

Before an Independent Hearings Panel
appointed by the Waimakariri District Council

under: the Resource Management Act 1991

in the matter of: Submissions and further submissions in relation to the
proposed Waimakariri District Plan, Variation 1 and
Variation 2

and: **Christchurch International Airport Limited**
Submitter 254

Memorandum of counsel for Christchurch International Airport
Limited regarding the evidence of Professor Charlotte Clark

Dated: 30 September 2024

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MAY IT PLEASE THE HEARINGS PANEL

- 1 This memorandum of counsel is provided on behalf of Christchurch International Airport Limited (*CIAL*). It responds to the Independent Hearings Panel's (*IHP*) Minute 39 dated 13 of September 2024 in relation to the provision of Professor Charlotte Clark's evidence on aviation noise and health effects. It seeks that the IHP:
 - 1.1 grant leave to file the evidence of Professor Clark as late evidence for Hearing Stream 10A; and/or
 - 1.2 accept the evidence of Professor Clark as relevant for Hearing Stream 7 (it was filed on time for that hearing stream); and
 - 1.3 confirm that the evidence of Professor Clark will be considered by the IHP when forming its recommendations.
- 2 As the Panel are aware, the evidence and legal submissions filed for *CIAL* in relation to Hearing Stream 7 were intended to address the distinction between the Christchurch City Council's Plan Change 14 (*PC14*) findings and what this IHP ought to find as other parties have raised in legal submissions and evidence that *PC14* is some sort of legal or evidential precedent for this IHP.
- 3 In particular, in lodging the evidence for Hearing Stream 7 *CIAL* was seeking to address the criticism raised by the Panel in *PC14* that they did not receive any expert evidence on health effects. *CIAL* disputes this as evidence was given as to health and amenity effects by Mr Day although it is accepted he is not a health practitioner. The evidence of Professor Clark was intended to address the issue of the evidence being given by a person who has medical qualifications.
- 4 The evidence of Ms Smith for *CIAL* for Hearing Streams 10A and Hearing Stream 7 already covers the causal link between aviation noise and adverse health effects. Professor Clark's evidence was simply intended to support the evidence of Ms Smith and was introduced to this IHP to avoid any suggestion that this Panel did not hear evidence of health effects.
- 5 There is no material difference between the evidence of Professor Clark's and the evidence that has already been presented as to aviation noise and health effects at previous hearing streams (albeit through the evidence of Ms Smith). Therefore, accepting Professor Clark's evidence does not create any issues of natural justice or procedural fairness.
- 6 On the above basis, *CIAL* submits that the evidence of Professor Clark is appropriate and relevant. *CIAL* requests that this material be accepted for filing and considered by the IHP when forming its recommendations.

- 7 Notwithstanding the above, if the IHP remain concerned about the possibility natural justice issues arising, we suggest that the IHP allow other submitters to either Stream 10A or Stream 7 the opportunity to have an expert health practitioner respond to Professor Clark's evidence.
- 8 Furthermore, should the IHP have any questions for Professor Clark, she could answer questions by way of a written response or be available at one of the remaining days for hearings on other topics. In order to assist on this point, we also **attach** the summary of evidence that Professor Clark had intended to read out at the Stream 7 hearing after Ms Smith had given her own evidence to demonstrate how Professor Clark's evidence was to support Ms Smith's evidence in Stream 7.

Dated: 30 September 2024



Jo Appleyard/Meg Davidson
Counsel for Christchurch International Airport Limited

Before an Independent Hearings Panel
appointed by the Waimakariri District Council

under: the Resource Management Act 1991

in the matter of: Submissions and further submissions in relation to the proposed Waimakariri District Plan, Variation 1 and Variation 2

and: Hearing Stream 7: Residential, Large Lot Residential, Ecosystems and Indigenous Biodiversity, Variation 1 and Variation 2

and: **Christchurch International Airport Limited**
Submitter 254

Summary statement of evidence of Professor Charlotte Clark
(aviation noise and health)

Dated: 17 September 2024

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SUMMARY STATEMENT OF EVIDENCE OF PROFESSOR CHARLOTTE CLARK

- 1 My name is Professor Charlotte Clark. This statement provides a summary of the report attached to my evidence (the *Report*) for Christchurch International Airport Limited (*CIAL*) on the proposed Waimakariri District Plan and the Variation. The Report sets out the evidence for effects of aviation noise on a range of health outcomes, focusing on evidence from methodologically robust, higher quality studies and systematic reviews published in peer-reviewed journal papers or by reputable public health agencies. To the extent that it is possible within my area of expertise, the Report also comments on the application of the evidence-base in the Christchurch context to assist with future land use planning decisions.

THE LINK BETWEEN AVIATION NOISE AND HEALTH OUTCOMES

- 2 Environmental noise is a public health issue as an environmental stressor which can have significant impacts on health and wellbeing because of the biological responses it can trigger in an individual.¹ In terms of aviation noise specifically, evidence links exposure to a range of health outcomes including those summarised below.

Annoyance

- 3 Annoyance is one of the most prevalent community responses and health effects in a population exposed to aircraft noise.² Annoyance is a health outcome which describes stress, cognitive, and emotional reactions to unwanted or disturbing sounds. These reactions can activate a range of biological systems impacting on physical and mental health. Annoyance is measured using an International Organization for Standardization (*ISO*) Technical Specification³, underlying the importance of this outcome for public health. Most guidelines or protection limit values are based on evidence relating to annoyance.
- 4 In terms of estimating the effects, given the relatively small population exposed to aircraft noise around Christchurch, and in New Zealand in general, no local estimates (exposure response function (*ERF*)) for annoyance are available. Therefore, the WHO generalised curve from the WHO Environmental Noise Guidelines 2018 (*WHO ENG*s) should be relied on, which was established from studies across a range of contexts including very small to large airports. The WHO generalised curve shows that increasing the population exposed to aircraft noise above 45 dB L_{den} would harm public health via annoyance effects. It follows that this would result in increased health costs or increase pressure to reduce noise through restrictions on airport operations.

Sleep disturbance

- 5 Sleep disturbance is a key outcome in relation to aircraft noise exposure.⁴ Two types of sleep outcomes in relation to sleep outcomes have been examined, subjective (self-reported) and objective (biophysiological changes).

¹ Paragraphs [2]-[4] of the Report discusses biological responses triggered by noise.

² Paragraphs [7]-[16] of the Report sets out the evidence relating to annoyance.

³ ISO/TS15666:2021. (2021). Acoustics - Assessment of noise annoyance by means of social and socio-acoustic surveys.

⁴ Paragraphs [17]-[22] of the Report set out the evidence relating to sleep disturbance.

- 6 ERFs for aircraft noise effects on objective and subjective sleep disturbance were published to inform the WHO ENGs. For objective sleep disturbance, the noise level at which the probability of an additional awakening began was around 37dB LA_{max, indoor}. For subjective sleep disturbance the ERF estimated that around 10% of the population were found to be highly sleep disturbed at 40dB L_{night}, rising to over 30% for exposures over 55dB L_{night}. The WHO review concluded that *“transportation noise affects objectively measured sleep physiology and subjectively assessed sleep disturbance in adults”* and it is worth reflecting on the levels of sleep disturbance seen at even the lowest levels of aircraft noise exposure.⁵ The subjective data analyses were also recently updated to suggest slightly stronger relationships between aircraft noise and sleep disturbance at higher levels of exposure.⁶ Chronic exposure to aircraft noise during sleep can also lead to cardiovascular mortality, with robust longitudinal evidence for effects on ischaemic heart disease, acute myocardial infarction, and stroke.⁷
- 7 As the Christchurch Airport operates 24 hours a day, the current Outer Control Boundary (which I understand controls density from the point where people are exposed to noise levels of 50dB L_{dn}) is likely to be greatly contributing to reducing the population experiencing more than one additional awakening per night.⁸ Should these zones be reduced in size or lost, the awakening contours for the airport are likely to increase considerably and impacts on public health will increase. Sleep disturbance in the population is a key driver for community concerns and would likely increase pressure to curtail night-time operations. Aviation related sleep disturbance is a key driver of worsening community relations for airports. With rising population exposure to noise Christchurch Airport will have to deal with increased complaints and campaigning against their business. This is politically challenging arena to operate in, taking up considerable time, energy, and resource to liaise with local communities, who often have competing interests and unrealistic expectations. This could impact airport operations and development.

Cardiometabolic health

- 8 Noise is linked to increased risk factors for poorer cardiovascular health, such as blood pressure (hypertension), stiffening of the arteries, and narrowing of arteries via effects on blood fats (atherosclerosis), which can lead to heart attacks and strokes.⁹ These are also risk factors for diabetes, and additionally stress can cause long-term elevation of cortisol, which increases a number of risk factors for diabetes including blood glucose and insulin resistance.¹⁰

⁵ Basner & McGuire, 2018.

⁶ Smith et al., 2022.

⁷ Saucy et al., 2021; Vienneau et al., 2022.

⁸ The health protection scheme proposed by Basner et al. (2006) to manage the risk of sleep disturbances associated with aircraft noise included the recommendation that on average there should be less than one additional EEG awakening induced by aircraft noise per night. Awakening contours, which are plotted using this approach are an important additional tool for estimating and managing the effects of aviation night-noise (Civil Aviation Authority, 2022).

⁹ Paragraphs [23]-[26] of the Report sets out the evidence relating to cardiometabolic health.

¹⁰ Several ERFs find statistically significant increases in risk for these cardiovascular outcomes, see for example Van Kempen et al., 2018; Vienneau et al., 2022; Vienneau et al., 2015; see also systematic review carried out for the WHO ENG 2018 (Van Kempen et al., 2018)).

- 9 Studies also suggest noise exposure might influence physical activity, which is plausible both via poorer cardiometabolic health which could reduce exercise but also via the potential for noisier environments to be less attractive for exercise.¹¹

Mental health, quality of life and wellbeing

- 10 Noise as an environmental stressor can impact mental health, wellbeing, and quality of life, both directly through influencing stress hormones which impact mood, but also indirectly through stress associated with annoyance and sleep disturbance.¹² Studies show that exposure to aircraft noise is associated with an increase in risk for depression¹³ and hyperactivity symptoms in children.¹⁴

- 11 Other factors such as annoyance¹⁵, noise sensitivity¹⁶ and existing mental health are also important to consider as these factors have also been linked to poor mental health outcomes.¹⁷ Evidence is also emerging to support a relationship between environmental noise and neurodegenerative outcomes and cognitive impairment such as dementia in later life.¹⁸

Children's learning

- 12 There is robust evidence that noise can influence children's learning and health in many ways including via communication difficulties, impaired attention, increased arousal, learned helplessness, frustration, biological stress responses, noise annoyance, and as a consequence of sleep disturbance on performance.¹⁹

Social inequality

- 13 Those of lower socioeconomic status are hypothesised experience greater exposure to noise, which alongside increased vulnerability to poorer health, and the availability of fewer resources (coping behaviours) and poorer conditions (e.g., poor housing) increases the risk for health-related impacts of noise.²⁰

THRESHOLDS AND MITIGATION

- 14 Increasingly, evidence for the effects of aviation noise on health effects is considered in relation to 'thresholds' for effects, to ensure the planning system protects and promotes public health (e.g., Environmental Impact Assessments & Health Impact Assessments).²¹ Different approaches have been taken for setting and identifying thresholds, but all adopt a precautionary, public health focused approach that focuses on where effects start with the aim to minimise and avoid population exposure, as opposed to setting 'limits' for the highest level of exposure. Noise is increasingly thought of as a 'no threshold' effect, as studies have demonstrated effects at lower levels of exposure and increasingly study effects from ~40dB upwards.

¹¹ Foraster et al., 2016.

¹² Paragraphs [27]-[31] of the Report sets out the evidence relating to mental health.

¹³ Hegewald et al., 2020.

¹⁴ Clark, Head, et al., 2021; Clark & Paunović, 2018a.

¹⁵ Gong et al., 2022.

¹⁶ Cerletti et al., 2020; Stansfeld et al., 2021

¹⁷ See for example Baudin et al., 2021; Nordin et al., 2013.

¹⁸ Cantuaria et al., 2021.

¹⁹ Paragraphs [32]-[34] of the Report sets out the evidence relating to children's learning.

²⁰ Paragraphs [35]-[37] of the Report sets out the evidence relating to socioeconomic status.

²¹ See Paragraphs [38]-[48] of the Report for a discussion on the WHO Guidelines, thresholds and mitigation measures.

- 15 This argument is further strengthened, given the difficulties and challenges of mitigating aviation noise. In my opinion, mitigation such as acoustic insulation should be a last resort and relied upon within the planning process sparingly. Evidence for the effectiveness of acoustic insulation on health is lacking, as are evaluations of the economic cost-benefits for health of such schemes. We cannot quantify the extent to which annoyance or sleep disturbance are reduced for residents with insulation compared to without. Residents often do not wish to keep their windows shut and can struggle to operate the ventilation systems installed. Acoustic insulation can also have unintended consequences on indoor air quality and overheating, both of which also influence health. Acoustic insulation also cannot mitigate effects in people’s gardens or in other outdoor community facilities. Access to gardens, greenspace, community facilities, and well-designed neighbourhoods are important health determinants, supporting physical activity, social relationships, play, recreational activities, and psychological restoration.²²
- 16 In the UK, the Department for Transport’s Transport Analysis Guidance monetises the health effects of noise for populations to assess the impacts of aviation proposals on the population²³, enabling different scenarios to be compared. For each 1dB change in average noise exposure, a monetary value is assigned for a change in annoyance, sleep disturbance, acute myocardial infarction (heart attack), stroke, and dementia, with effects calculated for the population exposed to $\geq 51\text{dB LAeq,16h}$ and $\geq 45\text{dB LAeq,8h}$. This economic evaluation is also used to identify where mitigation is required.

CONCLUSION

- 17 Exposure to aviation noise is linked to a range of health outcomes including annoyance, sleep disturbance, cardiometabolic health, children’s learning and mental health. In the Report it is noted that the evidence for the effects of aviation noise used to inform NZS 6805:1992 has increased considerably over the past few decades. It is important that future land use planning decisions for areas impacted by Christchurch Airport consider the evolving and increasing evidence that points to health effects at low levels of aircraft noise exposure.
- 18 Overall, I consider that the Waimakariri District is in an enviable and unusual position in that it has protected areas defined by planning that protect community health. This position should be maintained.

Dated: 17 September 2024

Professor Charlotte Clark

²² Public Health England. Improving access to greenspace. A new review for 2020.

²³ Department for Transport. TAG Unit A5.2. Aviation Appraisal. 2023