction, and many other buildings would exceed the criterion over following years.

It is noted that the allowance for uncertainty in preparing the overlay needs to be consistent with the corresponding rules applying within the overlay (otherwise neither function effectively).

The limitation for the overlay not to extend further than 100 metres from highways is a policy position that Waka Kotahi has adopted since it first standardised its approach to this issue in 2007. Technically there are noise effects that warrant control beyond 100 metres near busier highways, but the limitation has been made as a compromise to address the most significant effects without applying controls over an extended land area.

Following the national processing, the draft overlay is subject to additional verification by Waka Kotahi planning and environmental staff before potential use in each district. Currently, this has been completed for a small number of districts and others are in process. Manual alterations are made to the overlay for each district by the Waka Kotahi GIS team as required. The following matters are checked by desk-top inspection of the overlay along all highways in a district and are corrected as required:

- The overlay is extended around any sections of highway where it is absent from the modelling, generally at a fixed distance of 105 m from the centreline. This can occur

because the highway did not exist at the time of the modelling or because of missing road or traffic data in the modelling.

- Any large anomalies caused by contours around other arterial roads are removed.
- The overlay is removed from any highways that have been revoked or are in the process of being revoked.
- The overlay is extended around any unimplemented highway designations, generally at a fixed distance of 100 metres from the designation boundary.
- If the extent of the overlay is limited by the scope of a particular RMA process then it is restricted to the relevant spatial limits. For example, the overlay might only apply to certain zones or the furthest distance the overlay extends from highways might be capped at a value less than 100 metres.

Once processed the noise control boundary overlay for a district is made available initially on a web map. Access required to the web map (i.e. specific parties or public) is to be determined by the relevant Waka Kotahi planner. When required a GIS file will be provided for inclusion in the district plan maps. Waka Kotahi will also maintain a collated map of the final overlays adopted in each district.

Limitations of an overlay based on noise modelling

There are numerous intricacies associated with noise modelling that could be relevant to use of a noise contour as the basis for an overlay. However, the following points have particular impact on the use of model outputs in this context:

- Widescale national noise modelling is constrained by the quality and availability of input data in a suitable format for terrain, buildings and roads. This is different to modelling for a discrete roading project over say 10 to 20 kilometres, where it is practical to spend time checking and adjusting data, such as through ground truthing. Also, for individual projects, specific high resolution terrain data can be obtained if it does not already exist. It is not practical to apply the same processes to modelling 11,000 kilometres of the national state highway network. Therefore, while applying the same calculation algorithms, because the input data is constrained, national modelling is subject to greater uncertainties and inaccuracies than discrete project modelling.
- Modelling includes noise screening by buildings in the available dataset at that point in time. This is beneficial for land use controls as it means that if a site is screened from state highway noise by buildings on other sites the contour would be smaller and it might exclude that site such that it would not be subject to the controls. However, this approach does not account for changes to buildings post-modelling. For example, screening by an existing building on a site might result in noise contours excluding most of the site, including in the footprint of that building. If the existing building is removed, then new buildings on the site might be outside the relevant contour even though they may have high noise exposure warranting building treatment.

- The modelling is only for a single height above ground level (1.5 metres), intended for single storey buildings. Noise exposure is often higher at higher elevations due to a reduction in screening by other buildings or the terrain.
- As for buildings, the modelling is based on road and traffic conditions at a certain point in time (2020/2021). These parameters commonly change (e.g. resurfacing as part of routine maintenance) and can increase the extent of noise exposure. However, an overlay based on modelling would be fixed to the previous conditions so land use controls might exclude sites with noise exposure warranting building treatment at the time of development.

Waka Kotahi has proposed using an overlay based on noise contours as it can reduce the area over which land use controls apply and thus avoids a requirement for compliance assessment on some sites, which are likely to have lower noise exposure but would otherwise have been captured within a fixed distance. However, the above limitations of this approach mean that it will also exclude many sites where controls are warranted, particularly in urban areas where screening effects and higher buildings are more likely.