Before an Independent Hearings Panel of Wellington City Council

In the matter	of the Resource Management Act 1991 (the **Act**)
And	
In the matter	of hearing of submissions and further submisssions on the Wellington City Proposed District Plan (**PDP**), Stream 5 - Noise

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Statement of Evidence of
Darren Humpheson (Noise) for Wellington International Airport Limited

Dated: 18 July 2023

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1. INTRODUCTION

Qualifications and Experience

1.1 My full name is Darran Humpheson. I am a Technical Director of Acoustics at Tonkin & Taylor Limited (**T+T**).

1.2 I hold a Bachelor of Science degree with Honours in Applied Physics and a Master of Science degree in Environmental Acoustics. I am a Member of the Acoustical Society of New Zealand and a Member of the United Kingdom's Institute of Acoustics. I am a New Zealand representative of the International Organisation for Standardisation (**ISO**) technical committee ISO/TC 43 SC1 "Noise".

1.3 I have been employed in acoustics since 1991 and have previously held positions as a consultant for international firms AECOM (Technical Director 2013-2019), Bureau Veritas (Technical Director 2012-2013), RPS Group plc (Technical Director 2002-2012) and as a UK Ministry of Defence scientist (Head of the Royal Air Force's Noise and Vibration Division 1991-2002).

1.4 I have provided guidance and advice to airport operators, as well as national and local governments. I am an expert user of the Federal Aviation Administration (**FAA**) Aviation Environmental Design Tool (**AEDT**) and Integrated Noise Model (**INM**) aircraft noise modelling software and I have presented papers on aircraft noise modelling best practice. I currently provide acoustic services, including aircraft noise modelling to the New Zealand Defence Force (**NZDF**).

1.5 I have assisted Wellington International Airport Limited (**WIAL**) for the past 8 years. I have undertaken noise modelling of aircraft noise, prepared noise management plans for construction projects, developed the acoustic design for new buildings and assisted in developing the current designation conditions for Wellington Airport.[1] I am therefore familiar with the range of activities conducted at the Airport and the surrounding areas.

1 WIAL2 (Miramar South Area), WIAL 4 (Main Site Area) and WIAL5 (East Side Area) in the Wellington City Council Proposed District Plan.

Code of Conduct

1.6 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the Code of Conduct for Expert Witnesses contained in Part 9 of the Environment Court Practice Note 2023. I have complied with it in preparing my evidence. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2. SCOPE OF EVIDENCE

2.1 In this brief of evidence, I will:

(a) Review New Zealand Standard (**NZS**) 6805:1992 '*Airport Noise Management and Land Use Planning*' and its relevance to Wellington Airport;

(b) Provide an overview of aircraft noise at Wellington Airport, including the noise conditions of the Main Site Area designation (WIAL4), and the East Side Area designation (WIAL5) (together, the **Designations**) and the aircraft noise contours of the Wellington City Proposed District Plan (**Proposed Plan**) and those within the Wellington City Operative District Plan (**Operative Plan**);

(c) Discuss WIAL's submission relevant to Hearing Stream 5, which relates to the noise chapter (**NOISE**) of the Proposed Plan. Including, WIAL's suggested amendments to the NOISE chapter as provided in the evidence of Kirsty O'Sullivan (Planning evidence for WIAL);

(d) Discuss the evidence of Wellington City Council's (**Council**) noise experts; and

(e) Consider the section 42A evaluation as relevant to the above.

2.2 In preparing this evidence, I confirm that I have read the following documents:

(a) WIAL's submissions relevant to Hearing Stream 5 (in particular, the submission on the NOISE chapter).

(b) The section 42A report of Mark Ashby.

(c) The statement of evidence of Jo Lester (Planning Manager at WIAL) and Ms O'Sullivan (Planning evidence for WIAL).

(d) The statement of evidence of Malcolm Hunt and Sean Syman (acoustic experts for Council).

3. SUMMARY OF EVIDENCE

3.1 There are very few cities in the word which benefit by having an airport as conveniently located as Wellington Airport. The close proximity of residential areas to the airport has meant that Wellington International Airport Limited must manage the noise from aircraft operations and land based noise. Controls restrict when aircraft can operate, known as the curfew procedure, and the overall level of noise as established by the Airport's Air Noise Boundary (ANB), which is based on the 65 dB Ldn air noise contour in accordance with the airport noise management and land use noise standard, NZS 6805:1992. Although NZS 6805:1992 is over 30 years old, it is still the relevant standard to consider for noise management and land use planning for airports in terms of underlying principles and its measurement methodologies are a mandatory standard in the National Planning Standards.

3.2 Airports need to manage reverse sensitivity effects and the establishment of noise sensitivity activities close to Wellington Airport can result in conflicts without proper consideration of the health and amenity of future building occupiers. There is also the need to protect the safe and efficient operation of Wellington Airport. To meets these often conflicting needs appropriate noise management and land use controls are needed.

3.3 A new ANB for the year 2050 has been established for the purposes of the district plan review. Compared to the ANB in the Operative Plan, the new ANB is smaller in size even though it is based on a higher number of forecast aircraft movements compared to the existing ANB. This is a reflection that aircraft are quieter now compared to when the Operative Plan's ANB was produced in the late 1990s.

3.4 A new 60 dB Ldn noise contour has also been produced by WIAL for the purposes of inclusion within the Proposed Plan so that people in this overlay are on notice that they will experience adverse effects of aircraft noise and the need to impose land use controls, i.e. acoustic treatment for new and altered buildings. It will also be used by WIAL for the purposes of extending the acoustic treatment of WIAL's Quieter Homes Programme.

3.5 The Quieter Homes Programme provides acoustic treatment to qualifying existing dwellings and other noise sensitive activities within the current ANB. WIAL has committed to extending this programme to existing noise sensitive activities exposed to 60 dB Ldn via one of its designations (undertaking via a mediation agreement). This acoustic treatment will only require ventilation to buildings between 60 dB and 65 dB Ldn as doors and windows would only need to be closed to achieve the required internal performance standard of 45 dB Ldn in habitable rooms.

3.6 The Proposed Plan seeks to establish new sound insulation requirements for aircraft noise. These requirements only apply to new or altered buildings housing a noise sensitive activity. They do not apply to the Quieter Homes Programme.

3.7 The Council's noise expert, Mr Hunt, favours separate fixed outdoor to indoor sound insulation standards. I consider that this approach is at odds to the current arrangements in the Operative Plan and Quieter Homes Programme as well as the approach of three other Councils which have an international airport in each of their districts.

3.8 If accepted, the Proposed Plan will result in overdesign of buildings, result in inconsistent outcomes compared to the approach of the Operative Plan and lead

to increased costs for homeowners and developers. I prefer the existing approach of the Operative Plan and have prepared a new sound insulation standard NOISE-S16. I have also provided a revised ventilation standard which is a based on Mr Hunt's version and Plan Change 5E of the Christchurch District Plan, which simplifies the air change requirements by referencing back to the ventilation requirements of the New Zealand Building Code.

3.9 The land use controls I have mentioned only address noise when indoors. Outdoor noise amenity is also a key issue when managing reverse sensitivity effects. I therefore recommend that WIAL should have affected party status within the Air Noise Overlay as aircraft noise levels of 60 dB Ldn are still significant.

3.10 I also recommend that the Hearings Panel accept the relief relating to noise provisions sought by Ms O'Sullivan in her planning evidence.

NZS 6805:1992

3.11 NZS 6805:1992 is used to assess and rate aircraft noise in the vicinity of airports (including aerodromes / airfields). The Standard is concerned with land use planning and the management of aircraft noise at airports for the protection of community health and amenity values.

3.12 Although NZS 6805:1992 was published over 30 years ago, it is still the relevant standard to consider for noise management and land use planning for airports in terms of its underlying principles and its measurement methodologies are a mandatory standard in the National Planning Standards. This relevance is supported by the fact that there are no immediate plans by Standards New Zealand to withdraw or prompt a review or revision of the standard. A review would only be instigated by way of primary stakeholder engagement and/or by a technical committee appointed by Standards New Zealand.[2]

3.13 NZS 6805:1992 is used at the other international airports in New Zealand; Auckland, Christchurch and Queenstown airports. District plan reviews were

2 Confirmation sought from Standards New Zealand in January 2023.

completed in 2016 for Auckland, 2017 for Christchurch and Queenstown commenced in 2016 and is generally resolved.

3.14 NZS 6805:1992 uses the Noise Boundary concept to enable councils to establish appropriate land use planning controls for the management of aircraft noise associated with airports. The objective being to:

> '*avoid, remedy or mitigate any adverse effects on the environment, including effects on community health and amenity values while recognising the need to operate an airport efficiently*'.

3.15 The Noise Boundary concept involves setting an inner Air Noise Boundary (**ANB**) around an airport. Within the ANB, Table 1 of NZS 6805:1992 recommends that new residential, schools, hospitals or other noise sensitive uses are prohibited and that existing residential properties are acoustically insulated to ensure a satisfactory internal noise environment. The Standard also recommends that alterations or additions to existing residences or other noise sensitive uses shall be permitted only if fitted with appropriate acoustic insulation.

3.16 The ANB can also be used for setting a noise limit for the management of aircraft noise (noise compliance limit).

3.17 NZS 6805:1992 also defines an Outer Control Boundary (**OCB**) as the area within which new incompatible land uses should be prohibited unless a district plan permits such uses, subject to requirements to incorporate appropriate acoustic insulation. The objective of the OCB is for the protection of amenity values, whereas the ANB is to avoid adverse effects on community health.

3.18 NZS 6805:1992 requires the ANB and OCB to be based on the Day/Night Average Sound Level (Ldn) metric to define an average aircraft noise exposure value. The Ldn parameter is an average energy level over a 24-hour period with a 10 dB weighting for any aircraft noise events that occur between 10 pm and 7 am. The Ldn considers the noise level of each aircraft type and the number of corresponding aircraft movements at a particular location.

3.19 The 10 dB weighting means that one aircraft flight at night is the equivalent of 10 day time flights. The 10 dB weighting specifically accounts for the intrusiveness of noise at night and its potential impact on sleep. The logarithmic nature of the decibel unit (and Ldn) means that the loudest events generally tend to control the Ldn.

3.20 NZS 6805:1992 defines the ANB as the 65 dB Ldn contour, while the OCB is based on the 55 dB Ldn contour. NZS 6805:1992 provides a mechanism for councils to incorporate the ANB and OCB exposure contours within their district plans to establish compatible land use planning and to set limits for the management of aircraft noise.

3.21 NZS 6805:1992 also provides for councils to include alternative contours in a position further from, or closer to the airport if the council considers it more reasonable to do so in the special circumstances of the case.

3.22 The ANB and OCB can represent either the existing level of aircraft noise or a future forecast of aircraft noise. NZS 6805:1992 suggests that a minimum period of 10 years should be used as the basis of confirming the noise exposure contours.

3.23 Typically, the operators of commercial airports will project forward to a point 20 to 30 years into the future to reflect anticipated demand for passenger and freight movements. This forward projection not only considers changes in aircraft movements (increases) but also changes in aircraft types to reflect the introduction of new technology (i.e., phasing out of older aircraft and replacement with typically quieter aircraft) and planned changes in aircraft procedures. Some airport operators will use ultimate runway capacity forecasts to provide continued protection from issues such as reverse sensitivity effects or to 'permanently' safeguard land from future noise-sensitive development. I return to this matter below.

3.24 From my experience, a common criticism / misunderstanding of Ldn noise exposure contours is that they do not convey how noisy individual aircraft are. People now have access to decibel measuring apps on their smart phones and can measure the

noise of individual overflights, which adds to this misunderstanding as these apps cannot readily measure an Ldn.

3.25 For example, someone living on the edge of a 65 dB Ldn contour will experience the instantaneous sound level of individual aircraft movements at levels approaching 85-95 dB depending upon the person's proximity to the aircraft's flight path. Much of the criticism may therefore stem from a failure to understand the Ldn metric.

3.26 Long term noise monitoring (as described in NZS 6805:1992) is needed to verify the position of an Ldn noise exposure contour. The duration of the measurements[3] being dependent upon the number of aircraft movements, proximity to flight tracks and the variability in runway usage (wind direction). I will now explain why the Ldn metric is used to assess aircraft noise.

3.27 Research has shown that noise annoyance is informed by long term exposure to transportation noise.[4] This cumulative noise exposure is the reason why socio-acoustic studies investigate a person's response to long-term noise and use exposure based noise metrics. For example, ISO/TS 15666:2021 '*Acoustics – Assessment of noise annoyance by means of social and socio-acoustic surveys*', asks the question:

> '*Thinking about the last (12 months of so), where you are here at home, what number from 0 to 10 best shows how much you are bothered, disturbed or annoyed by (source) noise*'.

3.28 Use of noise exposure or energy average noise metrics, such as Ldn, are wide spread. For example, the United States also uses the Ldn noise metric, a significant number of European countries use a derivative of the Ldn called the Lden[5] and Australia uses the ANEF, which is similar to the Ldn (*Ldn≈ANEF+38*). Average energy noise exposure contours are therefore well established tools to describe a population's response to transportation noise.

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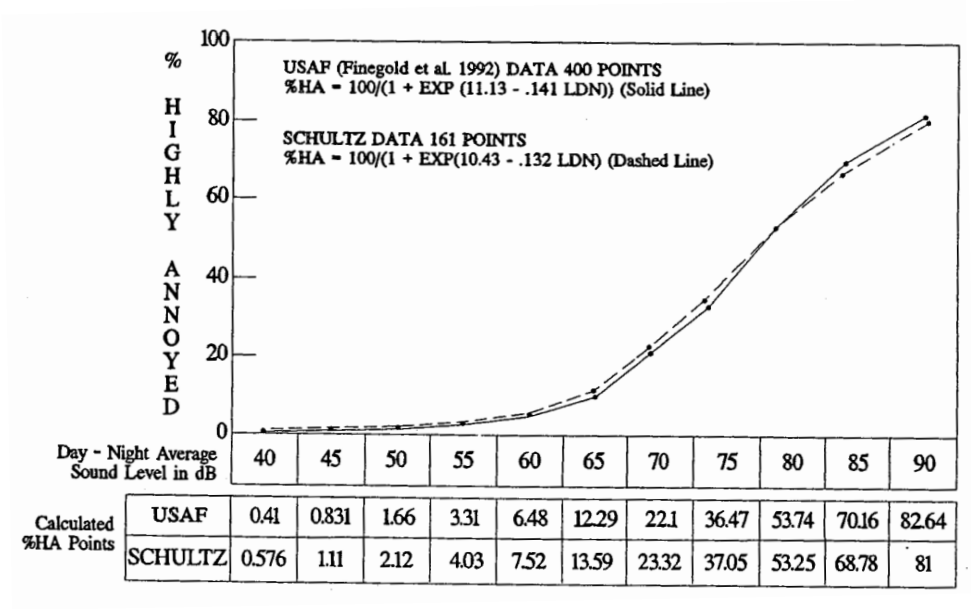
3 Monitoring duration may vary from a number of weeks to months depending upon local circumstances.

4 Schultz, T. J., "Synthesis of Social Surveys on Noise Annoyance," *Journal of the Acoustical Society of America*, Vol. 64, 1978, pp. 377–405.

5 Lden – similar to Ldn but day is 7 am to 7pm, evening - 7 pm to 11 pm with a +5 dB weighted and night - 11 pm to 7 am with a +10 dB weighting. It is the annual average sound exposure level.

3.29 The noise thresholds used in NZS 6805:1992 are based on the Schultz Curve, which showed that at 65 dB Ldn, 13.6% of the population would be highly annoyed (**% HA**) – see **Figure 1**. While the Schultz Curve remains the accepted basis for a number of transportation noise exposure-annoyance relationships, its original supporting scientific evidence and social survey data were based on socio-acoustic studies of the 1960s and 1970s.

3.30 The last in-depth review and revalidation of the Schultz Curve was conducted by the US Federal Interagency Committee on Noise (**FICON**) in 1992.[6] US Federal policy suggested that 12.3% of people are highly annoyed at 65 dB Ldn, see **Figure 1**, i.e., consistent with the Schultz Curve and therefore there was no change in adopting the 65 dB Ldn as the onset of significant community annoyance.[7]



Day - Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	90
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

Figure 1: Schultz and updated FICON(USAF) curves (source FICON 1992)

3.31 More recent analyses have shown that the exposure-response function (**ERF**) has changed, meaning that social surveys have generally shown higher annoyance than the Schultz Curve and the FICON revalidation exercise for the same noise exposure level. These analyses and survey data indicate that the Schultz Curve may not

6 Federal Interagency Committee on Noise (FICON). 1992. "Federal Agency Review of Selected Airport Noise Analysis Issues, Final Report: Airport Noise Assessment Methodologies and Metrics." Washington, DC.

7 Taken to be where ~10% of the population are highly annoyed, i.e. where there is a marked change in the annoyance response for a given Ldn.

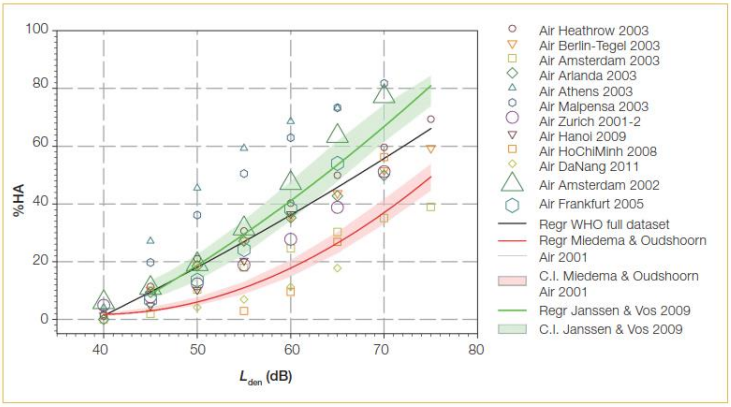
reflect the current community perception of aviation noise as used in NZS 6805:1992.

3.32 The most recent meta-analysis of various studies was published by the World Health Organisation (**WHO)** in 2018.[8] The authors of the WHO guidelines (**Guidelines**) found that the existing ERFs linking noise exposure and %HA with respect to aircraft noise required updating. The finding being that people were reporting higher level of annoyance at lower noise exposure levels than had previously been identified. For example, at 65 dB Lden (equivalent to ~64 dB Ldn) 45.5% of the population were found to be highly annoyed, see **Figure 2** and **Table 1** which have been taken from the Guidelines.

3.33 The authors of the Guidelines 'made a judgement about the smallest risk or RR [relevant risk] of the adverse health effect it considered relevant for each of the priority health outcome measures'. For %HA, this coincided with a 10% absolute risk value, i.e. comparable to the findings of Schultz and FICON which established 65 dB Ldn as the relevant noise level. This means that there is an approximate 20 dB variation in noise exposure level between the recommendation of the Guidelines and the Schultz Curve and FICON revalidation exercise for roughly the same population annoyance response.

3.34 Differences between the EFRs could be due to changes in people's attitudes toward aircraft noise; changes in their noise exposure (changes in aircraft, operations, frequency of flights); differences in the cultures of those being surveyed; differences in study design, implementation, or measurement; or a combination of these factors.

8 World Health Organisation, Environmental Noise Guidelines for the European Region, 2018.



Notes: ERFs by Miedema & Oudshoorn (2001, red), and Janssen & Vos (2009, green) are added for comparison. There is no indication of 95% CIs of the WHO dataset curve, as a weighting based on the total number of participants for each 5 dB L_{den} sound class could not be calculated; weighting based on all participants of all sound classes proved to be unsuitable. The range of data included is illustrated by the distribution of data points. For further details on the studies included in the figure please refer to the systematic review on environmental noise and annoyance (Guski et al., 2017).

Figure 2: WHO 2018 aircraft noise (source WHO Guidelines, Figure 13)

L_{den} (dB)	%HA
40	1.2
45	9.4
50	17.9
55	26.7
60	36.0
65	45.5
70	55.5

Table 1: Table 30 of WHO 2018 aircraft noise (Lden) and annoyance (%HA)

3.35 The authors of the Guidelines recommend exposure levels to protect population health. Long-term annoyance, impaired well-being, as well as self-reported sleep disturbance due to noise are classified by the WHO as health outcomes. Annoyance response is the most readily measurable and reliable indicator in self-reported social surveys. Therefore, ERFs for a certain decibel value can be used to infer health outcomes.

3.36 The authors of the Guidelines strongly recommend '*reducing noise levels produced by aircraft below 45 dB Lden, as aircraft noise above this level is associated with adverse health effects*'.

3.37 The Guidelines are intended to protect the vast majority of the population from any adverse health effect due to aircraft noise and are based on data from large European airports. The Guidelines do not consider the socioeconomic impact of achieving the guideline thresholds based on the way that current society operates,

for example the benefits of living and working close to an airport. I consider these circumstances further when I discuss the specifics of Wellington Airport.

3.38 I consider that the Guidelines place unreasonable expectations on policy-makers to implement suitable measures that would achieve the recommendations of the WHO 2018 Guidelines. Furthermore, the Guidelines offer no practical interventions which help to reduce or mitigate aircraft noise exposure to 45 dB Lden.[9] The Guidelines are therefore aspirational rather than a practicable means to avoid, remedy or mitigate any adverse effects on the environment, including effects on community health and amenity values.

3.39 As there are no plans by Standards New Zealand to withdraw or review NZS 6805:1992, and its measurement methodologies are referenced as a mandatory standard in the National Planning Standards,[10] NZS 6805:1992 still represents best practice for airport noise management. The need for effective management of aircraft noise is reinforced by the WHO's Guidelines, which support the need to carefully manage land use planning in aircraft noise affected areas.

3.40 I discuss the implementation of NZS 6805:1992 at Wellington Airport later in my evidence.

Other forms of airport noise

3.41 Land based noise is outside the scope of NZS 6805:1992, being subject to the assessment and rating procedures of NZS 6802:2008 '*Acoustics – Environmental noise*'. Construction noise is assessed and managed using NZS 6803:1999 '*Acoustics – Construction noise*'.

3.42 NZS 6802:2008 sets out a procedure for the assessment of environmental noise for compliance with noise limits and provides guidance for the setting of noise limits

9 This quantum of noise is less than the equivalent 24 hour level for a residential zone (55 dB during the day and 40 dB at night - even allowing for a 10 dB weighting at night).

10 National Planning Standards Clause 15, 2019. Mandatory direction 1 - 'Any plan rule to manage noise emissions must be in accordance with the mandatory noise measurement methods and symbols in [NZS 6805:1992].

for consent conditions, rules or national environmental standards. The Standard provides recommended guidelines levels for residential receivers.

3.43 During the daytime, the upper guidance level is 55 dB LAeq(15min), during the evening 50 dB LAeq(15min) and 40 dB LAeq(15min) at night. Daytime is defined as 7 am to 7 pm, evening as 7 pm to 10 pm and night as 10 pm to 7 am the following day. These guideline limits apply each day of the week.[11]

3.44 The relevant noise standards applicable to Wellington Airport align to those within NZS 6802:2008, except that the daytime period combines both the day and evening periods, which I discuss later in my evidence.

4. WELLINGTON AIRPORT

4.1 Wellington Airport is the subject of five designations in the Operative Plan. The designations that are relevant to my evidence are:

(a) Wellington Airport Miramar South Area Designation (**WIAL2**): provides for activities with an airport purpose on the block of land bordered by Broadway, Kauri Street, Kedah Street and Miro Streets, Miramar.

(b) Wellington Airport Main Site Area (**MSA**) Designation (**WIAL4**): provides for activities with an airport purpose at the main Airport site.

(c) Wellington Airport East Side Area (**ESA**) Designation (**WIAL5**): provides for activities with an airport purpose on the southern part of the adjacent Miramar Golf Course (not yet developed or occupied).

4.2 Noise specific conditions are included within each designation and Condition 32 of the Main Site Area Designation (WIAL4) requires WIAL to maintain and implement an Airport Noise Management Plan (**ANMP**). The newly amended ANMP has been

11 As defined in the World Health Organisation 1999 Noise Guidelines.

certified by Council after a community consultation period and was uploaded to the WIAL website[12] in June 2023.

4.3 The ANMP describes the measures that WIAL uses to manage noise generated by the Airport and how compliance is achieved and demonstrated with the relevant noise conditions of the designations. The ANMP describes how WIAL achieves the general duty set out in section 16 of the Resource Management Act 1991 (**RMA**) to adopt the best practicable option (**BPO**) to ensure that the emission of noise over land or water does not exceed a reasonable level.

4.4 The ANMP includes an Airport wide construction noise and vibration management plan (**CNVMP**) as an appendix. The CNVMP describes the procedures which WIAL and its contractors adopt to manage construction noise and vibration. I am the author of the CNVMP and I helped ANMP's principal author, Jo Lester at WIAL, on specific noise queries. I am therefore fully conversant with the scope and details of the ANMP.

4.5 The ANMP manages the noise from:

(a) aircraft operations - engine run-up, taxiing, take-off or landing at the airport of aircraft;

(b) land-based activities - including maintenance activities, APU (auxiliary power unit[13]), surface vehicles and any other sources within the aerodrome boundaries including construction activities.

4.6 Airport designations WIAL2, WIAL4 and WIAL5 include conditions that:

(a) limit the emission and control the hours of operation of land-based activities;

(b) manage construction noise and vibration;

12 https://www.wellingtonairport.co.nz/noise/air-noise/

13 Auxiliary Power Unit (APU) is small gas turbine engine usually mounted at the rear of an aircraft that provides power for starting engines and cabin air conditioning systems, and other control systems.

(c) apply with the emission, monitoring and modelling of aircraft noise;

(d) control the hours of operation for aircraft operations - curfew hours;

(e) provide acoustic insulation and mitigation for qualifying homes - Quieter Homes Programme;

(f) control the location and time of aircraft engine testing; and

(g) limit the location of aircraft operations at certain times (WIAL 5).

4.7 These conditions place specific responsibilities on WIAL to manage the effects of airport noise. Ms Lester in her corporate evidence for WIAL provides further context on this management and commitment. I consider these relevant conditions later in my evidence when I review the noise standards of the Proposed Plan.

Aircraft noise controls

4.8 Aircraft noise reduction at an airport is limited to controlling the following factors:

(a) Noise emissions of individual aircraft types;

(b) Number of aircraft movements for a representative busy day;

(c) Times that aircraft fly – noting that an aircraft movement at night is weighted by an extra 10 dB; and

(d) How and where aircraft fly – flight paths (ground tracks and vertical flight profile).

4.9 It is helpful to explain that WIAL has limited control over the noise emissions of aircraft individually and therefore why there is no condition which restricts noisy

aircraft at Wellington Airport.[14] However, WIAL does have to indirectly manage noisy aircraft as the Ldn metric is sensitive to the loudest aircraft – to put it simply, noisy aircraft take more of the ANB noise budget.

4.10 Time of day controls apply at Wellington Airport and aircraft operations (take-off/landing) must not occur during the following hours.

(a) Domestic operations: from midnight to 6 am

(b) International departures: from midnight to 6 am

(c) International arrivals: from 1 am to 6 am

4.11 These periods are part of the Airport's curfew procedure as defined in WIAL4, and I consider these restrictions to be an important element of managing the effects of aircraft noise at Wellington Airport.

4.12 There are also a number of exceptions to this procedure, which include disrupted flights and during statutory holiday periods as noted in the designation and ANMP. In terms of how and where aircraft fly, special noise abatement procedures apply at Wellington Airport and are imposed by Civil Aviation Rules[15] under the Civil Aviation Act 2023. These procedures define how aircraft fly in the vicinity of the Airport. I describe these procedures when I discuss the noise contour modelling.

Land use controls

4.13 Aircraft noise is an unavoidable consequence of living close to an airport and there are very few cities internationally which benefit by having an airport as conveniently located as Wellington Airport. A consequence of this convenience is that the immediate communities of Rongotai, Kilbirnie, Miramar and Strathmore Park will be affected by aircraft noise regardless of the regulatory operational controls and the local procedures utilised at the Airport. To manage the most

14 For example older generation commercial aircraft which no longer operate, e.g. Boeing 727 aircraft.
15 Civil Aviation Rules, Part 93 Special Aerodrome Traffic Rules and Noise Abatement Procedures.

affected homes, WIAL has purchased properties on Bridge Street and Calabar Road. This voluntary purchase of properties is in accordance with the recommendations of Table 1 of NZS 6805:1992.

4.14 Land use planning controls at Wellington Airport are based on NZS 6805:1992. In the Operative Plan, "aircraft operations" are required to be managed so that the 90 day rolling average 65 Ldn contour does not exceed the ANB.[16]

4.15 Unlike the recommendations of NZS 6805:1992, the Operative Plan provisions allow for noise sensitive development within the ANB. This is a consequence of the unique proximity of Wellington Airport to its neighbours when compared to other airports in New Zealand when the ANB and other noise provisions were put in place. Furthermore there is also no OCB in the Operative Plan. Ms Lester provides further background on this legacy approach in her evidence.

4.16 Airports need to manage reverse sensitivity effects and the establishment of noise sensitivity activities close to Wellington Airport can result in conflicts without proper consideration of the health and amenity values of future building occupiers. There is also the need to protect the safe and efficient operation of Wellington Airport as Ms Lester states in her evidence. To meets these often conflicting needs appropriate noise management and land use controls are needed.

4.17 WIAL has operated for the past 14 years a scheme to provide mitigation when people are inside qualifying homes,[17] which is consistent with the recommendations of NZS 6805:1992. WIAL offers owners of homes within the ANB a funded package of acoustic treatment to reduce aircraft noise in habitable rooms to a Ldn of 45 dB. This requirement is now detailed in Condition 28 of WIAL4 and is known as the Quieter Homes Programme.

4.18 As the construction of homes varies, tailored packages are offered to homeowners. As keeping doors and windows closed substantially reduces the impact of external noise levels, all packages include a mechanical ventilation system. For homes that

16 As defined in Map 35 of the Operative Plan.
17 And other noise sensitive activities.

already have the required acoustic performance, the only modification needed is to install a ventilation system.

4.19 WIAL has agreed to extend the Quieter Homes Programme by providing a ventilation package to existing homes over time to negate the need to open windows for ventilation. The qualifying noise level for this ventilation package is 60 dB Ldn.

4.20 If windows are closed at this noise exposure then homes will be able to achieve a reasonable internal sound level of 45 dB Ldn. Mitigation measures are not required below 60 dB Ldn as homes can readily achieve an indoor sound level of 45 dB Ldn with partially open windows. This addition to the programme will be achieved by an alteration to the relevant designations and is explained in Ms Lester's evidence.

4.21 As I will explain in the next section, new aircraft noise contours were produced by WIAL for the purpose of the district plan review. These new contours were provided to Council and have been included in the Proposed Plan and include an updated 65 dB Ldn contour for the purposes of establishing a new ANB, and the 60 dB Ldn.

4.22 There are 496 properties within the Proposed Plan's ANB[18] and appropriate land use planning controls are needed to manage reverse sensitivity effects by limiting new noise sensitive land uses being established within the ANB which coincides with the outer extent of the proposed Inner Air Noise Overlay. While there is no OCB in the Proposed Plan, an analogous 60 dB Ldn contour now included as the proposed Outer Air Noise Overlay has been produced within which new noise sensitive activities also need to be managed.

4.23 It is recognised that when people are outdoors in their gardens, noise from aircraft may result in short term disturbance while the aircraft passes. The frequency of these events will vary depending upon the time of day and will likely increase in the future with increased aircraft movements. Apart from the operational controls I have previously described, there are limited ways in which aircraft noise in outdoor

18 Section 42A report, paragraph 169.

amenity spaces can be reduced. The only meaningful solution is not to provide access to outdoor amenity spaces, thereby managing reverse sensitivity effects.

4.24 I discuss the merits of the sound insulation requirements of the Quieter Homes Programme compared to the Proposed Plan later in my evidence.

4.25 For noise sources other than operating aircraft, the ANMP documents how noise effects from these sources are managed, such as the location, times and noise emission levels (in part documented within the three relevant designations). For sake of brevity, I will not revisit the relevant conditions of the designations or repeat the contents of the ANMP. I do however comment on the noise requirements of the Proposed Plan later in my evidence.

Updated Noise Modelling

4.26 In 2020, WIAL engaged T+T to prepare new aircraft noise contours, in preparation for District Plan review, including an updated ANB. By way of background I now describe noise modelling best practice and the process involved in producing new aircraft noise contours.

4.27 NZS 6805:1992 does not describe how aircraft noise contours should be produced other than recommending that an appropriate model is used. However, industry best-practice guidance on aircraft noise modelling is available in the following documents:

(a) European Civil Aviation Conference (ECAC) Doc 29, Report on Standard Method of Computing Noise Contours Around Civil Airports, fourth Edition, 2016 [**ECAC Doc 29**].

(b) ICAO Doc 9911, Recommended Method for Computing Noise Contours Around Airports, second edition, 2018.

4.28 These documents include relevant guidance on modelling methodologies, including aircraft selection, movement numbers, flight tracks, flight profiles, noise

contour calculation, and verification procedures. The noise modelling review considered each of these factors by reviewing the noise model inputs, assumptions used in the noise models (calculation settings), and the modelling outputs (i.e. the appropriateness of the aircraft noise contours).

4.29 NZS 6805:1992 recommends that aircraft noise contours should be estimated using the Federal Aviation Administration's (FAA) Integrated Noise Model (**INM**) or other appropriate models. The INM is no longer supported by the FAA and the FAA's Aviation Environmental Design Tool (**AEDT**) is the replacement aircraft noise modelling software package.

4.30 Wellington Airport's ANB in the Operative Plan[19] was prepared in the 1990s and is derived from the 65 dB Ldn contour modelled using the INM. The ANB that features in the Operative Plan was calculated using manual adjustments to allow for the terrain screening to the west of the runway (Tirangi Road/Lonsdale Crescent). The Operative Plan's ANB extends the modelled 65 dB Ldn contour boundary to capture groups of dwellings or to provide a natural break due to the presence of a road, i.e. the ANB follows cadastral boundaries.

4.31 The updated 65 dB Ldn aircraft noise contour and a new 60 dB Ldn contour have been generated for Wellington Airport and these contours represent the future aircraft noise environment in 2050. The 2050 model is representative of the Airport's 2040 masterplan layout with revised terminal arrangements (north pier stand locations) and the ESA.

4.32 The contours have been generated using AEDT and have been validated against measured data from Wellington Airport's Envirosuite (formally known as Airport Noise and Operations Management System - **ANOMS**).

4.33 I carried out the AEDT modelling and authored a technical report[20] (**modelling report**), which details the approach to the noise modelling. The modelling was undertaken in accordance with ECAC Doc 29 and was peer reviewed by Laurel

19 Planning Map 35 of the Operative Plan.
20 Tonkin & Taylor Ltd, Wellington Airport Air Noise Boundary Review, May 2022.

Smith of Marshall Day Acoustics (instructed by WIAL). The modelling report was reviewed by Lindsay Hannah and Matthew Borich of Council's noise team.

4.34 Of relevance to this hearing is that the 2050 model includes:

(a) Projected aircraft movement data for 2050 provided by WIAL and their aviation consultant InterVistas, which comprised 142,770 annual scheduled movements with approximately 6.5% of scheduled movements occurring during the Ldn night-time period of 10 pm to 7 am.

(b) A further 13,000 non-scheduled movements derived from 2019 movement data (pre COVID-19). Military fixed wing movements fall within the non-scheduled category and were included in the noise contours.

(c) Annualised average number of 391.15 scheduled movements per day and a combined total of 426.08 with non-scheduled movements. A 5% uplift to these figures was included to represent a three-month busy period based on historic movement data in accordance with NZS 6805:1992.

(d) Next generation aircraft and new technology aircraft for electric 19 and 30 seat class and hybrid 50 seat class aircraft.

(e) Taxiing noise and turbo-prop engine runup prior to aircraft departing a gate. The Operative Plan's ANB does not include taxiing operations.

(f) Inclusion of aircraft operations in the future ESA, which is scheduled to be operational by 2050.

(g) Verification of the noise modelling using measured data from the Airport's noise monitoring terminals (**NMTs**) in accordance with ECAC Doc 29.

(h) Inclusion of terrain data to account for geometric differences between the aircraft noise source and at different ground elevation locations around the airport. The new AEDT model included 1 metre LINZ terrain data and line of sight screening.

4.35 The 2050 model includes new technology aircraft. Manufacturers, such as Airbus, are likely to introduce larger hybrid aircraft such as zero-emission hydrogen fuelled aircraft. However, the method of propulsion will still rely on propeller or high-by-pass ratio turbo fan engines and there will still be aerodynamic noise generated by the airframe and when flaps and landing gear are deployed. Noise emissions are likely to be similar in terms of noise generation compared to conventional fuelled aircraft of a similar size and age of production. Reasonable aircraft substitutions were made based on the seat class of these new technology aircraft by adopting comparable AEDT aircraft with "*best in class*" noise emissions.

4.36 Helicopter movements were not included in the modelling due to their low noise characteristics; very small movement numbers (with the majority being for medical emergencies and/or military operation and therefore exempt from the noise contours) and the variability in their flight paths.

4.37 Unlike forecasting future scheduled aircraft movements, predicting certain types of non-scheduled aircraft movements (unrelated to fixed-base operators or maintenance, repair and overhaul facilities) is subject to uncertainty. The noise modelling assumed that non-scheduled movements would remain consistent for the next 25 years or so. This is a reasonable assumption and applies equally to military and all other non-scheduled operations.

4.38 Aircraft used in emergencies or air ambulances are excluded from the contours as it would be unreasonable to expect these unplanned operations to be included within the noise contours due to the irregular nature of these operations. Similarly, aircraft used by heads of state, for official duties or responding to civil and natural events are also excluded.

4.39 ECAC Doc 29 recognises that the size and shape of aircraft noise contours are extremely sensitive to changes in the inputs. At high sound levels, such as 60-65 dB Ldn, these sensitivities are less pronounced close to the runway than at around 50 to 55 dB Ldn, as the location and distribution of flight tracks has a greater influence on the size and shape of the aircraft noise contours at these lower sound levels. As a consequence, the noise modelling concentrated on flight track influence on the 60 dB Ldn contour.

4.40 For northerly departures using runway (**RWY**) 34, aircraft will track towards the centre of Evans Bay and therefore RWY 34 departure track was modelled in accordance with the noise abatement procedures published in the Aeronautical Information Publication (**AIP**). These special procedures are imposed by the Civil Aviation Act 2023 and not the RMA; controls imposed by the RMA can only have effect below 1,000 feet over built-up areas.

4.41 It is typical to apply dispersion to account for the spread in flight tracks. There is a greater dispersion of arrivals traffic from the south over the Cook Strait as there is no requirement to follow defined flight tracks. To the north, there is limited dispersion across the extended runway centreline at distances within 5.5 km (3 NM) from the threshold of RWY 34. Aircraft will tend to turn outside the extents of the 60 dB Ldn contour and therefore the final model ignored dispersion on RWY 34. Dispersion on RWY 16 (departures) has also been ignored due to these aircraft movements to the south being over water (and onwards over Cook Strait).

Noise Control Boundary Overlay

4.42 The AEDT 2050 noise model has been used to generate a new 65 dB Ldn contour for the purposes of establishing an updated ANB and a new 60 dB Ldn contour for new land use controls in the Proposed Plan and for inclusion in the Quieter Homes Programme in the future.

4.43 Each modelled Ldn contour has then been adjusted to fit the nearest cadastral land boundaries so that the ANB and 60 dB noise boundary follow property and road boundaries. The purpose of these adjustments is that complete land parcels are

included so there is no ambiguity whether part of a property falls inside or outside a noise boundary. For ease of understanding, a noise contour is the output of a noise model, whereas an aircraft noise boundary uses the modelled contour line adjusted to property boundaries.

4.44 In this regard there are three noise control boundary overlays:

(a) Air Noise Boundary (**ANB**) – location of the 65 dB Ldn contour adjusted to property boundaries for the purposes of controlling noise from aircraft operations at the Airport (the limits of which are part of the designations);

(b) Inner Air Noise Overlay – land within the 65 dB Ldn contour (≥65 dB Ldn) adjusted to property boundaries;

(c) Outer Air Noise Overlay – land between the 65 dB Ldn contour and the 60 dB Ldn contour, fitted to property boundaries.

4.45 The Proposed Plan's ANB, excluding the contour contribution from the ESA, falls within the Operative Plan's ANB and therefore no new residential areas are included in the new ANB. While projected movement numbers in 2050 are higher than those modelled within the Operative Plan's ANB, it is the introduction of new and quieter aircraft types that has resulted in this slight reduction in ANB contour area. The section 42A report notes that the updated ANB reduces the number of affected sites from 696 in the Operative Plan to 496. This is a significant reduction in the number of affected sites and is due to the introduction of quieter aircraft types.

4.46 The proposed ANB will continue to be used as a control line for limiting the amount of noise from aircraft operations in accordance with NZS 6805:1992. This requirement is within Designation Condition 23 of WIAL4 and is demonstrated by a combination of annual noise modelling and noise monitoring. I discuss this matter later in my evidence when I discuss NMT locations.

4.47 The 60 dB Ldn contour, which in turn has defined the Outer Air Noise Overlay, serves two purposes:

(a) In the Proposed Plan, it defines the area where any new or altered homes or other noise sensitive activities must be provided with acoustic treatment and makes future occupiers aware that adverse effects of aircraft noise are anticipated. I discuss this requirement later in my evidence (acoustic insulation).

(b) In terms of the Quieter Homes Programme, as it will be amended through the designation, it defines the area within which existing homes and other noise sensitive will be progressively provided with acoustic mitigation in the form of mechanical ventilation in line with the Quieter Homes Programme.[21] Buildings in this area only need to have doors and windows closed to achieve the Quieter Homes Programme's internal design level of 45 dB Ldn, so no additional acoustic treatment is required.[22]

4.48 I further discuss the differences between the two approaches later in my evidence when I address acoustic insulation.

4.49 As an experienced aircraft noise modeller, the contours are based on the best available assumptions relating to aircraft movements in 2050 (numbers of aircraft movements and future aircraft types) and the modelling followed industry best-practice guidance. The contours are therefore suitable for informing future land use planning controls and the ANB can be used to set a limit for the management of aircraft noise.

4.50 I will now consider the relevant noise sections of the Proposed Plan and the relief proposed by WIAL's planning expert, Ms O'Sullivan, in her statement of evidence

21 Similar to the rollout of the Quieter Homes Programme, ventilation would be offered initially to the owners of the most affected properties, i.e. working outwards with the properties at the lower noise exposure levels being treated last.

22 The typical sound reduction for a standard home is in the range of 20 to 25 dB with windows and doors closed. At 60-64 dB Ldn, internal noise levels with a closed façade will achieve 45 dB Ldn or better.

5. PROPOSED DISTRICT PLAN

5.1 The Proposed Plan has noise standards which repeat a significant number of the noise conditions in WIAL's designations. I will leave the merits of replicating the designation conditions (principally those in WIAL4) to the evidence of Ms O'Sullivan. I discuss the practicalities of including certain designation conditions when I comment on the noise evidence of Mr Hunt.

5.2 I have reviewed the Objective and Policies of the noise chapter and I acknowledge the need to protect amenity values and people's health and wellbeing from adverse noise levels (NOISE-O1 and NOISE-P1) and reverse sensitivity (NOISE-O2). Amenity values include indoor and outdoor noise amenity which is especially relevant when considering the use of outdoor spaces. I discuss this issue when addressing the evidence of Mr Hunt, and the section 42A report.

Development within the Air Noise Overlay

5.3 As noted in Ms O'Sullivan's evidence, the Proposed Plan, as notified, seeks a more permissive approach to development in the Air Noise Overlay (ANB and 60 dB Ldn) than recommended by NZS 6805:1992. Limited noise sensitive development is permitted in the Proposed Plan's ANB rather than being recommended as being prohibited in NZS 6805:1992 and there is no limit in terms of the 60 dB Ldn.

5.4 The notified version of NOISE-R3 did not consider WIAL as an affected party for applications for noise sensitive activities within the Air Noise Overlay. Even at sound levels down to 60 dB Ldn, noise may negatively affect indoor and outdoor amenity as recognised by NZS 6805:1992 and unless appropriately managed, may lead to reverse sensitivity effects. The nature of development (site layout, design, and location of structures and buildings and outdoor amenity areas) within the Outer Air Noise Overlay can influence the degree of the noise effects. Similarly the sensitivity of the activity to noise will also be a consideration. For example, I would expect visitor accommodation to have a lower noise sensitivity compared to a home due to the transient use of the accommodation.

5.5 Ms Lester states in her evidence for WIAL that the airport is recognised as nationally and regionally significant infrastructure and consistent with NOISE-O2, should be protected from incompatible land uses, including the need to protect the airport from reverse sensitivity effects. I provide further information on this matter when I consider acoustic insulation requirements, specifically the issue of managing outdoor noise amenity.

5.6 I therefore support Ms O'Sullivan's recommendation that WIAL should be considered an affected party for applications for noise sensitive activities within the Air Noise Overlay

Construction

5.7 The permitted activity standard of NOISE-R2, applies if construction works occur during the core construction hours of 7.30 am to 6 pm Monday to Saturday **or** [my emphasis added] comply with the noise limits of NZS 6803:1999.

5.8 As worded, this means that provided works take place in the core construction hours then there are no noise limits. I would have expected that the word 'or' should be 'and' or more specifically if the noise limits of NZS 6803:1999 cannot be achieved that the activity status changes to restricted discretionary. I recommend that this rule is amended.

5.9 NOISE-R2 and NOISE-S2 are not directly relevant to Wellington Airport as WIAL 4 designation conditions 35 and 36 address construction noise for works which are carried out by WIAL or on behalf of WIAL.

Acoustic Insulation

5.10 WIAL has an established acoustic insulation scheme in the Quieter Homes Programme (now part of the Designation requirements) and Ms Lester discusses the scheme in her evidence. The scheme modifies the sound insulation performance of habitable rooms to enable an internal sound level of 45 dB Ldn to be achieved for homes within the ANB.

5.11 Operative Plan Rule 5.6.2.14 requires that any new habitable room within the ANB must be designed and constructed to achieve an internal level of 40 dB Ldn with doors and windows closed. For comparison, the Port Noise Affected Area within the Operative Plan (5.6.2.15) requires the sound insulation of habitable rooms to be greater than 30 dB $D_{nT,w} + C_{tr}$,[23] and this latter performance threshold is also used for noise generated within the Central Area, Business Areas and Courtenay Place Area.

5.12 The Quieter Homes Programme's standard of 45 dB Ldn differs to that of the Operative Plan equivalent as modifying the acoustic performance of an existing house to achieve better than (i.e. lower than) 45 dB Ldn within habitable rooms may be unreasonable in terms of the scale of the modifications required, the associated cost, and whether it is practicable to achieve.[24]

5.13 It is more efficient and cost effective to design a new building or an addition to an existing building, hence the lower internal sound level standard of the Operative Plan for new builds.

5.14 The typical sound reduction ($D_{nT,w}$) for a 1970s / 1980s home with single glazed sash windows is around 20 to 25 dB with doors and windows closed. At 65 dB Ldn, internal noise levels with a closed façade will achieve at least 45 dB Ldn. For a modern house that meets the current version of the New Zealand Building Code for thermal insulation a sound reduction of at least 30 dB is typical resulting in an internal sound level of 35 dB Ldn.

5.15 The Proposed Plan seeks to implement different sound insulation requirements in NOISE-S4 and NOISE-S5, which is at odds to the current approach in the Operative Plan (and the Quieter Homes Programme).

5.16 To help explain my concerns, I have compared the technical basis of both systems and the relative merits of each approach.

23 Outer Port Noise Affected Area > 30 dB DnT,w + Ctr & Outer Port Noise Affected Area > 35 dB DnT,w + Ctr

24 Hypothetically, for poorly constructed houses a rebuild may be more cost effective.

5.17 NOISE-S4 and NOISE-S5 apply different sound insulation requirements depending on the scale of noise experienced. NOISE-S4 applies to any habitable room in a building used by a noise sensitive activity in a new building or alteration or addition to an existing building within the Inner Air Noise Overlay (high noise). NOISE-S5 applies to similar activities falling in the Outer Air Noise Overlay (moderate noise). The proposed sound insulation requirements are:

(a) Inner Air Noise Overlay - 35 dB $D_{tr,2m,nT,w} + C_{tr}$.

(b) Outer Air Noise Overlay - 30 dB $D_{tr,2m,nT,w} + C_{tr}$.

5.18 These performance standards apply to the whole building envelope and apply equally to all habitable rooms, regardless whether they are for living or sleeping. This blanket approach will result in overdesign of certain room types as I will highlight later in my evidence.

5.19 To understand these requirements, I will breakdown the sound insulation performance descriptor into its separate elements:

(a) **D_{tr}** – is the level difference, in decibels, between the outdoor sound pressure level with road traffic noise as the source and the average sound level in the receiving room. There is an equivalent metric for aircraft noise but for simplicity D_{tr} has been used.

(b) **2m** – outdoor sound level measured at 2 metres in front of the façade.

(c) **nT** – the measured difference is normalised based on the reverberation of the receiving room (10 Log t/T – where t is the measured reverberation time and T is reference value of 0.5 seconds).

(d) **w** – weighted to establish a single figure rating descriptor and normalised by comparing to the reference curve published in ISO 717-1:2020 for airborne noise.

(e) **C_{tr}** – an A-weighted urban traffic noise spectrum correction to take into account low frequency noise. There is no comparable noise spectrum for aircraft noise.

5.20 All together the descriptor refers to the weighted standardised level difference with spectrum adaption term, Ctr, at 2 metres from the façade. The C_{tr} is a correction that accounts for the inherent poor sound insulation performance of a building envelope at the low and mid frequencies which are typical of transportation noise, including aircraft. It is typical that a Ctr correction of -2 or -3 is required and therefore if compliance with 30 dB $D_{tr,2m,nT,w} + C_{tr}$ is needed then for a C_{tr} of -3, the $D_{tr,2m,nT,w}$ term must be 33 dB.

5.21 The base $D_{tr,2m,nT,w}$ descriptor is used when undertaking on-site airborne sound insulation tests and refers to testing undertaken on site in accordance with ISO 717-1:2020 '*Acoustics – Rating of sound insulation in buildings and of building elements – Part 1*'. It considers all physical sound transmission paths through a façade including flanking paths, ventilation pathways, voids, windows, doors and walls.

5.22 The $D_{nT,w} + C_{tr}$ requirement of the Operative Plan is the weighted normalised level difference, plus C_{tr} and is a subjective level of sound insulation heard on a site. $D_{tr,2m,nT,w} + C_{tr}$ is a similar subjective level of measured sound insulation.

5.23 It is common practice when describing the sound reduction of construction materials to use the terms R_w[25] and STC.[26] These terms are laboratory measured values provided by a manufacturer which a specialist can use to determine the composite sound reduction for a building element, based on the size and likely reverberation time of the room. Manufacturers do not provide performance data using $D_{tr,2m,nT,w}$ and $D_{nT,w}$ as they are field performance metrics.

5.24 As an experienced acoustics specialist, I understand the Proposed Plan's sound reduction descriptor. For the lay person, including homeowners, developers, builders and architects, I doubt that they will understand that $D_{tr,2m,nT,w}$ is not the

25 Weighted sound reduction.
26 Sound transmission class – similar to Rw.

same as that provided by manufacturers and that a correction (C_{tr}) must be included to account for the spectral shape of the noise source.

5.25 In my opinion, use of $D_{tr,2m,nT,w} + C_{tr}$ complicates matters, likely leads to confusion and inconsistency, and requires Council to expend effort to assess compliance with NOISE-S4 and NOISE-S5 at the consenting stage for non-standard construction types not listed in Table I and Table II of the Proposed Plan's noise chapter.

5.26 Rather than a relative difference I prefer retaining the fixed internal threshold approach of the Operative Plan for aircraft noise as it provides greater consistency that a desirable internal noise environment will be provided. This can be demonstrated in **Table 2** below. I have ignored the C_{tr} term in the calculation as the Ldn internal sound level is A-weighted and will be less sensitive to the low to mid frequency sound levels and I have simplified the calculations by ignoring room dimensions. I discuss this mid to low frequency influence when I consider Mr Hunt's evidence.

5.27 The table compares NOISE-S4, NOISE-S5, the requirements of the Quieter Homes Programme (45 dB Ldn) and Rule 5.6.2.14 of the Operative Plan (40 dB Ldn), which is labelled NOISE-S16 (my preferred alternative to NOISE-S4 and NOISE-S5 for aircraft noise – see paragraph 5.34 below).

Table 2: Internal sound levels

Situation	Property Ldn dB	Performance Std	Required composite sound reduction dB	Resulting internal sound level (Ldn) dB
NOISE-S4 - Inner Air Noise Overlay	67	35 dB $D_{tr,2m,nT,w} + C_{tr}$	NA	32
	66			31
	65			30
NOISE-S5 - Outer Air Noise Overlay	60	35 dB $D_{tr,2m,nT,w} + C_{tr}$	NA	30
	64			34
Quieter Homes Programme (existing dwellings)	67	45 dB Ldn	22	45
	65		20	45
	60		15	45
	64		19	45
NOISE-S16 (new and altered dwellings)	67	40 dB Ldn	27	40
	65		25	40

	60		20	40
	64		24	40

5.28 As the $D_{tr,2m,nT,w} + C_{tr}$ is fixed for each Air Noise Overlay, a range of internal sound levels will result depending upon the external noise level. For a property just within the Inner Air Noise Overlay (65 dB Ldn) the resulting internal sound level will be approximately 30 dB, whereas for a property on the boundary of the two overlays at 64 dB Ldn, the internal sound level will be approximately 34 dB.

5.29 In my view this is not a reasonable outcome. The subjective difference between an external sound level of 64 dB Ldn and 65 dB Ldn is negligible, whereas there would be a perceptible difference between an internal level of 34 dB and 30 dB. This inconsistency results in a potential engineering overdesign of properties which I expand on below.

5.30 A fixed design threshold of the Operative Plan and Quieter Homes Programme is consistent with AS/NZS 2107:2016 '*Acoustics – Recommended Design Sound Levels and Reverberation Sound Levels for Building Interiors*'. This Standard provides recommended indoor design sound levels for residential and other buildings used for noise sensitive activities. There are separate performance standards for indoor living and sleeping areas.

5.31 The Proposed Plan's approach does not differentiate between different room uses and their sensitivity to noise and will result in a much higher level of sound reduction for living rooms than recommended by AS/NZS 2107:2016. This over design will result in additional construction costs.

5.32 I have a further concern with Council's approach. WIAL4 Designation Condition 28 requires WIAL to fund noise mitigation for all existing properties in the ANB (Inner Air Noise Overlay). This program has been operational for many years as outlined in Ms Lester's evidence. The design requirement for the Quieter Homes Programme is 45 dB Ldn. If a home is treated under the scheme and then the home owner seeks to extend their property, the performance requirements of NOISE-S4 would apply. This would result in differing noise measurement requirements and resultant noise environments within the property as shown in **Table 2**, and

inconsistent outcomes with regards to indoor noise amenity. This would only apply within the Inner Air Noise Overlay as apart from ventilation, there would be no need for acoustic treatment within the Outer Air Noise Overlay.

5.33 Council's approach would also result in inconsistent outcomes compared to homes constructed in accordance with the Operative Plan's ANB provisions. Council has not provided any evidence that the current sound insulation requirements in the Operative Plan's ANB need amending. I am not aware of any negative feedback that would justify aligning aircraft noise sound insulation with other sources of environmental noise. Furthermore, the Quieter Homes Programme is well established and operates efficiently and effectively (see Ms Lester's evidence) using a similar approach to that of the Operative Plan.

5.34 I agree with Ms O'Sullivan that an airport specific noise standard should be included within the Proposed Plan which uses the same acoustic requirements of the Operative Plan. For ease of referencing I have named the noise standard NOISE-S16 (and my preferred ventilation standard is NOISE-S17). I consider that a suitably worded standard is:

NOISE S16

1. *Any habitable room used by a noise sensitive activity in a new building or an addition or alteration to an existing building must be designed, constructed and maintained to achieve an internal noise level of Ldn 40dB, based on the Air Noise Overlay.*
2. *Within the Inner Noise Overlay, compliance with NOISE S16.1 shall be demonstrated by:*
   - *(a) Designing, constructing and maintaining all habitable rooms in a manner that accords with: Table I Minimum construction requirements and implementing a mechanical ventilation system in accordance with NOISE-S17; or*
   - *(b) Submitting a certificate to the Council from a suitably qualified acoustic engineer stating the design proposed will achieve this standard.*
3. *Within the Outer Noise Overlay, compliance with NOISE S16.1 shall be demonstrated by:*

(a) Implementing a mechanical ventilation system in accordance with NOISE-S17; or

(b) Submitting a certificate to the Council from a suitably qualified acoustic engineer stating the design proposed will achieve this standard

Ventilation

5.35 Although I am not a specialised ventilation expert I have knowledge of the ventilation requirements of Clause G4 of the New Zealand Building Code (**NZBC**) and have provided acoustics advice when installing ventilation systems.[27]

5.36 The Operative Plan has a ventilation standard (5.6.2.14.2) which requires:

> *'Any new habitable room within the Airnoise boundary depicted on Map 35 that is proposed to have openable windows must be provided with at the time of fit-out a positive supplementary source of fresh air ducted from the outside. The supplementary source of air is to achieve a minimum of 7.5 litres per second per person.'*

5.37 The Proposed Plan also includes ventilation requirements to negate the need to open windows to ventilate habitable rooms within the Air Noise Overlay (NOISE-S6).

5.38 I note that in some situations, a window can be partially opened to provide ventilation without compromising the acoustic performance of the building envelope and increasing internal noise levels. These situations typically occur for buildings which have habitable rooms facing away from the source of noise. At Wellington Airport, this situation may only occur for those areas immediately adjacent to the runway as the aircraft are still on the runway and are not at altitude, i.e. where the noise source is elevated the noise affects the whole building.

27 Wall penetrations resulting in acoustic weak points on a building façade and the generated noise of fan systems.

5.39 As I have already stated, for a new or altered home within the Outer Air Noise Overlay, only an appropriate ventilation system will be need to achieve an indoor sound level of 40 dB Ldn (NOISE-S16).

5.40 I have reviewed NOISE-S6 and Mr Hunt's redrafting of the ventilation standard and I discuss ventilation in detail when I comment on Mr Hunt's evidence.

Military

5.41 Unlike forecasting future scheduled movements, predicting certain types of non-scheduled movements (unrelated to fixed-base operators or maintenance, repair and overhaul facilities) i.e. military, is very imprecise. The noise modelling assumed that non-scheduled movements would remain consistent for the next 25 years or so. This is a reasonable assumption and applies equally to military and all other non-scheduled operations.

5.42 Unlike the Operative Plan (Rule 11.1.1.1.3), the Proposed Plan no longer requires NZDF military aircraft to comply with a separate noise boundary for military aircraft (55 dB Ldn), instead the noise of military aircraft is included within the noise contours. I discussed this proposal/change at the informal discussion meeting between WIAL and Council held on 23 May 2023.

5.43 Apart from the Hercules (C-130H) aircraft, other fixed wing aircraft listed[28] in the Operative Plan are no longer operated by NZDF. Current NZDF aircraft are considerably quieter than those listed in the Operative Plan.

5.44 Military movement numbers are a fraction of scheduled and other non-scheduled movements[29] and it is improbable based on the current and anticipated future fleet of NZDF aircraft that the resulting noise emissions will materially alter the size and shape of the aircraft noise contours and noise boundaries. This statement would not apply if NZDF undertook a military response to a significant event, such as a

28 Andover, B727, Orion and Airtrainer.

29 Annualised data for military movements is included within Appendix B of the noise modelling report and account for less than 1% of all movements.

civil incident or natural disaster. Responding to such events would be excluded from the calculation of the noise contours (condition 30 of WIAL 4).

5.45 I can confirm that the extents of the 2050 ANB are not materially influenced by military movements assumed in the modelling based on the activity that took place in 2019.

5.46 WIAL has an Airfield Operators Licence agreement with NZDF. Although the licence has not yet been renewed (expired August 2022), the licence states that the existing agreement continues to apply until such time a new agreement is entered into by WIAL and NZDF. The licence provides NZDF access to the facilities and services provided by WIAL. A key requirement of the licence is that NZDF will comply with the Wellington Airport Noise Management Plan (ANMP).[30] The overarching objective of the ANMP is that:

> '*Wellington Airport continues to provide for the ongoing operation and growth of the Airport, while minimising the effects of aircraft and airport noise on the surrounding community*'.

5.47 The ANMP in section 5.8 also states:

> 'The New Zealand Defence Force is permitted to undertake activities at Wellington Airport. While the New Zealand Defence Force is responsible for ensuring its own activities either comply with the relevant District Plan requirements and/or have the appropriate authorisations in place, it is WIAL's expectation that the New Zealand Defence will comply with all the relevant requirements set out in this ANMP.'

5.48 NZDF has a duty to minimise the noise effects of its activities at Wellington Airport. These activities include aircraft operations and sources of land based noise, including ground support equipment.

5.49 I therefore support the omission of a separate military aircraft noise compliance rule in the Proposed Plan.

30 https://www.wellingtonairport.co.nz/documents/4022/ANMP_May_2023.pdf

Compliance

5.50 The Envirosuite system is used by WIAL to demonstrate compliance with the ANB since the NMTs are near to the ANB in the Operative Plan. Although the ANB in the Proposed Plan is slightly smaller, the locations of the NMTs do not need to change as an adjustment can be made to account for the amended location of the ANB in the Proposed Plan.

6. WELLINGTON CITY COUNCIL EVIDENCE

6.1 Noise evidence has been prepared by Mr Hunt and Mr Syman. Of relevance to my evidence Mr Hunt addresses airport noise and sound insulation and while Mr Syman does not address noise issues specific to the airport, he does consider reverse sensitivity effects from road-traffic and railways, which is relevant to reverse sensitivity effects in general.

6.2 I have only considered aspects of their evidence which are relevant to my observations of the Proposed Plan, as notified, and the amendments that WIAL proposes in Ms O'Sullivan's evidence.

Evidence of Malcolm Hunt

6.3 I support the need to amend the noise contour definitions[31] and to address minor changes to the drafting in APP4 as noted by Mr Hunt.

6.4 My main focus is on the application of the sound insulation requirements of NOISE-S4 and NOISE-S5 and the ventilation requirements of NOISE-S6.

Sound insulation

6.5 Mr Hunt in his evidence is critical of sound insulation standards being based on an A-weighted fixed internal limit, as the building envelope (external walls, roof and ceilings) may poorly control low frequency sound transmission from outside to

31 Mr Hunt evidence paras 29 to 40.

inside. He considers that the approach adopted by the Operative Plan and Quieter Homes Programme to be technically inferior compared to sound insulation standards of NOISE-S4 and NOISE-S5.

6.6 As I have already stated, the Operative Plan uses a fixed internal limit for protection against aircraft noise for new or altered buildings. Furthermore, the Auckland Unitary Plan,[32] Christchurch District Plan[33] and the Queenstown Lakes District Plan[34] all use the same approach with a fixed internal limit of 40 dB Ldn within sensitive spaces subjected to aircraft noise.

6.7 Similar to port noise, aircraft noise is assessed using the time of day weighted noise exposure level, Ldn. Road-traffic and railway noise use an unweighted (in terms of time of day) noise exposure level, LAeq. In comparison, port noise and aircraft noise will generally result in higher noise levels due to the addition of the 10 dB weighting for activity at night. This difference supports the need to assess road-traffic, railway, port and aircraft noise differently. This approach is further supported by socio-acoustic surveys which show that the annoyance response (ERF) to transportation noise differs depending upon the mode. Aircraft noise will invoke the greatest response, followed by road-traffic and then railways (there is no ERF for port noise).[35]

6.8 I agree with Mr Hunt that the use of C_{tr} will provide better protection at the mid to low frequencies. However, having prepared acoustic design reports for new housing subject to aircraft noise, it is standard practice to calculate the composite sound insulation across the frequency range of 63 to 4,000 Hz and to use the spectral characteristics of the noise source.

6.9 I have provided an example calculation below (**FIGURE 3**) for a hypothetical new dwelling on the edge of the Inner Air Noise Overlay.[36] The resulting internal sound level is 37 dB Ldn which would achieve the 40 dB Ldn performance standard that I

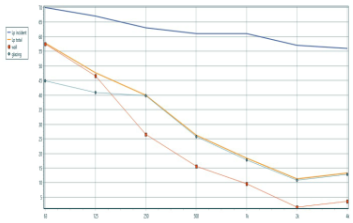
32 AUP D24.3.
33 Rule 6.1.7.2.2 in sleeping areas (50 dB Ldn in other habitable spaces).
34 Rural zone – 21.5.6.
35 WHO 2018 Guidelines.
36 Calculated using INSUL 9.0 software and the construction details for a façade – this example ignores sound through the roof to simplify the calculation detail.

have recommended (and is consistent with the Operative Plan). This example demonstrates that the frequency of the noise is taken into account when determining compliance with an internal A-weighted criterion, such as the Ldn.

Outdoor To Indoor Sound Transmission (v9.0.22)

Program copyright Marshall Day Acoustics 2017
Margin of error is generally within Rw ±3 dB
- Key No. 5650
Job Name:
Job No.: Initials:dahu
Date:7/12/2023
File Name:wall.ixl

Comment: Property on 65 dB Ldn boundary



Source	Octave Band Centre Frequency (Hz) 63	125	250	500	1k	2k	4k	Overall dBA
Incident sound level (freefield)	70.0	67.0	63.0	61.0	61.0	57.0	56.0	65
Path								
Element 1 ,wall STL	-12	-20	-36	-45	-51	-55	-52	
Facade Shape factor Level diff.	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	
Area(+10LogA) [3.6 m^2]	6	6	6	6	6	6	6	
Element sound level contribution	58	47	27	16	10	2	4	34
Element 2 ,glazing STL	-23	-24	-21	-33	-41	-44	-41	
Facade Shape factor Level diff.	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	
Area(+10LogA) [2.4 m^2]	4	4	4	4	4	4	4	
Element sound level contribution	45	41	40	26	18	11	13	33
Receiver								
Room volume(-10LogV) [25 m3]	-14	-14	-14	-14	-14	-14	-14	
Reverberation time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
RT (+10LogT)	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	
Equation Constant	11	11	11	11	11	11	11	
Room sound level	58	48	40	26	18	11	13	37

Figure 3: Example calculation for compliance with 40 dB Ldn inside

6.10 I therefore do not agree that relying on an internal design standard based on an A-weighted level will result in a poorer outcome. For the reasons I explained earlier, a fixed internal design standard will result in more consistent outcomes, will not lead to an overdesign of rooms and the corresponding financial burden to homeowners and developers.

6.11 The approach I prefer is also consistent with the Quieter Homes Programme, which has a slightly reduced design target to reflect the need to modify existing constructions. I recommend that for sound insulation within the Air Noise Overlay, an airport specific noise standard (NOISE-S16) is preferred for the reasons I have set out above and earlier in my evidence.

6.12 One of Mr Hunt's comments[37] is that there are no maps that plan users can rely on to understand the level of aircraft noise affecting the building. I can confirm that 1

37 Mr Hunt's evidence, paragraph 60.

dB contours from the 2050 WIAL Model can be made available to Council and could be incorporated in a future revision of the ANMP.

6.13 Mr Hunt in his evidence does not consider the need to protect outdoor amenity. As I have already noted, NOISE-O1 requires consideration of amenity values; both indoor and outdoor noise amenity. The amenity value of a townhouse/apartment to its occupiers may be different to that of a family home with an outdoor amenity space such as a garden.

6.14 It is all very well being able to acoustically treat a building to provide an appropriate indoor noise environment, but in my experience, the issue of outdoor amenity is a consistent theme raised by members of a community affected by airport noise and leads to complaints being made.

6.15 An understanding of the type of development and how it will be used by its occupiers is therefore important when considering issues such as amenity and reverse sensitivity. Even at sound levels down to 60 dB Ldn, noise will affect both indoor and outdoor amenity as recognised by NZS 6805:1992 and the WHO Guidelines.

6.16 Accordingly in my view there should be appropriate controls on land use so as to protect the Airport from reverse sensitivity effects and WIAL should have affected party status for applications within both the Inner Air Noise Overlay and Outer Air Noise Overlay.

Ventilation

6.17 I understand Mr Hunt has sought expert advice from a mechanical engineer to inform a revised ventilation standard, NOISE-S6. There is no technical statement/evidence from the mechanical engineer which supports Mr Hunt's recommendations.

6.18 Changes proposed by Mr Hunt include the need to provide comfort cooling and heating, a limit on the noise generated by the mechanical ventilation system and the need for rapid (flush/purge) ventilation. I have a number of issues with his

revision of NOISE-S6. However I agree with Mr Hunt and having reviewed other district plans that best practice is to now include requirements for heating and cooling within rooms and to have limits on the noise generated by the system.

6.19 Paragraph 1 of the Mr Hunt's drafting states that the ventilation requirements of the NZBC must be achieved and then identifies minimum ventilation rates for two window configurations; those that have windows that can be opened and those that don't (or do not have windows). Mr Hunt recognises that the ventilation rate for rooms that have openable windows is 3 room air changes per hour (current NZBC minimum is 2 air changes per hour).[38] This is a contradiction in flow rates, i.e. NZBC requirement versus recommended 3 room air changes per hour.

6.20 The second window configuration is for rooms that do not have a window that can be opened for rapid ventilation.

6.21 Unlike road traffic noise, aircraft noise comprises discrete events as aircraft take-off and land, rather than relatively continuous noise generated by passing vehicles. During these periods of quiet, occupants have the option to open windows and doors for rapid ventilation, which then negates the need to have a ventilation system which has a higher air flow setting.

6.22 Within the Air Noise Overlay I do not consider it necessary to have a ventilation system capable of providing a high ventilation rate (at least six air changes per hour) as aircraft noise is not present all of the time. Within the Air Noise Overlay this will simplify the specification of the ventilation system and will result in a cost saving.

6.23 I am also aware of Christchurch's plan change 5E that considered noise sensitive activities near roads and rail (**PC5E**) which recently considered the issue of ventilation.[39] Rather than specifying the ventilation rate, PC5E deferred to the requirements of the NZBC. I am aware that PC5E has legal effect, subject to two

38 Mr Hunt's evidence (Para. 111.a).

39 https://ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan/changes-to-the-district-plan/proposed-changes-to-the-district-plan/plan-change-5/

minor amendments.[40] Therefore PC5E represents the most current consideration of a ventilation standard in a district plan that I am aware of.

6.24 I have therefore drafted an alternative ventilation standard (named NOISE-S17) based on the outcome of PC5E and Mr Hunt's NOISE-S6 in part:

> *NOISE-S17*
>
> *The indoor design sound levels in NOISE-S16 shall be achieved at the same time as the ventilation requirements of Clause G4 of the New Zealand Building Code, or any amendment to or replacement of that clause. If windows are required to be closed to achieve the indoor design sound levels then an alternative means of ventilation shall be required within habitable rooms and shall generate sound levels not exceeding:*
>
> *1. 35 dB $L_{AEq(30s)}$ at night time in bedrooms; and*
>
> *2. 40 dB $L_{AEq(30s)}$ in any other habitable space (excluding bedrooms) when measured 1 metre away from any grille or diffuser.*
>
> *3. The room is provided with cooling and heating that is controllable by the occupant and can maintain the inside temperature between 18°C and 25°C;*
>
> *4. Mechanical ventilation systems shall include Filter Class of at least ISO Coarse 70%, and the filter shall be readily serviceable.*
>
> *5. Where ventilation ducting is built in and not serviceable, it shall be rigid.*
>
> *6. Where ventilation ducting is serviceable, it may be flexible.*
>
> *7. Confirmation of compliance with this standard will be required by a qualified professional.*
>
> *8.*

6.25 Unlike proposed NOISE-S6, my recommended ventilation standard does not state the ventilation rate as the notified Proposed Plan's (and that of the Operative Plan) ventilation rate of 7.5 litres of air per person per second may no longer be relevant in a future change to Clause G4 of the NZBC. Furthermore, different air flow rates apply in different building uses and therefore adopting 7.5 litres per person per second is contrary to other requirements of the NZBC.

6.26 Ms O'Sullivan includes proposed NOISE-S17 in her evidence.

40 The relevant change is the inclusion of comfort heating and cooling to rooms.

Evidence of Mr Syman

6.27 Mr Syman does not provide evidence specific to Wellington Airport or the relevant airport noise standards.

6.28 Mr Syman does however agree that a fixed internal noise limit can achieve similar reverse sensitivity outcomes as NOISE-S4 and NOISE-S5.[41] His view is that there is a need to maintain consistency across different sources of noise for ease of application and therefore he agrees with the approach of Mr Hunt by adopting a relative ($D_{tr,2m,nT,w} + C_{tr}$), rather than fixed internal limit. I disagree with Mr Syman for the reasons outlined above when discussing Mr Hunt's evidence.

7. S42 A REPORT

7.1 Mr Ashby has prepared the S4A evaluation report and supports the acoustic evidence prepared by Mr Hunt. Mr Ashby favours retaining the noise standards recommended by Mr Hunt in his evidence and Ms O'Sullivan provides further context in her planning evidence on the duplication of designation conditions in the Proposed Plan.

7.2 I disagree with Mr Ashby at his paragraph 177 with respect to the sound insulation of new or altered habitable rooms. It is my opinion that the design requirements of NOISE-S4 and NOISE-S5 will result in an overdesign which will mean that unnecessary additional costs will occur compared to the approach of the Operative Plan and that proposed in my evidence.

7.3 I also disagree with Mr Ashby that it is unnecessary for WIAL to have affected party status within the Outer Air Noise Overlay as the '*effectiveness of acoustic insulation and ventilation standards will enable a reasonable level of residential intensification*'.[42] His statement only considers indoor amenity and neglects noise experienced in outdoor spaces, which in my opinion is an important consideration,

41 Mr Syman Evidence, paragraph 22.
42 Section 42A report, paragraph 178.

and for the reasons I have already discussed, WIAL should have affected party status within the complete Air Noise Overlay.

Dated 18 July 2023

Darran Humpheson