BEFORE THE QUEENSTOWN LAKES DISTRICT COUNCIL HEARINGS PANEL

UNDER	the Resource Management Act 1991
IN THE MATTER	of the review of parts of the Queenstown Lakes District Council's District Plan under the First Schedule of the Act
AND	
IN THE MATTER	of submissions and further submissions by **REMARKABLES PARK LIMITED**

STATEMENT OF EVIDENCE OF MALCOLM JAMES HUNT ON BEHALF OF REMARKABLES PARK LIMITED

NOISE

CHAPTER 17 – AIRPORT MIXED USE ZONE

18 November 2016

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INTRODUCTION

1. My name is Malcolm James Hunt. I am the principal of a Wellington-based environmental noise consultancy Malcolm Hunt Associates.

2. I am a self-employed noise consultant, a position I have held for 25 years at my Wellington based firm, Malcolm Hunt Associates, an environmental consultancy firm specialising in environmental noise and vibration.

3. Details of my qualifications and relevant past experience are at **Appendix A** to this evidence.

4. I have been retained by Remarkables Park Limited (**RPL**) to provide expert evidence in relation to noise matters raised by Queenstown Airport Corporation's (**QAC**) submission on the Proposed District Plan.

CODE OF CONDUCT

5. I confirm that I have read the code of conduct for expert witnesses as contained in the Environment Court's Practice Note 2014. I have complied with the practice note when preparing my written statement of evidence, and will do so when I give oral evidence before the hearings panel.

6. The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in the evidence to follow.

7. Unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

8. I understand it is my duty to assist the hearing commissioner impartially on relevant matters within my area of expertise and that I am not an advocate for the party which has engaged me.

SUMMARY

9. My evidence focuses on the following:

(a) Noise issues relevant to establishing Activities Sensitive To Aircraft Noise (**ASANs**) within the Airport Mixed Use Zone (**AMUZ**);

(b) The proposed extension of daytime hours set out within the noise rule applying to land-based activities in the AMUZ; and

(c) The proposed 5 dB increase for the noise rule applying to land-based activities in the AMUZ when received within sites zoned Rural General.

10. More specifically, my evidence covers the following AMUZ noise matters;

(a) Rule 17.5.8.1 – Visitor Accommodation within the Air Noise Boundary (**ANB**). My evidence is that this is inconsistent with the generally held approach to prohibiting noise sensitive development in areas of high aircraft noise around airports;

(b) For the reasons set out, the acoustic insulation requirements of Appendix 13 are inadequate to provide appropriate acoustic insulation to buildings housing ASANs) located within the ANB. The relative lightweight constructions recommended in Appendix 13 will fail to provide a suitable indoor sound climate, such as Ldn 40 dBA indoors based year 2037 contours. Parts of the AMUZ which lie within the ANB will be exposed to aircraft noise levels reaching as high as Ldn 75. This level of outdoor aircraft noise is not contemplated by Appendix 13, which was developed for application at sites likely to receive up to Ldn 65 dB;

(c) My recommendation is to follow the recommendations of NZS6805:1992, which does not provide an exemption for Airports to develop noise sensitive activities within the ANB;

(d) I have reviewed the Report by Marshall Day Acoustics (**MDA**) (**attached** as **Appendix B**), which acknowledges aircraft noise effects for occupiers of

visitor accommodation and do not agree with their recommendation to somehow disregard the effects on people occupying these accommodation buildings because of the few nights spent within such facilities;

(d) I support (on noise effects grounds) the intent of Rule 17.5.8.2, which provides for ASANs within the lower noise areas, between the ANB and the Outer Control Boundary (**OCB**) subject to incorporating sufficient acoustic insulation within the building envelope.

(e) Rule 17.5.6 (General Noise Rules) - Below are my reasons for opposing the alteration of daytime and night time hours within the general activity AMUZ noise performance standard. These changes have the effect of increasing the AMUZ "daytime" period by 4 hours per day. In other words, the more restrictive noise limits applying during night time hours are proposed to apply for 4 less hours per day. This will affect noise received within adjacent residential zones and sites within the Remarkables Park Zone (**RPZ**). I recommend retaining the AMUZ permitted activity daytime / night time definitions that normally apply throughout the remainder of the district, and which were held as adequate and confirmed at the hearings held in 2014 on Plan Change 28.

(f) General Noise Rule 17.5.6 includes an allowance for the AMUZ activity noise to be received within the Rural Zone at levels 5 decibels higher than the Rural Zone noise limit normally applying to permitted activities within the Rural zone. In my view, the effects of this increase have not been adequately identified, nor is there a recognised need for such an increase.

VISITOR ACCOMODATION

11. The term "visitor accommodation" is referred to within the Proposed District Plan definition of "Activities Sensitive To Aircraft Noise" (ASANs) which reads[1];

> "Activities Sensitive To Aircraft Noise - Means any residential activity, visitor accommodation activity, community activity and day care facility activity as defined in this District Plan including all outdoor spaces associated with any educational facility, but excludes activity in police

> stations, fire stations, courthouses, probation and detention centres, government and local government offices."

12. I fully support the inclusion of visitor acomodation within the definition of "Activities Sensitive to Aircraft Noise'. My concerns centre on Rule 17.5.8.1 in the AMUZ, which permits buildings containing Visitor Accommodation located within the ANB, provided they are acoustically insulated.

13. More specifically, my concerns are that:

(a) It is an unwelcome precedent that the Proposed Plan makes allowance for ASANs to be established within high aircraft noise areas in the AMUZ[2].

(b) It is contrary to the recommendations of NZS6805:1992 which forms the basis of aircraft noise management elsewhere within the Proposed Plan; and

(c) While the Ldn 40 dB indoor noise standard is an appropriate design target, the stipulated method for determining conformance with this Indoor Design Sound Level (i.e. conformance with Appendix 13 of the Operative Plan) is considered inadequate to provide an inadequate degree of acoustic isolation. Due to high outdoor levels of aircraft noise found within the ANB (up to 75 dB), my calculations below show the generic construction standard prescribed within Appendix 13 of the Operative Plan will be insufficient to reduce outdoor noise to Ldn 40, the stated indoor design level.

14. I have reviewed the MDA Report which acknowledges that reverse sensitivity and adverse noise effects may be associated with the development of visitor accommodation within the AMUZ. However, the report does not represent a viable assessment of environmental effects. It fails to adequately consider indoor noise effects or the ability of the proposed acoustic insulation standard to address this effect. Instead, the MDA Report indicates effects would be mitigated because the land owned is by or designated for QAC, therefore QAC can exercise a degree of control around the construction, management and location of such facilities. However, no specifics are provided.

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[1] I Queenstown Lakes Proposed District Plan Chapter 2 (Definitions) at page 2-2.

15. The MDA Report states[3] "..an appropriate design sound level for visitor accommodation would be an internal sound level of 40 dB Ldn" which I agree with. However the MDA Report goes on the state:

> "….sound insulation rule should be consistent with drafting confirmed by the Environment Court in its third interim decision on Plan Change 35, specifically Rule 7.5.5.3(vi) of the Residential Zone."

I note this rule (and the MDA Report) refers to the minimum construction requirements for acoustic insulation set out in Appendix 13 which is reproduced as follows:

Appendix 13

The following table sets out the constructions required to achieve appropriate sound insulation within the airport Air Noise Boundary (ANB).

Table 1: Sound Insulation Requirements – Acceptable Constructions.

Building Element		Minimum Construction
External Walls	Exterior Lining:	Brick or concrete block or concrete, or 20mm timber or 6mm fibre cement
	Insulation:	Not required for acoustical purposes
	Frame:	One layer of 9mm gypsum or plasterboard (or an equivalent combination of exterior and interior wall mass)
Windows/Glazed Doors		4mm glazing with effective compression seals or for double glazing 6mm-6mm airgap-6mm
Pitched Roof	Cladding:	0.5mm profiled steel or masonry tiles or 6mm corrugated fibre cement
	Insulation:	100mm thermal insulation blanket/batts
	Ceiling:	1 layer 9mm gypsum or plaster board
Skillion Roof	Cladding:	0.5mm profiled steel or 6mm fibre cement
	Sarking:	None Required
	Insulation:	100mm thermal insulation blanket/batts
	Ceiling:	1 layer 9mm gypsum or plasterboard
External Door		Solid core door (min 24kg/m^2) with weather seals

[2] Most of the AMUZ land area at the airport lies within the Ldn 65 dB contour and could receive as high as Ldn 70 to 75 dB in my experience.

[3] At page 6

16. At **Appendix C** to this evidence I attach a prediction of indoor sound level based on a 50m^3 habitable room (perhaps a hotel room) constructed as per the above Appendix 13 minimum requirements. This prediction, carried out using INSUL, a reputable and reliable software package developed by Marshall Day Acoustics, indicates an indoor aircraft noise level of Ldn 48 dB indoors within a room constructed to comply with Appendix 13, with its windows closed. This is 8 dB in excess of the "appropriate design sound level for visitor accommodation" of 40 dB Ldn quoted within the MDA Report, which is a significant and noticeable short-coming in acoustic insulation standards in my view.

17. This failure of the Appendix 13 insulation requirements to adequately mitigate in the higher noise areas inside the ANB, indicates Appendix 13 is not suitable for use in higher noise areas. In fact, because this minimum construction of habitable rooms only achieves a 22 dB reductions in outdoor A-weighted sound levels, it is arguable that the minimum constructions set out in Appendix 13 are only likely to achieve the desired indoor sound levels (Ldn 40 dBA) in areas exposed up to Ldn 62 dBA.

18. The MDA Report fails to address the recommendations of NZS 6805:1992 *Airport Noise Management & Land Use Planning*, which prohibits noise sensitive development such as visitor accommodation on sites located within the ANB. The MDA Report seems to take some solace from the likely outcome that if people are annoyed or awoken by aircraft noise, then they will be moving on and no problems associated with repeat effects are likely to be experienced.

19. I disagree that restricting the number of days on which adverse effects occur in short stay accommodation facilities, on average, achieves any reduction/mitigation of effects. The assessment should only consider the effects of that short stay facility on the health and well-being of that visitor, whilst staying on-site. In my view, the short-stay nature of these facilities only deals with the cumulative noise effect and does not address the effects experienced at the time. Further, I cannot see how MDA can be sure that guests will only stay for one or two nights. The airport is centrally located in a district where demand for accommodation is high. Is it proposed that prospective guests have to prove that they are transiting before they can book a room?

20. I note that many airports have hotels or visitor accommodation located nearby, however this does not mean that they are located within high noise areas such as

the ANB. Auckland International airport has two hotels more or less "on site" but I understand that neither hotel is located within the ANB for that airport.

21. Council's Section 32 report (page 25) contends that provision for short term visitor accommodation within the zone will create "efficiencies and conveniences" for airport passengers and states that typically such people would expect and be sympathetic to a degree of noise from the airport. However, I consider this to be a superficial assessment as it only considers whether or not a noise complaint arises, not whether the person is awoken or annoyed by noise events whilst staying in the short term accommodation at a high noise site within the AMUZ. Furthermore, where nearby land is appropriately zoned for Visitor Accommodation so it is difficult to see how efficiency or convenience is improved by any meaningful margin. In my view, it would be more efficient to take a two minute taxi ride and get a full night sleep.

QUEENSTOWN AIRPORT SUBMISSION

22. Under the operative District Plan, approximately 25 ha of Queenstown Airport is zoned for Airport purposes. The Proposed District Plan proposes that 124 ha of land currently zoned for Airport Purposes or Rural General be zoned "Queenstown Airport Mixed Use Zone". This is providing for future airport development on a massive scale.

23. According to the QAC submission, the airport seeks flexibility offered by the provisions of the proposed Queenstown AMUZ as it will:

> "...provide for a range of airport and airport related activities that are expected of modern airports, while balancing the need to maintain an attractive and memorable gateway to the District."

24. The approach I recommend to airport noise management and land use is that of New Zealand Standard, NZS 6805:1992 *Airport Noise Management & Land Use Planning* which has a well-established at this and other airports around New Zealand. This standard provides technical guidance for the management of airport noise effects at airports in New Zealand.

25. The recommendations of NZS6805:1992 revolve around a principle that noise sensitive uses do not locate on land within the highest noise area, that is land within the future L_{dn} 65 contour (ANB). Such uses may be permitted within the L_{dn} 55 to 65 areas (Outer Control Boundary (OCB)) so long as acoustic insulation is incorporated within new buildings housing noise sensitive activities defined in the District Plan.

26. It is notable that submitters to the Proposed Plan such as the QAC and airline operators have generally support Policy 4.2.3.8, which requires ASANs to be prohibited or to otherwise control the establishment of ASAN within those parts of the adjacent Urban Growth Boundaries within the ANB or OCB for Queenstown Airport.

ASSESSMENT

27. A function of a territorial authority as set out in Section 31(1)(d) of the Act is to control the emission of noise and the mitigation of the effects of noise. The Airport is a land use activity which has existing and potential future adverse noise effects over large areas of Frankton. This arises from the use of the Airport by aircraft approaching to land on and taking off from, the runways at Queenstown Airport.

28. Establishing an accommodation facility within the ANB will result in high levels of aircraft noise being received. Aircraft noise events that are received at high levels can cause adverse effects, including reverse sensitivity effects on the Airport.. I am aware reverse sensitivity concerns are very real and drive significant processes under the RMA at airports all around New Zealand. NZ Airports[4]. Recent feedback on the proposed National Policy Statement On Urban Development[5], dated February 2016 makes it very clear that airports heavily oppose noise sensitive development around airports. The submission from Airports NZ to the NPS stated:

> "…reverse sensitivity effects pose a substantial threat to the ongoing operation of New Zealand's airport infrastructure, and have materially constrained airport infrastructure in the past."

[4] NZ Airports are an organisation whose purpose is to facilitate co-operation, mutual assistance, information exchange and educational opportunities for member airports.

[5] https://www.nzairports.co.nz/assets/Files/public/NZ-Airports-initial-feedback-on-proposed-NPS-on-urban-development-Feb-2016-FINAL.1.pdf

29. At hearings I have attended in Christchurch, I have witnessed Commodore Hotel located in Memorial Avenue, near Christchurch International Airport presenting evidence of complaints from guests staying at the hotel regarding aircraft noise. I am aware that the co-locating of transport hubs and short stay accommodation offers efficiencies to travellers. However I do not recommend this arrangement if, as in this case, there is significant potential for adverse effects due to an (potentially) inappropriately designed hotel establishing on a site within the ANB high noise area. Further, there are viable alternatives to allow hotels to develop on nearby sites in Frankton which are not subject to high levels of aircraft nosie (in which case the Appendix 13 insulation standards would provide an adequate amount of acoustic protection). In my opinion the alleged convenience of housing a hotel on airport land is overstated. I understand the new Ramada Hotel is only a short drive away.

30. I believe there can be no doubt short stay facilities house activities that are sensitive to noise and should be treated, in a planning sense, accordingly. The careful location outside the ANB would be the most efficient means of dealing with the potential adverse effects that I am concerned about. I recommend this approach as it also coincides with the recommendations for locating ASANs in other areas affected by aircraft noise.

31. I have observed through the notified provisions of the Proposed District Plan and though reading various the s.42A reports, committee and commissioner recommendations that the protection of areas affected by significant levels of current (or future) aircraft noise from inappropriate noise sensitive development is a major focus. The sensible extension of this approach is to control, in a consistent manner, development of noise sensitive activities within the proposed AMUZ.

32. I recognise that the AMUZ is intended to provide for a range of airport related service, business, industrial and commercial activity to support or complement the functioning of Queenstown Airport. However, I do not see this intention as consistent with Objective 17.2.2.3, which seeks to “avoid the establishment of activities that are incompatible with the ongoing operation and functioning of Queenstown Airport” in relation to ASANs.

33. However, I would normally expect that the zone rules would include the appropriate prohibitions on the full range of ASANs, or within areas with less aircraft noise (e.g. Ldn 55 to 65 dB). Where such sensitive facilities are warranted, the District Plan

should set out a carefully developed set of acoustic insulation standards, which would result in Ldn 40 dBA or similar indoors. As per my calculations discussed above at paragraphs 16 and 17, this has not happened in this case. I am aware of other district plans which specify two minimum construction regimes to attain a separate medium or high standard of acoustic insulation, which each standard applied depending on the expected outdoor noise climate (e.g. Within the ANB (high noise) and between ANB and the OCB (moderate noise)).

34. Either way, the acoustic insulation achieved using as a guide Appendix 13 is considered to fail in providing adequate protection for sensitive indoor spaces that require acoustic protection from the effects of outdoor aircraft noise.

35. Rules 17.4.3 to 17.4.9 seek prohibited status for the following types of activities (inclusive) Forestry, Factory Farming, Mining Activities, Offensive Trade Licence under the Health Act, Residential Activities, Community Activities, and Day Care Facilities. In my view this list should also include Visitor Accommodation

Indoor noise effects

36. Through my investigations I have become aware of research on indoor noise levels and awakening due to noise. A good review is found within *Finegold and Elias*[6] regarding the effects of indoor sound exposure levels (SEL) levels on sleep awakening.

37. From my review, I have assessed the Appendix 13 acoustic insulation requirements stipulated within the minimum building construction descriptions, and relied upon by QAC's experts as providing not more than 28 dB reduction outdoors-to-in, with windows closed.

38. Available information on single aircraft events presented at the Plan Change 35 hearing[7] of a typical Airbus A320 departure to the south results in sound levels of between 103 and 95 dB within the area to be zoned AMUZ.

39. This would mean the SEL within habitable rooms that complied with Appendix 13 would receive indoor SEL levels between 67 and 75 dBA for a short stay

[6] Finegold, L. S. and Elias, B. *A predictive model of noise induced awakenings from transportation noise sources*. Proceedings of Internoise. 2002 (cd rom). Filename: in02_444.pdf. 2002. Dearborn (MI).

accommodation facility located within the ANB, based on the authoritative FICAN 1997 study[8] (see Figure 1).

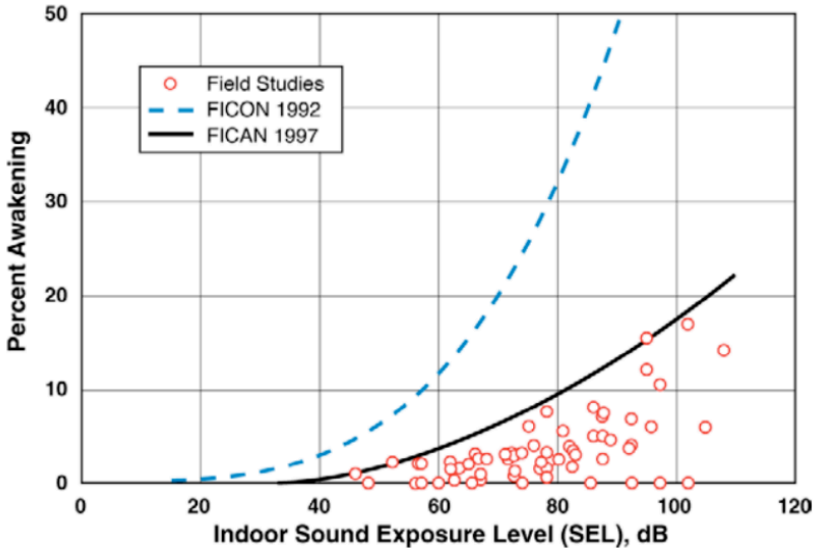

Figure 1 Indoor SEL noise levels versus Percent Awakening. Ref. 4

40. On this basis I predict indoor SEL levels between 67 and 75 dBA for a short stay accommodation facility located within the ANB, for a building constructed as per Appendix 13 requirements. This will result in around 5% to 7% of people experiencing awakening due to aircraft noise events such as an A320 departure. This is an unsatisfactory situation and could lead to complaints to the Airport as well as disrupt the sleep of travellers.

41. The issue of appropriate land use planning controls to manage aircraft noise effects has been the subject of debate at other airports. I note Mr Chris Day of MDA stated at paragraph 164 of his in evidence on behalf of Christchurch International Airport to the Christchurch Recovery Plan hearings held in March 2016 that;

> "In my opinion the Standard prefers to 'avoid' the effects of airport noise, ahead of mitigation. Table 2 in the Standard states that new residential inside the OCB "should be prohibited unless a district plan permits such uses, subject to a requirement to incorporate appropriate acoustic insulation."

42. Mr Day's evidence emphasises how partial mitigation through sound insulation is a much less desirable option to avoiding the effects of airport noise through

[7] Figures 2 and 3, evidence in chief, M Hunt dated 2010

appropriate land use controls. He stated that section 17 of the RMA, sets out a duty to "avoid, remedy or mitigate" adverse effects and in his opinion, 'avoiding' was the preferable option. (a copy of the statement of Mr Day is **attached** as **Appendix D** to this evidence).

Hours of Operation

43. Rule 17.5.6.1 of the AMUZ states:

> "noise from land-based permitted activities in the zone must not emit noise exceeding the following noise limits at any point within any Residential Zone, the notional boundary in the Rural Zone, or at any point within Activity Areas 1, 3, 4, 6 and 8 of the Remarkables Park Zone:
>
> a. Daytime (0700 to 2200 hrs) 55 dB LAeq (15 min)
> b. Night-time (2200 to 0700 hrs) 45 dB LAeq (15 min) 70 dB LAFmax"

44. The MDA Report attached to the QAC submission identifies “consistency and currency with surrounding zones” and “operational hours of Queenstown Airport” but seems to ignore the important interface between the proposed AMUZ and sites currently zoned for residential purposes located in the area or rural dwellings on rurally zoned sites. The focus seems to be providing for "airport related activities" which service the airport rather than a rational assessment of where the interface noise effects may arise and the significance of these potential effects.

45. The MDA Report does recognise that longer operational hours for land based activities within the AMUZ may impact on amenity for nearby receivers. The areas affected actually encompass residential sites with the Rural Zone, residentially zoned sites and Activity Areas 1, 3, 4, 6 and 8 of the RPZ.

46. I do not support the proposed definition of daytime and night time within the general activity AMUZ noise performance standards. The definition increase daytime by 4 hours per day. The AMUZ permitted activity noise rule is said to be based on the hours adopted from aircraft noise assessment methods recommended under NZS6805:1992, however this Standard does not apply to general land use noise performance standards. The recommendation is to focus on the potential effects within receiving environments, ensuring daytime hours that will adequately protect

[8] Federal Inter-agency Committee on Aviation Noise (1997). “Effects of Aviation Noise on Awakenings from Sleep”

residential and sensitive receiver sites from undue commercial land use activity noise, especially during the late evening period 8pm to 10pm when the ambient sound levels are reduced.

47. There appears to have been no assessment of noise effects that would likely result from the proposed increase in daytime hours associated with the AMUZ general noise rule 17.5.6.

48. In addition, I see no justification, or assessment of effects of, the proposed 5 dB increase applying to rural receiver sites. The effects of this 5 dB increase have not been assessed in my view, and could cause quite a noticeable affect for some receivers. As with the extended daytime hours, little regard has been had for potential adverse consequences of these changes, yet potential benefits have been identified multiple times regarding this change.

CONCLUSION

49. I have considered the methods set out to manage the effects of noise from aircraft and other sources with the AMUZ. I have specifically critiqued the proposal to allow short stay visitor accommodation within the area close to the airport receiving maximum levels of aircraft noise (ANB). I have set out that not only would allowing such sensitive uses inside the most noisy zone surrounding the airport would be inconsistent with the approach of a relevant NZ Standard (NZS6805:1992) but would be inconsistent with the remainder of the Proposed Plan which I support in terms of avoiding incompatible land uses developing within noisy areas.

50. One of the main failures of the proposal to allow for short stay accommodation within the AMUZ is the total failure of the proposed acoustic insulation rule (Appendix 13) to provide an adequate level of acoustic protection against outdoor aircraft noise. I have calculated the minimum acoustic design standard of Ldn 40 dB to be exceeded by at least 8 dB. I have pointed out how this standard is really only fit for stipulating acoustic insulation in buildings exposed to lower levels of aircraft noise, namely Ldn 62 dBA or below.

51. I have set out the reasons why I do not support the changes in permitted activity (non-aircraft) noise rules of the AMUZ which seek to extend the noisier daytime period and (reduce the lower noise night time period) on the basis that this would

better align with the way aircraft noise is managed at the Airport. I do not accept that the need for this extension to the prescribed daytime period is necessary or consistent with sustainable management of resources. For similar reasons, I do not support the permitted activity AMUZ noise limits applying in rural areas which allow noise received at rural sites to 5 dB higher than noise received within that zone from permitted activities, or noise received in the Rural zone from other activities in other non-AMUZ zones.

18 November 2016
Malcolm James Hunt

APPENDIX A – QUALIFICATIONS AND EXPERIENCE

1. I hold a Bachelor of Science Degree from Victoria University and a Master of Mechanical Engineering Degree specialising in Acoustics from the University of Canterbury where I completed my thesis on environmental acoustics.

2. I hold other qualifications with respect to the Environmental Health Officer Qualification Regulations 1975, and I also hold a Royal Society of Health Diploma in Noise Control.

3. I have held the past position of Vice President of the New Zealand Acoustical Society and Elected Committee Member of the Society.

4. I have been on a number of past New Zealand Standard's committees for acoustics, including the past New Zealand Standards committees reviewing NZS6801 and NZS6802 covering the measurement and assessment of environmental noise.

5. A major portion of my 25 years' experience has been in the assessment of noise-related effects of a wide range of commercial, industrial, transportation, or energy type projects. In many cases I have advised on noise control measures through both engineering methods and management plans. I have assessed noise effects within sensitive receiver sites such as residential sites, aged-care facilities, schools and hospitals. In many projects I have provided advice in relation to appropriate building materials and methods to control the intrusion of outdoor noise sources.

6. My firm has also conducted a number of district-wide community sound level surveys and provided independent District Plan noise reviews for a number of territorial authorities across New Zealand. My involvement in such projects has led to presenting noise-related evidence at Boards of Inquiry, and the Environment Court, District Court and High Court of New Zealand.

7. I have completed the 'Making Good Decisions' courses for Resource Management Act Practitioners which provides me with current certification as an RMA Practitioner able to undertake a role as a Commissioner assisting Consent Authorities with RMA decision-making processes.

8. I am experienced in the technical evaluation of environmental noise, and assessment within planning proceedings relating to environmental noise.

9. Regarding airports and aerodromes I have extensive experience in the technical evaluation of aircraft noise and planning proceedings relating to noise. I have designed functional and effective engine testing noise enclosures at Nelson Regional Airport and Wellington International Airport.

10. I have provided noise consultancy advice to Wellington International Airport Limited

(WIAL) since 1993. I have extensive experience in the measurement of aircraft noise emissions from this commercial airport, both through automated aircraft noise monitoring systems and manual “hands on” measurements. I also have experience with the aircraft noise prediction programs including the INM model.

11. In addition to my work at Wellington International airport I have been involved with noise investigations at several airports nationwide, two of which involved international aircraft movements. A sample of airport, aerodrome and airfields I have personnel worked at are provided as follows:

- Wellington International Airport
- Palmerston North International Airport
- Queenstown Regional Airport
- Gisborne Regional Airport
- Whangarei Regional Airport
- Nelson Regional Airport
- Ardmore Aerodrome
- Kaipara Aerodrome
- Thames Airfield
- Waipukurau Airfield

12. also have experience with aircraft noise assessment and design works carried out for the New Zealand Defence Force at Ohakea and Whenuapai Airbases..

APPENDIX B – MARSHALL DAY ACOUSTICS REPORT

MARSHALL DAY Acoustics

QUEENSTOWN AIRPORT MIXED USE ZONE

Acoustical review of proposed District Plan provisions

Rp 001 R01 2014513A

19 November 2014

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Project: **QUEENSTOWN AIRPORT MIXED USE ZONE**

Report No.: **Rp 001 2014513A**

Document control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Client Draft			28 October 2014	Steve Peakall	
Issued	R01		19 November 2014	Steve Peakall	Christopher Day

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1.0 INTRODUCTION

Marshall Day Acoustics (MDA) has been engaged to provide advice on the appropriateness of the noise rules in the Operative Queenstown Lakes District Plan Queenstown Airport Mixed-Use Zone (MUAZ).

The rules are to be reviewed as part of the overall Queenstown Lakes District Council (QLDC) District Plan Review. MDA has been asked to evaluate whether the existing rules need to be updated. In addition to this MDA has been asked to provide comment on whether visitor accommodation is an appropriate land use in this zone.

This report details the potential issues that may arise should the rules remain unchanged and proposes revised noise rules where appropriate. The review of the airport designation and provisions relating to the airport noise boundaries is outside the scope of this report.

A glossary of technical terminology is provided in Appendix A, and the existing MUAZ rules are shown in Appendix B.

2.0 CURRENT NOISE PROVISIONS

In summary there are two noise related issues that relate to the MUAZ rules as they currently apply in the Operative Queenstown Lakes District Plan. Each of these is discussed below.

2.1 Activity Status

The current rules state that most types of activities sensitive to aircraft noise (ASANs) are prohibited in the MUAZ. This is considered generally appropriate. One of the reasons for this is defined in the zone purpose of the MUAZ (paragraph 6.2.1) which states that the zone is "*characterised by airport related activities necessary for the transport interface role of Queenstown Airport, but which do not strictly achieve the purpose of the Aerodrome Designation*".

This definition therefore inherently suggests that most noise sensitive activities, particularly residential, are not intended for the zone and do not achieve the desired zone outcomes as they are not 'airport related'.

However, as the definition also states, airport related activities should be allowed to establish and these are often activities that produce some noise emissions themselves. Examples of these kinds of activities would be retail outlets, cafes, restaurants, car hire companies and associated vehicle maintenance facilities. These activities complement the efficient operation of the airport. Another example of an activity that may be considered airport related is visitor accommodation.

The intent of the rules as they are written should generally still apply, in that most types of ASANs should remain prohibited activities. The one exception to this would be visitor accommodation. This is discussed further in section 3.1.

2.2 General Noise Limits

Rule 6.2.5.2 (iv) (a) provides the zone noise rules that apply. It is important to note that these relate to general activities that occur in the zone, and not to aircraft operations. We note however that based on the provisions of Plan Change 35 (PC35), these would also

currently apply to any planned engine testing activity that occurs in the zone. Unplanned engine testing would be exempt from noise limits. Generally speaking the noise rules are similar to those that apply elsewhere in the District, and are consistent with the general noise rules that apply at other airport zones throughout New Zealand.

Overall, the noise limits apply to noise emissions from *non-residential* activities occurring in the zone, as they affect adjacent *residential* activities in other zones. There are currently no noise rules relating to noise emissions affecting activities *within* the zone.

The rules contain daytime and night-time noise limits for noise emissions, with a maximum noise level control also applying at night, to control potential sleep disturbance effects.

The noise rules are similar to the QLDC residential zone noise rules, except that the numerical noise limits applicable to MUAZ noise emissions are 5 dB less stringent. However the numerical noise limits are consistent with those permitted in the adjacent Remarkables Park Zone.

In general the noise limits are appropriate. However, a number of minor modifications are recommended to ensure consistency with other chapters of the District Plan, and to ensure that activities allowed to establish in the zone can operate efficiently, and at the same time, not have undue adverse noise effects on the surrounding community. These are discussed in section 3.2 below.

2.3 Construction Noise

Rule 6.2.5.2 (iv) (b) refers to construction noise and its control. In our opinion this rule is appropriate and can be retained.

2.4 Exclusions

Rule 6.2.5.2 (iv) (c) sets out the activities that are not included in the MUAZ noise rule controls. In summary these are the airport itself, windfarms and helicopter landing areas associated with the airport. This rule is also still appropriate and can be retained.

3.0 RECOMMENDATIONS

3.1 Visitor Accommodation

As discussed above, it is considered appropriate in this case to define visitor accommodation as an activity that can establish in the zone.

One reason for this is that the intent of the zone is to provide airport related activities. Visitor accommodation is one activity that can be considered airport related.

That is, the provision of visitor accommodation can be considered an airport related activity because people may wish to stay near the airport if they have an early morning flight, or want to take the opportunity to stay after initially arriving in Queenstown. The provision of such an activity may better suit some people's travel itineraries than having to stay off site.

It is noted that there is a recent trend for airport based visitor accommodation to establish in New Zealand for this reason, one example being Auckland.

Should visitor accommodation be allowed to establish in the MUAZ, then reverse sensitivity issues and adverse noise effects would need to be properly addressed through updates to the zone rules.

In terms of reverse sensitivity, it is the opinion of MDA that this can be adequately managed by ensuring that no long term accommodation is provided for, such as residential accommodation. The reasons for this are that generally speaking visitor accommodation in the MUAZ would be:

- Used by people for short term stays, unlikely to exceed a day or two in duration
- There would be minimal expectation for outside space to be provided; the main use of visitor accommodation would be for people in transit, at the beginning or end of a vacation and therefore not explicitly on holiday in the MUAZ
- Typically people using such accommodation would also be using the airport services so may generally expect and be sympathetic to a degree of impact by the airport.

Nevertheless, because the MUAZ is still adversely affected by airport noise, and visitor accommodation is a type of ASAN, then any developments would need to be fitted with sound insulation to endure a satisfactory internal noise environment is achieved.

It is recommended therefore that the MUAZ rules include reference to an appropriate internal design sound level.

It is the opinion of MDA that an appropriate design sound level for visitor accommodation would be an internal sound level of 40 dB L_{dn}, applicable to any rooms where people stay. This would not be required for any rooms used for commercial activity associated with the management of visitor accommodation.

The text of such a sound insulation rule should be consistent with drafting confirmed by the Environment Court in its third interim decision on Plan Change 35, specifically Rule 7.5.5.3(vi) of the Residential Zone. Reference to Appendix 13 (as confirmed by the Environment Court in its third interim decision) which specifies the sound insulation requirements for ASANS inside the airport noise control boundaries should also be made.

In terms of residential accommodation, it is noted that sound insulation does not deal with the outdoor noise environment. New Zealanders in general, enjoy an 'outdoor' type of lifestyle that includes activities such as barbecues, gardening and entertaining friends and family. As a result an unsatisfactory external noise environment is a potential source of residential complaint with demands to reduce noise, potentially affecting airport operations.

In our opinion, minimising the number of people affected by airport noise by restricting residential development is an appropriate form of land use planning inside the MUAZ. These external noise environment issues would not occur with visitor accommodation inside the MUAZ.

When consideration is given to the above, visitor accommodation could be allowed in the MUAZ. However because residential activity is a different type of ASAN, this should remain prohibited.

3.2 General Noise Limits

As discussed in section 2.2 above, it is considered appropriate that the general noise controls be retained, but with some minor amendments.

The proposed text revisions for the rule are provided below:

"Sound from activities measured in accordance with NZS 6801:2008 and assessed in accordance with NZS 6802:2008 shall not exceed the following noise limits at any point within any Residential Zone, the notional boundary in the Rural Zone, or at any point within Activity Areas 1, 3, 4, 6 and 8 of the Remarkables Park Zone:

daytime	*(0700 to 2200 hrs)*	*55 dB $L_{Aeq\ (15\ min)}$*
night-time	*(2200 to 0700 hrs)*	*45 dB $L_{Aeq(15\ min)}$*
night-time	*(2200 to 0700 hrs)*	*70 dB L_{AFmax}"*

If residential activity is allowed to establish in the Frankton Flats zone, then the rule above should be adjusted to ensure these areas are also protected.

In our opinion the noise controls should retain a separate daytime and night-time noise limit and in this case, MDA recommend the same numerical limit as currently exists is also retained. The night-time maximum noise limit should also be retained.

However, it is recommended that the time periods to which the noise controls apply be amended. Currently the daytime period is defined as 8 am – 8 pm. We recommend this be adjusted to 7 am – 10 pm. There are a number of reasons for this, including:

- To account for airport related activity in the zone occurring at the same times that the airport itself is operational (daytime period defined in NZS 6805 as 7am – 10 pm).
- To provide consistency with the time periods that apply to similar activity that can occur in both the Remarkables Park Zone and the Frankton Flats zone, both of which adjoin the MUAZ.

We note that the rule as worded above would mean that there is no noise control between activities in the zone that are not noise sensitive. In our opinion this is acceptable, because noise related issues for such activity is unlikely to occur. It is also noted that the MUAZ only includes land owned by the airport or contained within its designation, and as such, it can exercise a degree of control over who it leases this to, and therefore to what extent a leasee can make noise. In addition, there would still remain a duty on any occupier to ensure noise does not exceed a reasonable level.

If the general noise rules were to remain unchanged, there is a risk that the ancillary activities which service the airport may not comply with the noise rules and this may also detrimentally impact the ability of the airport to effectively operate.

4.0 CONCLUSION

Marshall Day Acoustics has reviewed the Operative Queenstown Airport Mixed Use (MUAZ) rules as they relate to noise. The noise rules for the zone are generally appropriate but can be updated to better reflect the requirements of an international airport, without unduly impacting on the surrounding community.

The revisions that should be made relate to; ensuring the general noise rules are consistent with the surrounding zones, allowing airport related activity to occur during airport operational hours, allowing visitor accommodation to establish inside the zone provided it is fitted with appropriate sound insulation, and ensuring residential activity continues to be prohibited.

APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{dn}	The day night noise level which is calculated from the 24 hour L_{Aeq} with a 10 dB penalty applied to the night-time (2200-0700 hours) L_{Aeq}.
Sound Insulation	When sound hits a surface, some of the sound energy travels through the material. 'Sound insulation' refers to the ability of a material to stop sound travelling through it.
NZS 6801:2008	New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of environmental sound"*
NZS 6802:2008	New Zealand Standard NZS 6802:2008 *"Acoustics – Environmental Noise"*
NZS 6805:1992	New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"*

APPENDIX B: EXISTING QUEENSTOWN AIRPORT MIXED-USE ZONE RULES

QUEENSTOWN AIRPORT MIXED-USE ZONE - RULES 6

6.2 Queenstown Airport Mixed-Use Zone Rules

6.2.1 Zone Purpose

The Mixed Use Zone comprises part of the underlying zone for Queenstown Airport in the vicinity of Lucas Place and Robertson Street at Frankton. It is characterised by airport related activities necessary for the transport interface role of Queenstown Airport, but which do not strictly achieve the purpose of the Aerodrome Designation - the safe and efficient operation of Queenstown Airport. The purpose of the zone is to provide for the continued viability of these activities and to maximise the efficient use of airport land. Future activities within the zone will be provided for without undue regulation, as long as amenity and building appearance standards are met.

6.2.2 District Rules

Attention is drawn to the following District Wide Rules which may apply in addition to any relevant Zone Rules. If the provisions of the District Wide Rules are not met then consent will be required in respect of that matter:

i	Transport	- **Refer Part 14**
ii	Subdivision, Development and Financial Contributions	- **Refer Part 15**
iii	Hazardous Substances	- **Refer Part 16**
iv	Utilities	- **Refer Part 17**
v	Signs	- **Refer Part 18**
vi	Relocation Buildings and Temporary Activities	- **Refer Part 19**

6.2.3 Activities

6.2.3.1 Permitted Activities

Any activity which complies with all the relevant **Site** and **Zone** Standards and is not listed as a **Controlled, Discretionary, Non-complying** or **Prohibited** Activity.

6.2.3.2 Controlled Activities

i The addition, alteration, and construction of all buildings in respect of location and external appearance.

6.2.3.3 Discretionary Activities

i Any activity not listed as a **Non-Complying** or **Prohibited Activity** and complies with all the **Zone** Standards but does not comply with one or more of the **Site** Standards shall be a **Discretionary Activity** with the exercise of the Council's discretion being confined to:

(a) the matter(s) specified in the standard(s) not complied with; and

(b) the extent to which the activity is dependent on an airport location.

ii Industrial Activities, except the processing of natural materials.

6.2.3.4 Non-Complying Activities

The following shall be **Non-Complying Activities** provided they are not listed as a **Prohibited Activity:**

i Conference facilities.

ii Commercial activities, other than retailing.

iii Any activity not listed as a Prohibited Activity and does not comply with one or more of the relevant Zone Standards, shall be a **Non-Complying Activity.**

6.2.3.5 Prohibited Activities

The following shall be **prohibited**:

i Forestry Activities

ii Visitor Accommodation

iii Residential Activities

iv Commercial Recreational Activity

v Community Activities

vi Farming

vii Factory Farming

viii Mining Activities

ix Any activity requiring an Offensive Trade Licence under the Health Act 1956

x Residential Flat

6.2.4 Non-Notification of Applications

An application for a resource consent for the following matters may be considered without the need to obtain a written approval of affected persons and need not be notified in accordance with Section 93 of the Resource Management Act 1991, unless the Council considers special circumstances exist in relation to any such application.

(i) Applications for the exercise of the Council's discretion in respect of the following **Site** Standards:

- **Visual Amenity**
- **Landscaping**

6.2.5 Standards

6.2.5.1 Site Standards

i Building Coverage
Maximum site coverage - 75%

ii Building Setback
(a) Setback from the Zone boundary shall be 10 m.

(b) Setback from any road shall be 6 m.

iii Landscaping

(a) At least 10% of each site shall be landscaped.

(b) Those properties fronting Lucas Place and Hawthorne Drive shall provide and maintain a landscape strip extending the full length of the road boundary, except across entranceways. The strip shall be not less than 1 metre deep and shall have an average depth of 4 m over its entire length.

iv Office Accommodation
Office accommodation shall only be provided as part of an activity undertaken within the Zone.

v Land Transport Facilities
Land transport facilities shall be limited to the following:

- garaging, including servicing of tour buses and facilities for tour buses

- courier sorting and distribution centre
- car valet services
- rental car facilities.

6.2.5.2 Zone Standards

i Building Height
Maximum building height - 9 m

ii Glare

(a) All exterior lighting installed on sites or buildings within the zone shall be directed away from adjacent sites, roads and public places.

(b) All roofs of buildings shall be finished or treated so they do not give rise to glare when viewed from any public place.

(c) No activity shall result in a greater than 10 lux spill (horizontal or vertical) of light onto any adjoining property within the zone, measured 2 m inside the boundary of any adjoining property.

(d) No activity shall result in a greater than 3 lux spill (horizontal or vertical) of light onto any adjoining property which is zoned for residential purposes.

iii Retail Sales

(a) Retail sales and displays are restricted to areas within the airport terminal and to such goods that serve the needs of the travelling public.

(b) Any goods displayed for sale and/or retailing shall be limited to the sale of those goods within the airport terminal.

iv Noise

(a) Sound from activities measured in accordance with NZS 6801:2008 and assessed in accordance with NZS 6802:2008 shall not exceed the following noise limits at any point within any Residential Zone or at any point within Activity Areas 1, 3, 4, 6 and 7 of the Remarkables Park Zone:

(i) daytime (0800 to 2000 hrs) 55 dB $L_{Aeq(15\ min)}$

(ii) night-time (2000 to 0800 hrs) 45 dB $L_{Aeq(15\ min)}$

(iii) night-time (2000 to 0800 hrs) 70 dB L_{AFmax}

(b) The noise limits in (a) shall not apply to construction sound which shall be assessed in accordance and comply with NZS 6803:1999.

(c) The noise limits in (a) shall not apply to sound associated with airports or windfarms. Sound from these sources shall be assessed in accordance and comply with the relevant New Zealand Standard, either NZS 6805:1992, or NZS 6808:1998. For the avoidance of doubt the reference to airports in this clause does not include helipads other than helipads located within any land designated for Aerodrome Purposes in this Plan.

v Industrial Activities

(a) There shall be no processing of natural materials.

6.2.6 Resource Consents - Assessment Matters – Airport Mixed Use Zone

6.2.6.1 General

i The following Assessment Matters are other methods or matters included in the District Plan, in order to enable the Council to implement the Plan's policies and fulfil its functions and duties under the Act.

ii In considering resource consents for land use activities, in addition to the applicable provisions of the Act, the Council shall apply the relevant ***Assessment Matters*** set out in Clause 6.2.6.2 below.

iii In the case of ***Controlled and Discretionary Activities***, where the exercise of the Council's discretion is restricted to the matter(s) specified in a particular standard(s) only, the assessment matters taken into account shall only be those relevant to that/these standard(s).

iv In the case of ***Controlled Activities***, the assessment matters shall only apply in respect to ***conditions*** that may be imposed on a consent.

v Where an activity is a ***Discretionary Activity*** because it does not comply with one or more relevant Site Standards, but is also specified as a ***Controlled Activity*** in respect of other matter(s), the Council shall also apply the relevant assessment matters for the Controlled Activity when considering the imposition of conditions on any consent to the discretionary activity.

6.2.6.2 Assessment Matters

In considering whether or not to grant consent or impose conditions, the Council shall have regard to, but not be limited by, the following assessment matters:

i Non Complying Activity – Conference Facilities

(a) The extent to which the activity is dependent on an airport location.

ii Building Coverage

(a) The extent to which the proposed buildings will be compatible with the character of the local environment, including the scale of other buildings in the surrounding area.

iii Setback from Zone Boundaries

(a) The extent to which a limited building setback from the zone boundary is necessary in order to allow more efficient or practical use of the remainder of the site.

(b) The extent to which alternative practical locations are available for the building or structure.

(c) The degree to which the proposed building will detract from the pleasantness, coherence, openness and attractiveness of the site as viewed from adjoining zones.

(d) The degree to which the proposed building will detract from the outlook and privacy of people on adjoining zones.

(e) The degree to which proposed landscaping, including plantings, will mitigate the effects of limited building setback from a neighbour's in adjoining zones.

(f) The extent to which the proposed building, will be compatible with the appearance, layout and scale of other buildings and sites in the surrounding zones.

(g) The extent to which the proposed building will have a size, form, and external appearance which are sympathetic to, and in visual harmony with, the surrounding environment.

(h) The extent to which the use of the proposed building will detract from the pleasantness or amenity of adjoining zones, in terms of such matters as noise, smell, dust, glare or vibration.

iv Landscaped Areas

(a) The effect of any reduced landscaping in terms of the visual impacts of the buildings in the Zone and the scale of these buildings.

(b) The effect of any reduction in landscaping and screening on the visual impacts of outdoor storage areas.

(c) The extent to which the site is visible from adjoining sites, particularly those in residential zones, and the likely consequences of any reduction in landscaping standards or screening.

(d) Any aspects of the proposal, which may compensate for reduced landscaping or screening, including the nature of planting or materials used, the location of parking manoeuvring or storage areas and office accommodation.

(e) The relative importance of landscaping on the particular site concerned, taking account of the visual quality of the surrounding environment, particularly where a low standard of visual quality exists and improvement is necessary.

(f) The nature of the business activity itself, and any particular adverse visual impacts it may have.

(g) The effect of any reduction in tree planting provision, particularly in respect to the visual character of car parking areas and building scale.

v Office Accommodation, Land Transport Facilities, Industrial Activities and Retailing

(a) The extent to which the activity is dependent on an airport location.

vi Building Height

(a) With regard to proposals that breach one or more zone standard(s), whether and the extent to which the proposal will facilitate the provision of a range of Residential Activity that contributes to housing affordability in the District.

APPENDIX C – Copy of INSUL Calculation Based On Appendix 13 Table 1

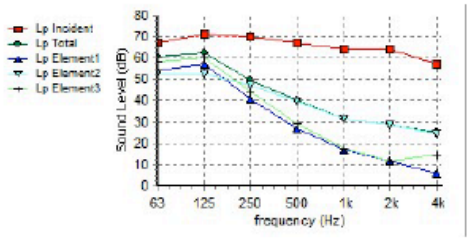
Sound Insulation Prediction (v8.0.4)

According to EN12354/3

Title :Queenstown Visitor Accom Insulation Test

Comments :

This is a test of the Appendix 13 minimum construction requirements, tested against Ldn 70 dBA outdoors.



Date: 17 Nov 16 Initials:Malcolm

File Name: Calculation.inz

	Octave Band Centre Frequency (Hz)							Overall dBA
Source	63	125	250	500	1k	2k	4k	
Incident sound level (freefield)	67	71	70	67	64	64	57	70
Path								
Element 1 ,Walls STL	-14	-14	-30	-41	-48	-53	-52	
Facade Shape Level diff.	0	0	0	0	0	0	0	
Area (+10Log A) [10 m2]	10	10	10	10	10	10	10	
Element sound level contribution	54	57	41	27	17	12	6	42
Element 2 ,Window s STL	-12	-16	-20	-25	-30	-33	-30	
Facade Shape Level diff.	0	0	0	0	0	0	0	
Area (+10Log A) [4.5 m2]	7	7	7	7	7	7	7	
Element sound level contribution	52	52	47	39	31	28	24	43
Element 3 ,Skillion Roof STL	-11	-13	-28	-40	-49	-55	-45	
Facade Shape Level diff.	0	0	0	0	0	0	0	
Area (+10Log A) [14 m2]	11	11	11	11	11	11	11	
Element sound level contribution	58	60	44	29	17	11	14	45
Receiver								
Room volume (-10Log V) [50 m3]	-17	-17	-17	-17	-17	-17	-17	
Reveberation time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
RT (+10Log T)	-3	-3	-3	-3	-3	-3	-3	
Equation Constant	11	11	11	11	11	11	11	
Room sound level	60	63	50	40	32	29	25	48

APPENDIX D – Copy of Evidence of C. Day on Behalf of Christchurch International Airport, presented at the hearings on the proposed Christchurch Replacement District Plan.

Before the Independent Hearings Panel
at Christchurch

under: the Resource Management Act 1991 and the Canterbury Earthquake (Christchurch Replacement District Plan) Order 2014

in the matter of: Submissions and further submissions in relation to the proposed Christchurch Replacement District Plan

and: The Chapter 6: General Rules and Procedures **Stage 2** Proposal

and: **Christchurch International Airport Limited**
Submitter 2348 / F-2817

Statement of Evidence of Christopher Day

Dated: 17 February 2016

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CHAPMAN TRIPP

STATEMENT OF EVIDENCE OF CHRISTOPHER DAY

INTRODUCTION

1 My full name is Christopher William Day.

2 I am a founding partner and principal of Marshall Day Acoustics Limited.

3 I have the qualification of Bachelor of Engineering (Mechanical) from Monash University in Melbourne, Australia. For the past 40 years I have worked in the field of acoustics, noise measurement and control in England, Australia and New Zealand, specialising in transportation noise and acoustics for the performing arts. My work over the last 35 years has included noise control engineering and town planning work for various major corporations and City Councils within New Zealand, and I have been engaged on numerous occasions as an expert witness before the Environment Court.

4 I have been significantly involved with airport noise at all the three major airports in New Zealand as well as many of the smaller regional airports, including Queenstown Rotorua, Whangarei, Dunedin, Invercargill, Wanaka, Ardmore, Hamilton, Tauranga, Nelson, Omaka, Paraparaumu, Gisborne, Masterton, and Taupo.

5 At Auckland Airport my firm has been engaged by the Manukau City Council and the Airport Company, at Wellington by the Board of Airline Representatives of New Zealand (BARNZ) and Wellington International Airport Limited (WIAL), and at Christchurch by Christchurch International Airport Limited (CIAL). Our work has involved noise predictions, computer modelling, noise boundary development and automated noise monitoring.

6 My firm has been engaged by CIAL since 1992 to advise on various noise issues including the preparation of the original noise contours to form the basis of the airport noise provisions in the Christchurch, Waimakariri, and Selwyn District Plans (referred to as the 1994 Study) and also to advise on a number of specific land use consent applications and plan changes that have arisen since then. My firm carried out the recalculation of the noise contours for Christchurch in 2007 which involved a complete remodelling of future operations and included consultation and agreement with the so-called 'Panel of Experts'.

7 On this occasion I have been asked to assist CIAL and the panel with the airport noise provisions in the Rural chapter of the proposed Christchurch Replacement District Plan (*the proposed District Plan*).

8 Although this is not an Environment Court hearing (or a hearing being conducted under the Resource Management Act 1991), I note that in preparing my evidence I have reviewed the code of conduct for expert witnesses contained in part 7 of the Environment Court Practice Note 2014. 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. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

9 This evidence will discuss the avoidance of adverse noise effects through airport noise management and land use planning. This involves noise controls rules to manage the extent of noise produced by the airport and land use controls to avoid noise sensitive activities from establishing within the Airport Operational Noise contours and the Engine Testing Noise contours.

Previous Evidence

10 I have previously given evidence on issues relating to the Airport Operational Noise Contours at the Residential and Commercial/Industrial stage 1 hearings before this panel and the Rural stage 2 hearing.

11 I have repeated much of that evidence here for the benefit of those new members of the Panel who were not present at those hearings and for submitters. The sections that are repeated are:

- NZS 6805:1992 "Airport Noise Management and Land Use Planning";
- the background to the 2007 Christchurch operational noise contours;
- community response to aircraft noise;
- the need for Land Use Planning to avoid adverse effects; and
- sound insulation as a means to mitigate noise effects.

12 For those who have read my previous evidence you can skip those sections and read the new evidence as follows:

- Executive Summary (paras 13 to 24);
- Operational noise; 2015 compliance monitoring & 2007 remodelling (paras 55 to70);

- Engine Testing Noise (paras 71 to 130);
- Engine Testing Noise LUP (paras 168 to 171);
- Review of the evidence of Dr Chiles (paras 171 to 188); and
- Conclusion (paras 189 to 192) .

EXECUTIVE SUMMARY

13 The lack of appropriate land use planning around airports has historically caused significant numbers of people to be exposed to airport noise and has initiated operational constraints on airports. The fore-fathers at Christchurch have managed to avoid this situation by farsighted planning of the airport location and by protection of a 'green-belt'.

Airport Operational Noise Contours

14 A comprehensive study carried out by Marshall Day Acoustics in conjunction with the international 'Panel of Experts' established in 2007, an appropriate set of airport operational noise contours to be used as the basis for 'Airport Noise Management and Land Use Planning' at Christchurch International Airport. These contours are referred to generally as the '2007 Expert Panel' contours.

15 These 2007 contours are 24% smaller by area than the previous (2004) City/District Plan contours primarily due to improvements in aircraft technology reducing aircraft noise. The aviation industry has achieved a remarkable reduction in 'noise at source' over the past 60 years of over 20dB (see Figure 6).

16 The 2007 contours have been incorporated into the Canterbury Regional Policy Statement 2013, the Selwyn and Waimakariri District Plans and the Land use Recovery Plan. By virtue of changes directed via the Land Use Recovery Plan, the 50 Ldn Air Noise Contour is also incorporated into the operative Christchurch City Plan. The 50 Ldn Air Noise Contour forms the boundary inside which noise sensitive activities have, for a very long time and after a number of Court cases, been considered by decision makers to be inappropriate.

17 In my opinion, there are adverse effects from aircraft noise inside the 50 Ldn Air Noise Contour. While the adverse effects are less than, for example, they are at 65 Ldn Air Noise Contour, they are nevertheless real. If land is available elsewhere in the Christchurch region for new residential development (or intensification), in my opinion, it is not sensible from an acoustics perspective to allow new noise sensitive activities inside 50 Ldn Air Noise Contour if it can be avoided. I am aware that my advice is just one input to the decision making on land use restrictions.

18 A number of factors confirm there are adverse effects from aircraft noise inside 50 Ldn Air Noise Contour and that it is not a desirable noise environment in which to locate new residential development.

19 Overseas studies have shown that between 50 and 55dB Ldn, 3% to 12% of people were found to be highly annoyed by aircraft noise. A

Christchurch study has shown higher levels of annoyance with 10% to 15% of the population Highly Annoyed in this environment (50dB to 55dB). At higher noise levels (for example at 55-60 dB) this increases to 15% to 22%. The general noise rules in the operative City Plan also support the use of 50 Ldn as the point at which land use restrictions apply as they specify 49 dB Ldn for the protection of Living 1 to 4 Zones from industrial/commercial noise and aircraft noise is generally accepted as more annoying than other sources of noise.

20 If noise sensitive activities such as residential development, hospitals and education facilities are allowed in the area between 50 to 55dB Ldn, the number of people adversely affected by aircraft noise would increase.

21 Specifying sound insulation to be fitted to buildings in these noise environments will not eliminate all the adverse effects of noise, due to open windows and an unsatisfactory outdoor noise environment.

Engine Testing Noise Contours

22 The principles which I discuss in relation to aircraft operational noise at Christchurch Airport apply equally to noise generated by engine testing activities (ground running of aircraft engines on-wing). Engine testing noise contours have been developed by Marshall Day for engine testing, and the modelling and inputs used to generate these contours are explained below.

23 In my opinion, as with operational noise, there are adverse effects from the noise generated by engine testing activities within the 50 Ldn Engine Testing Contour. A noise rule has been proposed to constrain these effects to a similar level to what currently takes place. Fortunately, there are relatively few residential properties within the current and future engine testing noise contours. In my opinion, additional noise sensitive activities within this contour should be avoided where ever possible, in the same way as they are within the 50 Ldn Air Noise Contour.

General

24 Christchurch Airport is in a unique position in that historically a buffer zone around the airport has been maintained to avoid the adverse effects of aircraft noise on people (take-offs, landing, taxiing and regulatory on-wing testing). Secondly, this buffer is required to provide protection for the airport against reverse sensitivity effects. In my opinion, both these effects need to continue to be addressed.

NEW ZEALAND STANDARD NZS 6805

25 In 1992, the Standards Association of New Zealand published New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning" with a view to providing a consistent approach to noise planning around New Zealand airports.[1] The Standard has been used by virtually every district council since 1992 and it is one of the few noise standards that has not been put up for revision or amendment.

26 The Standard uses the "Noise Boundary" concept as a mechanism for local authorities to:

26.1 "establish compatible land use planning" around an airport"; and

26.2 "set noise limits for the management of aircraft noise at airports"

27 The Noise Boundary concept involves fixing an Outer Control Boundary (OCB) and a smaller, much closer Airnoise Boundary (ANB) around the airport. The location of the ANB is based upon the projected 65 dB Ldn contour, and the location of the OCB is generally based on the projected 55 dB Ldn contour but the standards allow for District Councils to choose another contour for the OCB and historically Christchurch has used 50 dB Ldn. For completeness, I note that the Standard does state in paragraph 1.4.3.8 that the local authority may show "the contours in a position further from or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case". The Christchurch authorities decided many years ago to use the 50 dB Ldn contour for the location of the OCB.

28 The New Zealand Standard was written in 1992 – well before the community response surveys discussed later in this evidence (Bradley 1996, Miedema 1998, Taylor Baines 2002). The land use planning recommendations and amenity protection guidelines in the Standard are thus based on earlier research (Schultz 1978) which I will discuss later in this evidence.

29 The Standard recommends that inside the ANB, new noise sensitive uses (including residential) should be prohibited. Between the ANB and the OCB new noise sensitive uses should also be prohibited unless the district plan permits such uses subject to appropriate sound insulation. In my opinion, this shows the overall approach is still avoiding such activities where ever possible.

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[1] **Exhibit 14, Residential hearing.**

30 The Standard is based on the Day/Night Sound Level (Ldn) which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10 decibel penalty applied to night flights (see Appendix A for a full list of terminology and the figures explaining Leq , Ldn and SEL from the Residential Hearing). Ldn is used extensively overseas for airport noise assessment and it has been found to correlate well with community response to aircraft noise.

31 In addition to land use controls, NZS 6805 proposes maximum noise emission limits for airports. The ANB is also nominated as the location for future noise monitoring of compliance with an Ldn 65 dB limit.

THE CHRISTCHURCH AIRPORT OPERATIONAL NOISE CONTOURS

32 As discussed above, the New Zealand Standard recommends planning and management procedures be based on predicted noise contours (Ldn) for some future level of airport activity. The Standard recommends (in clause 1.4.3.1) that a "minimum of a 10 year period be used as the basis of the projected contours."

33 Clearly, it is important for a major international airport to plan for a period significantly longer than 10 years. At Auckland International Airport the recently updated contours are based on a projection for the year 2044 (30 years). At Wellington International Airport the projections were based on the long term airport capacity.

Christchurch 1994 Study

34 My firm was engaged in 1992, together with a series of airport planning experts, to develop noise contours for Christchurch Airport. The study involved a dual approach of examining future growth projections and a study of long term airport capacity. In summary, Christchurch International Airport Limited developed future aircraft operational scenarios for the airport through consultation with their airport planning consultants and users of the airport. These scenarios were developed from the then current, 1993 domestic and international billing details, significant research on anticipated growth rates for the industry and the information on airline fleet replacement preferences.

35 The 'high' forecast growth, predicted total annual movements of 145,000. CIAL discussions with the airport planning consultants suggested the maximum capacity of the airport, with the technology available at that time, was 140,000 movements per annum. Thus, this slightly lower figure was used in the 1994 noise contour predictions. It was anticipated at the time that this capacity would be reached between the years 2015 and 2020.

36 Several computer based models have been developed to predict aircraft noise levels in areas surrounding airports. The most widely used of the models (and the model referenced in NZS 6805) is the Federal Aviation Authority (FAA) Integrated Noise Model (INM). The version of the INM program that was current in 1994 was used by Marshall Day Acoustics to predict the future Ldn contours around Christchurch International Airport. The resultant contours were an accurate 'best practice' estimate of the future noise contours for Christchurch and were later included in the various District Plans.

2007 Study

37 In 2007, several parties agreed that the noise contours for Christchurch should be updated to include new operational procedures and updated knowledge of future aircraft types. I understand this was driven by the upcoming review of the Regional Policy Statement. Marshall Day Acoustics, Airbiz, Yellow Hat Consultants and Airways were engaged to carry out a detailed study to determine future flight tracks, aircraft types and numbers of aircraft movements to provide the input for an updated INM study. The work was carried out in consultation with Mestre Greve Associates from Seattle. Most input parameters were agreed by the consultants however some inputs remained in contention.

38 Later, in 2007 a panel of noise and aviation experts was formed to resolve the remaining 'differences'. Seven aviation and noise experts from NZ, Australia and the USA met together in a three day workshop to find an agreed position on input data to be run in the INM.

39 The people involved in the 'Expert Panel' were; Assoc Professor John-Paul Clarke (engaged by SDC & Chairman), Kevin Bethwaite (Airways), Chris Day & Laurel Smith (MDA, engaged by CIAL), Vince Mestre, Bill Bourke and Barry Malloch (engaged by Foster, the appellant in the then relevant Environment Court proceeding that had initially 'triggered' the expert panel process).

40 The key issues for discussion were as follows:

- Flight tracks
- Runway utilisation
- Aircraft movements/capacity
- Fleet mix
- Future quiet aircraft
- Consideration of NZS 6805

- Modelling/measurement uncertainty.

41 The flight tracks for the study were developed by Kevin Bethwaite of Airways and include the latest developments in navigational and fuel saving procedures. Mr Bethwaite is a world leader in the field of airspace management.

42 The airport capacity using the dual runway and Simops was originally determined by Airbiz to be 220,000 movements per annum. Associate Professor J-P Clarke was of the view that the capacity was only 175,000 mpa.

43 The fleet mix agreed by the expert panel includes the quietest aircraft that were known to be available in the next 20 years. The mix did not included futuristic aircraft that are only in the conceptual design stage.

44 The outcome from the panel was that the modelling approach used by the CIAL experts in the initial 2007 Study was adopted on virtually all issues (flight tracks, fleet mix etc) with the following modifications. The airport company reluctantly agreed to a reduction in airport capacity for the modelling exercise from 220,000mpa to 175,000mpa but I understand they do not resile from their position that capacity is greater and the contours are therefore conservative. There were also some minor modifications to the approach profiles and an increased use of the cross wind runway.

45 Marshall Day Acoustics subsequently ran these agreed input parameters in the 'then current version' of the INM to produce the updated noise contours. These revised contours are sometimes also referred to as the 'Expert Panel' contours or the '175k' contours.

46 The contours thus, represent the best possible prediction of future airport noise levels that was available at that time. The 'Expert Panel' was just that – the largest collection of experts on aircraft noise prediction that has been assembled in New Zealand.

Area of Influence

47 The updated airport noise contours when compared to the earlier version are generally shorter along the main flight tracks to the N-E, S-W and N-W but slightly wider along the eastern side of the airport. This change in shape has resulted in some landowners now finding their properties are no longer inside the contour and some others are now within the area.

48 It is interesting to note that the total area of land covered by the 50 Ldn Air Noise Contour has reduced from 173 km^2 to 131 km^2, i.e. the updated contours are significantly smaller than the previous City

Plan contours (1994 study). This reduction in overall area (and subsequent reduction in future noise impact on the community) was primarily due to the replacement of older noisier aircraft with newer quieter technology and slightly due to improvements in the INM modelling.

49 The following Figure shows areas in green where the 50 Ldn Air Noise Contour has shrunk, and areas where the updated contour is larger, in red.

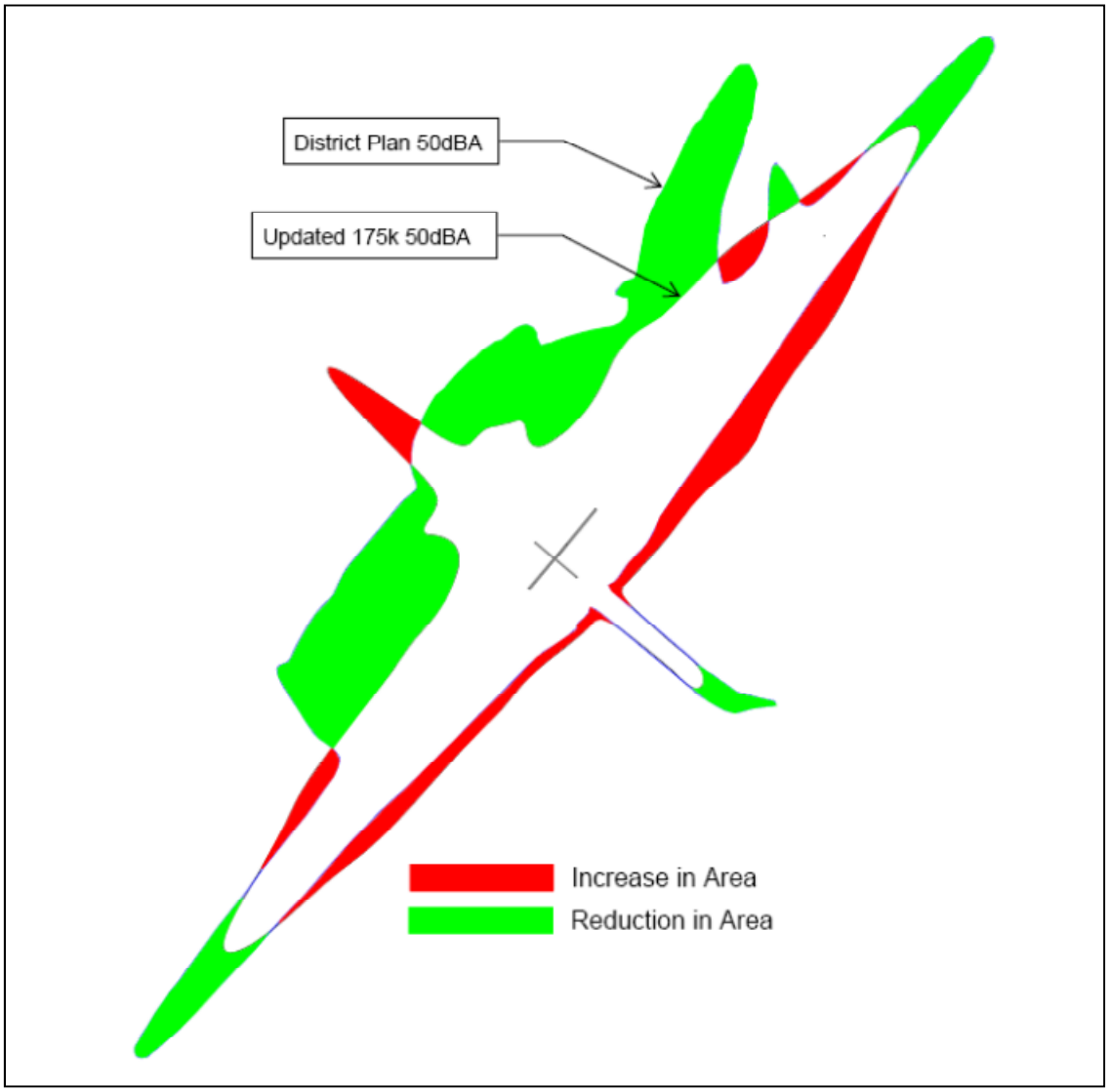


Figure 1 - District Plan vs Updated 175k (50 Ldn Air Noise Contour)

Current Noise Levels

50 It is important to remember that all the noise contours discussed so far are future noise contours based on projections of future aircraft operations when the airport reaches 'capacity'. The current noise

levels produced by current aircraft operations are obviously less than the projected noise contours. The current level of airport activity is approximately 75,000 commercial movements per annum (mpa) (year 2014) and the projected contours are based on 175,000 mpa whenever that figure is reached.

51 Submitters to previous plan change and resource consent applications have often previously commented that they live inside the District Plan noise contours and they don't find aircraft noise a problem. What they have misunderstood is that the District Plan noise contours are for future airport activity where the number of aircraft movements will be almost double the current operations. They will currently be experiencing much lower levels of noise.

Noise Monitoring

52 The Christchurch City Plan (Rule 1.3.5) requires the airport to comply with a noise limit of 65 dB Ldn at the future 65 dB Ldn noise contour and to carry out noise monitoring to confirm compliance.

53 Marshall Day Acoustics have been monitoring noise levels at Christchurch since 2008. The noise levels have generally been measured for a period of three months at locations agreed through discussion with the Council. Measured noise levels and annual compliance contours are published each year in a noise monitoring report.

54 The reports show that the airport has complied with the City Plan noise limits each year from 2008 to 2014.

2015 Noise Monitoring

55 The analysis of last year's operations at CIA has just been completed as part of the annual noise monitoring regime. Staff from CIAL and Airways collate a large database of every commercial aircraft movement at CIA during 2015. Each record includes (amongst other details) type of movement (departure or arrival), time of movement, aircraft type, runway used, destination and is provided to MDA in a spreadsheet.

56 This spreadsheet is then interrogated to determine the busiest rolling three month period for noise compliance assessment. The busiest three months in this case is based on the total movements at the airport per day – all runways combined. The data from this busiest three months is then entered into the INM to produce the 'Annual Compliance Contour (ACC). This is included as **Attachment A** and shows the 2015 ACC is well within the city plan 65 L_{dn} compliance contour thus the airport complies with the city plan noise rule.

57 In 2015 a significant tranche of resurfacing maintenance work was required to be carried out on the main runway (RWY02/20). This work caused aircraft movements to be transferred to the north-west runway (RWY11/29). Because of the infrequent use of RWY11/29 the city plan noise contours over Fendalton are considerably smaller than for RWY02/20.

58 The CIA spreadsheet was thus analysed to determine the busiest three months of activity on runway 29. As expected this three months included the main runway resurfacing period. It is interesting to note that the airport received a number of complaints from residents around Fendalton regarding the noise from the increased number of flights.

59 The spreadsheet data for this period was entered into the INM again and the subsequent contours are included as **Attachment B**. It can be seen that the noise contours from this busiest Runway 29 period lie along the city plan contour in some places. The noise level in this case just complies with city plan noise rule/contours. This result also explains some of the negative response from residents in the area at the time.

Monitoring Tolerance

60 This recent unusual use of RNW 29 almost causing non-compliance with the airport operational noise rule, highlights a potential problem in the future. Other physical occurrences could cause abnormal use of one of the runways – for example, earthquake damage or extreme weather patterns, that could cause a short term and infrequent non-compliance.

61 I recommend that a tolerance of 2dB for exceptional and infrequent circumstances be included in the operational noise compliance rule. Considering that a change in noise level of 2dB is not discernible and that the operational noise contours are based on a conservative capacity (175k mpa) as discussed earlier, this 2dB tolerance is, in my opinion, reasonable.

Remodelling the 2007 Contours

62 Some submitters have suggested that the 2007 contours should be remodelled as part of this Replacement District Plan process. While this is not scheduled to happen until 2017 at the earliest, CIAL asked three of the team that were part of the 2007 re-contouring process (Kevin Bethwaite, Iain Munro, and Marshall Day), the question, "if you did the work again now, is there anything that has changed at CIA (considering future capacity operation) that might indicate that a remodelling of the operational noise contour needs to occur". We were particularly interested in any changes that might have resulted to the assumptions as a result of the Canterbury earthquakes.

63 **Mr Bethwaite** from Airways considered how the flight tracks might now be designed for the future and found no significant changes would be made if the work was done now. **Mr Munro** of Airbiz considered changes to future fleet mix, growth rates, airport capacity and runway allocation. His conclusion was also that nothing has arisen within his field of expertise that would significantly change the noise modelling inputs.

64 MDA have reviewed the evidence of **Mr Bethwaite** and **Mr Munro** and agree that the 2007 Expert Panel contours would not change significantly based on their findings. However CIAL asked MDA to investigate the effect that updates to the INM software might have on the size and shape of the noise contours.

65 Since 2007 there have been four updates issued for the INM software. The reason for this is that computer predictions models such as the INM, have some inherent level of inaccuracy (they are predictions) and consequently they get 'upgraded' with later versions as modelling techniques and manufacturers aircraft noise data are improved and updated. Over the years, MDA has found from extensive noise measurements at Auckland, Queenstown and Wellington airports that the INM was under predicting the noise for some aircraft. We wrote to the FAA on a number of occasions explaining this and received a response that our measurements were wrong. It is interesting to note that subsequent 'upgrades' over the years have increased the noise levels from these aircraft and generally produced larger noise contours.

66 To test the effect later versions of the INM may have on remodelling of the 2007 contours, my colleague Steve Peakall has run the 2007 Expert Panel input data in the latest version of the INM (7.0d). The result is shown along with the 'Expert Panel' contours in **Attachment C**.

67 **Attachment C** shows that the latest version of the INM predicts slightly larger noise contours than the Expert Panel modelling. I recommend these updates and potentially other data updates, are included in the next review of the noise contours, whenever that is deemed to be appropriate.

Helicopter Noise

68 Helicopters were not included in the original INM noise modelling that produced the operational noise contours (1994 and 2007 modelling) so they should not be assessed using the operational noise contours.

69 MDA involvement with noise from Garden City Helicopters revealed that inclusion of noise from the relocated Garden City Helicopters in the compliance modelling, would cause a breach of the 65dBA Ldn

operational noise contour. This approach is inappropriate for the reasons explained in the paragraph above.

70 I recommend that NZS6807:1994 'Noise Management and Land Use Planning for Helicopter Landing Areas' be used to manage the noise from helicopter operations at Christchurch Airport. NZ6807 is similar to NZS6805 in that it recommends establishing a 'helinoise boundary' for the management of incompatible activities, with a reciprocal requirement on operators to monitor and manage noise levels.

ENGINE TESTING NOISE

71 Two quite separate forms of engine testing take place at CIA; On-wing engine testing and off-wing tests in the Engine Test Cell facility.

72 The Engine Test Cell facility is a large industrial building and involves major long term planned maintenance of aircraft engines. Aircraft engines requiring significant overhaul work are removed from aircraft and serviced remotely in specialized maintenance facilities. After the maintenance is completed, the engine is fixed to a test bed inside a specially designed test chamber which is attached to a series of airflow tunnels containing silencing equipment. To ensure the engine meets required performance parameters engine runs at sustained high power settings for long periods are required. On occasion due to post run adjustments repetitive testing may be required. This industrial building and the specialist silencers inside it were designed by MDA many years ago to comply with the normal district plan noise limits for industrial activities.

73 On-wing engine testing, on the other hand, is part of the day to day airport operations and involves relatively short duration intermittent tests as part of routine safety maintenance. The aviation industry has very strict procedures regarding the need to run an engine after engine related maintenance before it can be used in flight. Routine and unplanned work on an engine will often require a period of idling or a short full power run of the engine. I understand, the testing of aircraft engines is an activity that is vital to the operational viability of a major airport with scheduled flights.

74 Noise mitigation for on-wing engine testing noise is difficult in a similar way that it is for aircraft operational noise – because the aircraft is operating 'in the open'. Small differences can be made through location management and time of test and engine enclosures have functional difficulties and relatively low acoustic performance as will be discussed later.

75 Historically, on-wing engine testing at CIA has been managed by the Christchurch International Airport By-Laws: Section 52. Stationary Engine Testing as shown below:

52. Stationary Engine Testing

1) No person shall start up or run an aircraft engine in a hangar

2) Subject to subclause (3) of this by-law, no person shall start up or run an aircraft engine for the purposes of stationary testing in an open space at the airport unless-

a) The total duration of engine testing in respect of any aircraft does not exceed 5 minutes, or

b) The engine testing is carried out in a special facility approved in writing by the airport manager, or

c) The engine testing is carried out at the threshold of Runway 11 or, when Runway 11 is in use, in the holding bay on the main taxiway and under the direction of Air Traffic Control, or

d) The testing is carried out at such other place and in such other manner as shall be approved by the airport manager before the test commences.

3) Nothing in subclause (2) of this by-law authorises the testing of an aircraft engine testing between 2300 hours and 0600 hours unless –

a) The testing is necessary to provide an urgent scheduled flight, or

b) the person responsible for the testing delivers to the airport manager within 24 hours after the testing a report which sets out-

i) The date, time and duration of the test; and

ii) The reason for the test

iii) The date and time for the scheduled flight for which the test was necessary

76 Some time ago, the Council indicated it would like to retire the By-Law and implement specific noise controls for on-wing engine testing within the next review of the District Plan. I understand, CIAL agree with this at a level of principle as the bylaw is not satisfactory. MDA has been involved with the CIAL, Air New Zealand (ANZ) and the Council in developing the proposed controls. This work is explained in detail below, however first I would like to explain the noise parameter proposed to be used for the assessment and management of engine testing noise (L_{dn} 7day).

Engine Testing Noise Parameter

77 There are no New Zealand Standards that are specifically intended to control on-wing engine testing noise emissions. I am also unaware of any specific international standards for the assessment of engine testing noise emissions. Therefore bespoke rules are required as has been the case at most other New Zealand airports.

78 Broadly, engine testing noise is similar to aircraft operational noise, in that it involves short duration moderate level noise events from aircraft jet engines on the wing. Thus typical engine testing noise rules in New Zealand use the Day/Night (Ldn) as used for noise from airport operations – take-offs, landings and taxiing. A lot of on-wing engine testing is very similar to taxiing as the aircraft is at low power for moderate durations. In fact engine testing occurs on some occasions while the aircraft is taxiing to the gate.

79 The concept that short duration intermittent noise sources are controlled and assessed using 'energy averaging' parameters such as L_{dn}, $L_{eq,24hr}$ and $L_{eq,9hr}$, is recognised practice. Relevant examples are aircraft noise, helicopter noise and train noise.

80 New Zealand is the only country that I am aware of that uses a single 15 minute sample (NZS6802) to control the compliance noise level of a source. While 15 minutes may be appropriate for a continuous or cyclical industrial noise source, it is not, in my opinion, appropriate for short duration intermittent noise sources. By way of example, a short duration noise event of 50dB for 5 minutes once per year, would exceed the night-time noise limit of 40 dB and be assessed as 'unacceptable' under NZS 6802. In my opinion, this is an inappropriate concept for intermittent noise.

81 Most engine testing noise rules in New Zealand use averaging over 8 to 24 hours and Auckland Airport uses the 7 day average Ldn (further detail below). 7 day averaging addresses the situation where moderate noise on one night is balanced by relief from noise on a series of other nights. From my professional and personal experience, it is my opinion that this is an appropriate concept.

82 I currently live approximately 800m from the north/south motorway in a suburb in Auckland. I am screened from the motorway by a small hill and the noise level is generally between 35 to 40 dBA most nights. However, when there is a light breeze blowing from a particular direction, the sound is 'bent' over the hill and the noise level at my house is 50 to 55 dB. I would not live there if the noise level, every night, was 50 to 55 dB of continuous noise. The 'average' noise level over the week/month is considered reasonable due to the much lower noise levels at other times and this matches my subjective response. The same principle can be applied to noise

from engine testing experienced at residential properties near the Airport in Christchurch.

83 The noise averaging that is used in engine testing noise rules at other airports around New Zealand can be summarised as follows; Auckland uses 7day averaging. Whangerei, Timaru, Rotorua, New Plymouth, and Nelson all use 24 hour averaging. Hamiton uses night averaging and Gisborne and Palmerston North use 1 hour averaging.

84 The other airports are unusual. Wellington does not allow engine testing between 2300 and 0600hrs but it has a curfew on aircraft operations which is the very situation Christchurch seeks to avoid. Queenstown completely exempts the testing of jet engines from any noise limits and uses NZS6802 (15min parameters) for the small general aviation aircraft maintenance. Tauranga is the only airport that I am aware of, that uses the NZS6805 15 minute sample approach to control engine testing noise.

85 The engine testing noise rules proposed in the notified CRDP are based on the Auckland Airport engine testing rules which use the 7 day L_{dn} parameter. In my opinion this is an appropriate approach for Christchurch.

ENGINE TESTING MODELLING AND MONITORING

86 In order for appropriate engine testing noise controls to be proposed at Christchurch, it was recognised at an early stage that current noise emissions would need to be quantified. Because engine testing involves multiple locations and variations in time, a spatial and temporal understanding of noise emissions was thus necessary.

87 This led to the development of the Engine Testing Noise Monitoring Software (*ETMS*) that could calculate noise emissions at multiple receiver locations, based on actual records of engine testing that had occurred at multiple source locations.

88 In addition to this, the software and database records were used to model the worst case engine testing noise contours for various scenarios as discussed in detail below. The bulk of this technical work has been carried out (under my supervision) by my colleague, Mr Steve Peakall and he is available at this hearing to answer detailed questions if required.

Engine Testing Activity Data

89 In order to be able to quantify the level of engine testing noise in the community, it is necessary to know what engine testing activity has previously occurred.

90 Records of night-time testing have been formally collated since late 2010, and these specific details were incorporated into the ETMS to enable accurate noise calculations to be undertaken.

91 Maintenance staff record a detailed set of information including the type of engine testing activity, aircraft model, date and time, wind direction, and speed, duration of each engine 'on' time, power setting and aircraft orientation, as well as the location of the test. This data is then sent to CIAL for their records and entered into the ETMS by Marshall Day Acoustics. These records are then used to calculate community noise exposure for different locations using the ETMS. An example of the report required from maintenance staff can be found in the Ground Running Procedures attached to **Mr Boswell's** evidence.

92 It is noted that until 2015 only tests carried out by Air New Zealand engineers were recorded, and that daytime tests were not being regularly recorded. This means that in some cases engine testing events, particularly the daytime Antarctic ground run events were not input automatically into the database. Daytime records are now being collected.

Noise Source Data

93 An essential component of the ETMS calculation procedure is a detailed knowledge of the noise level emission levels of each aircraft type. This information includes noise level and directivity patterns and a variety of engine settings for each aircraft. This data has been collected via noise measurements at Christchurch and elsewhere, in conjunction with noise emission data sourced from aircraft manufacturers.

94 For each type of aircraft on which engine testing occurs at Christchurch, noise level emissions data has been sourced through a literature review and discussions with the manufacturers, the main exceptions being the B757 and P3 Orion.

95 Data for these two aircraft types were not available at the time of the ETMS development. Because of the limited number of tests that occur for these aircraft types, estimates of the noise emissions have been used. Any inaccuracies in these estimates are not expected to significantly affect the overall community noise levels. Detailed data for the C130 Hercules has been added in the last year.

96 Noise emission data comprises noise level measurements in polar plot form, for various engine types and under various thrust settings. This enables a fully comprehensive set of noise emissions data to be used. All manufacturer noise emission data is based on-site noise measurements of aircraft, with measurements occurring

under reference meteorological conditions and at reference microphone positions.

97 Marshall Day Acoustics has undertaken a number of noise measurements in close proximity to various aircraft engine test events at Christchurch and these have been complimented by measurements at locations in the community. These noise level measurements have been used to ensure that the manufacturers' data is accurate, and represents actual engine testing noise levels in practice. The noise measurements ensure that noise emissions data used in the calculations is accurate.

Computer Noise Modelling

98 Computer noise modelling was then employed to calculate community noise exposure levels for a number of different scenarios. The noise levels calculated at the initial stage was sound pressure levels at the 16 receiver locations.

99 The verified noise emissions data was used in noise modelling software to calculate noise levels for each possible engine testing scenarios at each receiver location. The purpose of this is develop a database of noise levels received at each location for each scenario so that differing noise exposure levels in the community can then be calculated.

100 Each scenario is based on a specific:

- Aircraft type
- Power setting
- Orientation
- Location

101 Based on these parameters there are more than 300 operating scenarios which have been calculated.

102 Computer noise modelling was carried out using SoundPLAN, an internationally recognised computer noise modelling software package.

103 In summary, a digital topographical model of the area of interest was entered into SoundPLAN together with locations of the noise sources (noise levels have been predicted in accordance with the algorithm detailed in ISO9613-2: 1996- Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation (ISO9613) as implemented in SoundPLAN.

104 ISO9613 considers a range of frequency dependent attenuation factors, including spherical divergence, atmospheric absorption, ground effect, acoustic screening and directivity effects. It assumes meteorological conditions favourable to propagation from sources (downwind at wind speeds 1 -5 m/s in all directions), and as such, calculates slightly conservative sound levels.

105 The directivity effects that have been included are taken from the manufacturers' noise emission data, with the exception of the C130, which has been developed using directivity data from INM ground run up calculations.

Engine Testing Noise Monitoring Software (ETMS)

106 The calculated sound pressure levels for each one of the above operating scenarios are then compiled into a database in the ETMS. It is the ETMS that is then used to calculate community noise exposure based on this noise level database and the historic records of time/duration of each operation activity.

107 The Engine Testing Monitoring Software has been developed by Marshall Day Acoustics for CIAL. It is similar in concept to the software used to show compliance with the general aircraft noise emissions (INM) in that it is based on the records of the actual engine testing that has been carried out.

108 As discussed above, aircraft maintenance staff record a detailed set of test information (including of the type of engine testing activity, aircraft model, date and time, wind direction, and speed) into the software so that the noise exposure levels can be calculated in the nearby community. It is intended that the ETMS will be used as the basis for on-going monitoring and reporting of compliance with the proposed District Plan rules, following them being made operative.

109 In summary, the ETMS was used to calculate community noise exposure using the following methodology:

- Marshall Day Acoustics reviewed all engine testing activity at CIA between January 2011 and December 2014, which included the various aircraft locations and orientations;
- 16 representative receiver locations around the airport were used, to ensure noise levels were assessed with an appropriate spatial representation; and
- At each receiver location the worst case week (from all weeks January 2011 - December 2014) of noise levels was calculated. The worst case week was in some cases different for each receiver, depending on the location of engine testing activity relative to that receiver.

Engine Testing Noise Contours

110 The ETMS was used to calculate worst case historic noise emissions between 2010 and 2014 so that the extent of community noise impact could be determined, and appropriate noise controls developed.

111 Using this data, the worst case noise levels at each location were reviewed to ascertain what engine testing activity was responsible. This activity was then entered into SoundPLAN noise modelling software to calculate a set of worst case noise contours for each location.

112 This set of worst case noise contours was then overlaid on a map and the outer extent of each contour was drawn, creating one overall worst case Christchurch Airport engine testing noise contour.

113 In addition to this, to account for expected growth over time of engine testing activity, an allowance of 60% growth was included. This is based on information provided by Air New Zealand, and is consistent with the expected growth of the general Airport operations. This future growth is consistent with that allowed for under the expert panel general airport contours that were the subject of the Regional Policy Statement Plan Change 1.

114 These noise contours became known as the Engine Testing Noise Control Boundaries (*ETNCB*) and are attached as **Attachment D**.

115 Following the analysis of the worst case noise level predictions, it was determined that daytime records had not been provided to MDA prior to 2015. An extensive review by Air New Zealand and CIAL staff enabled collation of all daytime records previously missed. There were no daytime tests undertaken in the worst case weeks described above, so the original ETNCB remain valid. I note also that daytime tests are 10 times less significant than night-time tests because of the nature of the Ldn metric.

116 Further analysis was also undertaken specifically for Antarctic Operations. All Antarctic tests occur during daytime, but it was recognised that these occur for significant durations on each occasion, and are often concentrated in a particular week. Specific calculations of daytime worst case Antarctic operations show that noise exposure in the community was approximately 7 decibels lower than the ETNCB. This is primarily due to the daytime nature of these tests, and that for the majority of the time the tests are conducted at idle power (lower noise levels). It is considered therefore that the ETNCB remain a valid representation of the worst case engine testing noise exposure at Christchurch (including daytime operations and Antarctic operations).

Constrained Engine Testing Contours

117 These 'worst case' Engine Testing noise contours developed above were forwarded to the Council after request and subsequently included in the notified CRDP. The contours cover a slightly larger area than the Operational Noise contours with a 'bulge' around the Bishopdale area. The additional residential properties contained in this area were proposed to be subject to land use planning (LUP) controls similar to the operational noise LUP controls.

118 A number of residents living in this area have submitted against these LUP provisions and some attended the mediation session in December 2015 and expressed their concerns. Steve Peakall and I attended this mediation session. Prior to mediation MDA, CIAL and Air New Zealand had worked on mitigation options to determine whether the 'worst case' scenario used in the modelling could be mitigated to reduce the size of the Engine Testing contours. By moving test locations and limiting some night-time testing, an alternative 'average busy week' was developed by Air New Zealand.

119 A revised set of constrained, contours were produced at mediation and have now been produced formally as part of CIAL relief. These contours are noticeably smaller than the notified contours and fall within the operational noise contours (see **Attachment E**). I understand that Air New Zealand and CIAL are comfortable that while these contours are a significant reduction on what has occurred occasionally in the past and effectively include no growth, they can proceed with them as the basis of a noise control rule.

Ground Running Enclosure

120 As mentioned previously, stationary aircraft need to face into the wind to run their engines under test. Thus any noise enclosure needs to be relatively open to allow air to flow freely to the engine. Three sided enclosures without a roof can work if sufficiently large and do provide some noise mitigation. A photograph of a typical GRE is shown below.

121 Preliminary investigations of a ground running enclosure (GRE) were presented at the mediation meeting. A number of requests for further information were made during mediation and that information has been provided to those who attended. One of the issues raised in mediation was the acoustic performance of a proprietary GRE – submitters were surprised that our modelling was showing a noise reduction in the residential area of only 5dB when the manufacturer claim 15dB.

122 My colleague, Mr Peakall met with Dr Chiles in Auckland and opened our calculations to him. I understand from discussions and from Dr Chiles's evidence, that he agrees with our calculation procedures and agrees with our finding that while the performance of the GRE may be 10 to 15dB close to the enclosure, at large distances the noise reduction will be very much less – 0 to 5dB.

123 During the meeting with Mr Peakall, Dr Chiles suggested an alternative orientation of the GRE to improve its performance. This option has been modelled along with the original orientation opening to the north-west and the results are shown in the noise contours on **Attachment F and G** attached.

124 Mr Peakall has also calculated the noise reduction achieved at specific residential locations as shown in the Figure below, with the GRE opening to both the NW and to the NE as requested by Dr Chiles.

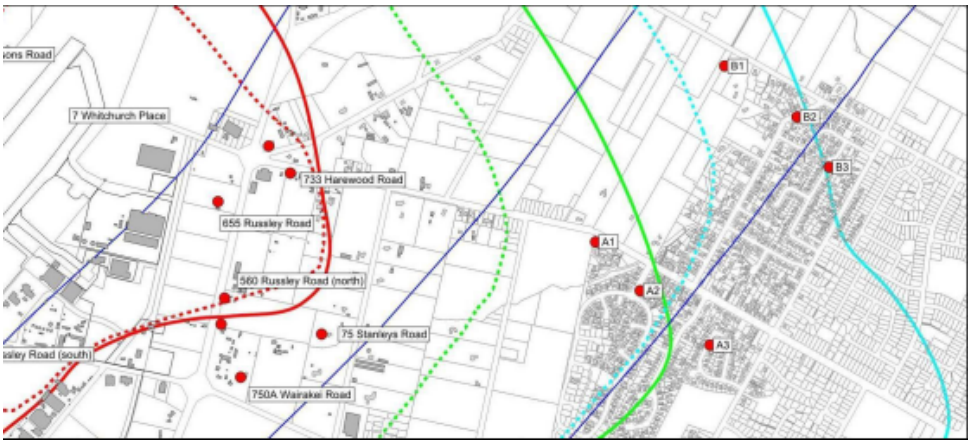


Figure A – Bishopdale Receiver locations

125 The calculated GRE noise reduction for each location is shown in Table A below.

Table A – Ground Running Enclosure Noise Reduction

Receiver Location	GRE in NW Orientation	GRE in NE Orientation
Position A1	1 dB	2 dB
Position A2	2 dB	3 dB
Position A3	2 dB	3 dB
Position B1	2 dB	0 dB
Position B2	1 dB	1 dB
Position B3	1 dB	1 dB

126 The table shows that the reductions achieved by the GRE in either orientation, are in my opinion small (2dB reduction is not discernible). I understand from Air New Zealand that the cost of a GRE large enough to accommodate the A320 would be in the order of $12M. Whether this small noise reduction versus cost means the GRE would meet the 'best practicable option' (BPO) under section 16 of the RMA, is outside my area of expertise. Dr Chiles says in paragraph 6.7 of his evidence, that under NZS 6806 for road traffic noise, noise mitigation is not implemented unless it provides 3 to 5 dB noise reduction, depending on the number of 'receivers' involved. To me this confirms 3 to 5dB of mitigation is of marginal benefit.

Engine Testing Noise Rule

127 The culmination of all this work was that a set of engine testing noise rules were included in the notified CRDP. In concept, the rules specify a noise limit (Ldn 7 day) that is not to be exceeded at 5 'monitoring' locations spread around the airport. Noise levels are to be calculated for compliance from existing noise emission data and daily records of engine testing events. The calculations are to be verified by a selected number of measurements every two years.

128 There has been significant discussion with the Council as to the precise wording of these rules and I will leave Mr Bonis to comment on the best form that these should take. On the technical side, the noise limit needs to be lowered or the monitoring locations moved, to accommodate the 'constrained engine testing noise contours.

129 The calculations of noise mitigation from a GRE highlight the fact that the mitigation achieved varies with distance. The current version of the Engine Test Noise (ETN) rule, has the monitoring locations clustered around the 65 dB L_{dn} contour. To give the residents additional protection, I recommend that a few monitoring locations on the 55 dB L_{dn} contour are added to the implementation of the rule. This is a relatively simple matter.

130 Finally, it is my opinion that the ETN rule should include a tolerance of 2dB for exceptional and infrequent circumstances so that CIAL does not have a short term period of non-compliance during the life of the plan which would trigger the need for a consent. Dr Chiles has pointed out in his evidence that teething problems may be experienced with the use of the ETMS for compliance. Considering that a change in noise level of 2dB is not discernible and that the 'worst case' scenario and growth have been eliminated in the constrained contours, this 2dB tolerance is, in my opinion, reasonable.

COMMUNITY RESPONSE TO NOISE

131 What level of airport noise is acceptable for residential activity? The general philosophy is that there are no significant adverse effects from airport noise below 45 dB Ldn. However, above 65 dB Ldn the adverse effects are generally agreed to be serious. Clearly there is not a sudden point at which noise effects 'switch in' — it is a sliding scale. This sliding response is shown by the research into community response to noise.

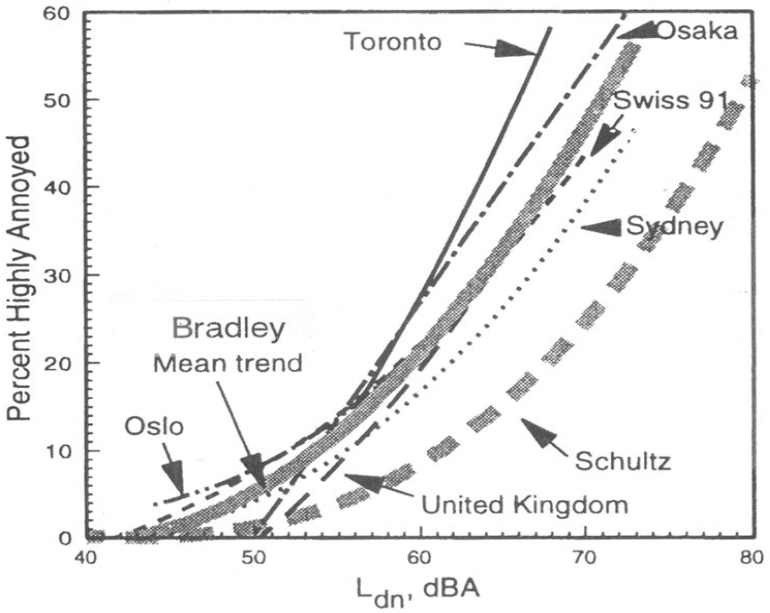
132 In 1978 Schultz (ref 1) combined the results of 11 different community response studies to produce a curve of the percentage of people highly annoyed versus transportation noise level Ldn. The studies involve the number of different transportation noise sources

(trains, road traffic and aircraft etc). The Shultz curve is shown in Figure 2 below as the thick 'dashed' curve.

133 I was involved with a review of the New Zealand Standard NZS6805 during its drafting and the Schultz curve was used in the development of the land use planning guidelines in the Standard.

134 In the 1990's, Bradley [ref 2] combined the results of a number of specific aircraft noise studies, to provide a relationship for community response to airport noise. The resulting graph (Figure 2 below), shows the various individual airport studies and the overall 'Bradley Mean Trend' for all studies.

Figure 2 - Community Response to Aircraft Noise (Bradley ref2)



135 A later synthesis by Miedema 1998 [ref 4] of further research at additional airports, shows slightly lower levels of annoyance (Figure 3 below). Miedema updated this work in 2001 [ref 6] and the resultant annoyance curve showed a slightly higher level of annoyance than the 1998 study (11% vs 9% HA at 55dB Ldn).[2]

136 In 2002, Taylor Baines and the Christchurch City Council carried out a detailed study of community response to different types of noise in various areas of Christchurch.[3] The purpose of this exercise was to see whether Christchurch people were less sensitive to airport noise than the overseas studies indicated to determine whether the overseas studies could be relied on. Taylor Baines used a paper by Fields [ref 5] to ensure the community response questions were

[2] **See Affidavit of Chris Day filed at the Residential hearing 22 April 2015.**

[3] **Exhibit 15, Residential hearing.**

consistent with those used in the overseas research. The study analysed responses from approximately 450 houses exposed to aircraft noise levels from 45 to 67 dB Ldn.

137 Marshall Day acoustics analysed the data gathered during the Taylor Baines study to produce a trend line demonstrating the percentage of people highly annoyed by aircraft noise for Christchurch for comparison with the overseas research.[4]

138 The results of the Christchurch analysis are shown below in Figure 3 along with the Bradley (1996) and Miedema (1998) studies discussed above.

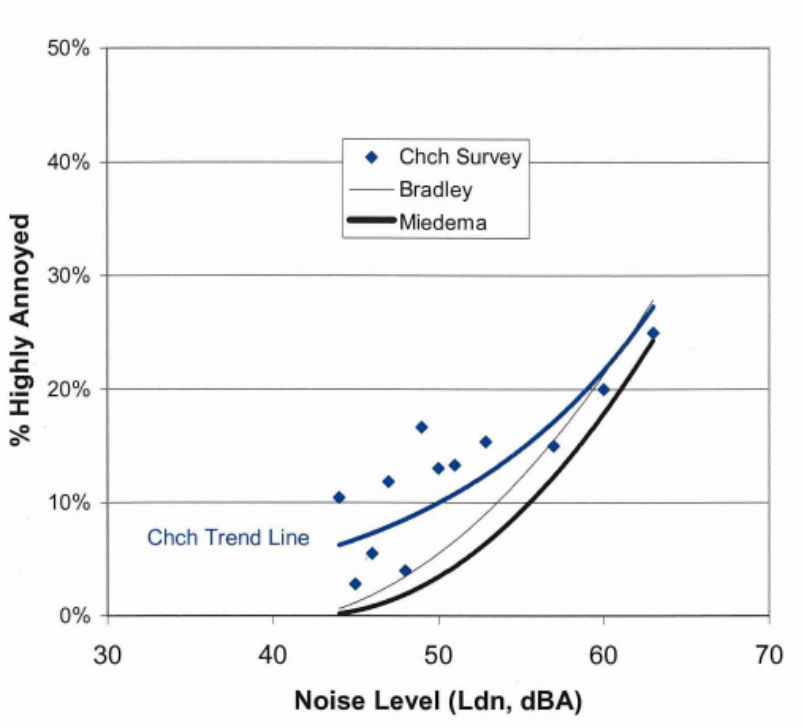


Figure 3 - Community Response to Aircraft Noise (Christchurch)

139 Figure 3 shows the characteristic spread of results for a community noise survey showing the highly variable response within the population. However, the 'Christchurch Trend Line' (blue line) shows an exponential 'best fit' curve of the summed data.

140 This trend line shows that Christchurch people in the lower noise areas (Ldn 45 to 55 dBA) are more annoyed than the synthesis of surveys from overseas – Bradley and Miedema. For people living in

[4] **See affidavit of Chris Day dated 22 April 2015 for explanation of methodology and raw data.**

Christchurch, the study shows 10% to 15% of people are highly annoyed in the 50 to 55 dB Ldn area. By comparison, the overseas studies show 3% to 12% of the population are highly annoyed in this noise band.

141 Appendix B provides a graph from the Miedema 2001 study which shows that aircraft noise is noticeably more annoying than both road traffic noise and rail noise.

142 The 1994 noise contours and land use planning controls starting at 50dB Ldn were adopted in the notified Christchurch District Plan in 1995. There were also a number of unsuccessful applications for noise sensitive activities inside the 50dB Ldn prior to the Taylor Baines study in 2002 (notably Gargiulo 2000).[5] The adoption of the 50dB Ldn protection in the 1990s was based on the overseas community response data.

143 In my opinion, both the Christchurch data and the overseas data confirm that the 50dB Ldn plus environment is not a sensible location for new noise sensitive activities, if it can be easily avoided.

LAND USE PLANNING CONTROLS

144 Land Use Planning can be an effective way to minimise population exposure to noise around airports. Aircraft technology and flight management, although an important component in abating noise, will not be sufficient alone to eliminate or adequately control aircraft noise. Uncontrolled development of noise sensitive uses around an airport can unnecessarily expose additional people to high levels of noise and can constrain, by public pressure as a response to noise, the operation of this significant resource.

145 It is interesting to note that the New Zealand Standard's starting point for new residential development located between the OCB and ANB is to prohibit it (unless the District Plan permits it subject to sound insulation). Local authorities have approached this differently around the country but it is significant that Christchurch City have to date taken a 'mid way' position and have restricted densities in conjunction with requiring sound insulation rather than out-right prohibiting new dwellings in this area (OCB to ANB).

146 By way of comparison, Queenstown have prohibited new noise sensitive activities inside the OCB for rural land (existing entitlement within residential zones is allowed to proceed with mitigation).

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[5] ***Gargiulo v Christchurch City Council*** **High Court, Christchurch AP32/00, 6 March 2001.**

Historical Land Use Protection

147 As stated earlier, the location of the OCB at most New Zealand airports is generally based on the projected 55 Ldn Air Noise Contour. However, NZS 6805 does state in paragraph 1.1.4 that "This Standard shall not be used as a mechanism for downgrading existing or future noise controls…"

148 The Waimairi section of the Transitional Christchurch District Plan has historically included a 'Noise Exposure Line' which is located near the projected 50 dB Ldn airport noise contour.

149 If intensification were allowed inside the noise contours in Christchurch, this would be a significant 'downgrading' of the previously existing noise controls from an acoustics perspective.

District Plan General Noise Limits

150 Because other airports have generally not used 50dB Ldn as the onset of land use planning controls, 50dB Ldn may be seen as unusual or 'highly conservative'. By way of comparison, however, the operative City Plan sets the noise limit for protection of Living 1 to 4 Zones as 49dB Ldn.[6] This gives an indication of what the Council has seen as a reasonable 'receiving noise level' for the protection for residential amenity in the Christchurch context.

151 I understand that via the notified pCRDP the following activities (broadly) have been classified as 'sensitive activities to aircraft noise - residential activities, education activities including pre-schools, and health care facilities.

152 In my opinion, it is reasonable that all these uses should be protected to a level of 50dB Ldn from general noise sources as they are in the general district plan noise rules. It is therefore equally reasonable that these same uses should not be allowed to establish next to an existing noisy activity at levels higher than 50dB Ldn.

Complaints

153 At the various hearings in which I have given evidence about noise associated with airports, I often hear, "But there aren't many complaints at the moment" and "I live in this area and the planes don't bother me".

154 There are a number of reasons for the lack of complaints about aircraft operational noise from Christchurch Airport. Firstly, the historic land use planning has meant that there are relatively few people exposed to aircraft noise at Christchurch. Secondly, people do not complain if they know their complaints are likely to have no

[6] **Operative Christchurch City Plan, Volume 3, Part 11 Health and Safety, 1.3 Specific Rules – Noise Control.**

effect. If the airport is operating in its normal mode and they are annoyed, they know nothing can be done about the noise. When the airport changes an operation (flight paths or runway length) then significant complaints can arise. The recent trial in Auckland of alternative arrival procedures caused the number of complaints to jump from 2 per month to a maximum of 500 per month.

155 The comments that "I live in this area and the planes don't bother me", overlook the fact that the noise contours (and thus land use planning) are based on future noise levels – not current noise levels. The number of aircraft movements in the 'Expert Panel contours' adopted, are over double the current movements.

156 The Taylor Baines study shows that of the relatively few people exposed to current levels of aircraft noise at Christchurch there are a number who are 'highly annoyed' but are not complaining.

SOUND INSULATION

157 Some advocates of residential development in areas affected by aircraft noise have submitted that sound insulation fitted to proposed dwellings is sufficient on its own to avoid the adverse effect of noise and to protect the interests of the Airport. I understand the argument to be, that sound insulation provides sufficient mitigation, regardless of the population density of the land involved. In my opinion, this assertion, that sound insulation is all that is required to prevent reverse sensitivity effects, is incorrect for a number of reasons.

158 Firstly, the level of sound insulation required in the 50 to 60 dB Ldn area is provided by a standard house. No additional construction techniques or materials are required in this area. However, 5% to 18% of the population is still typically highly annoyed by aircraft noise in this environment, even though they have the opportunity to close their windows and achieve 'WHO satisfactory noise levels' inside. This is why sound insulation, on its own, is insufficient and land use controls in the form of density restrictions are the only real form of mitigation available in this case.

159 Secondly, houses exposed to aircraft noise, are likely to operate with their windows closed to reduce internal noise levels, particularly at night. Three scenarios are then likely:

159.1 the windows are kept closed resulting in an unsatisfactory level of fresh air; or

159.2 a ventilation system or air-conditioning system is installed to improve air quality at significant cost; or,

159.3 the windows are left open resulting in an unsatisfactory noise environment.

160 Each of these scenarios is likely to result in complaints from the residents. It is interesting to note that residents involved in the Auckland Airport mediation forum were shocked to learn that they would have to shut their windows to achieve an acceptable internal noise environment.

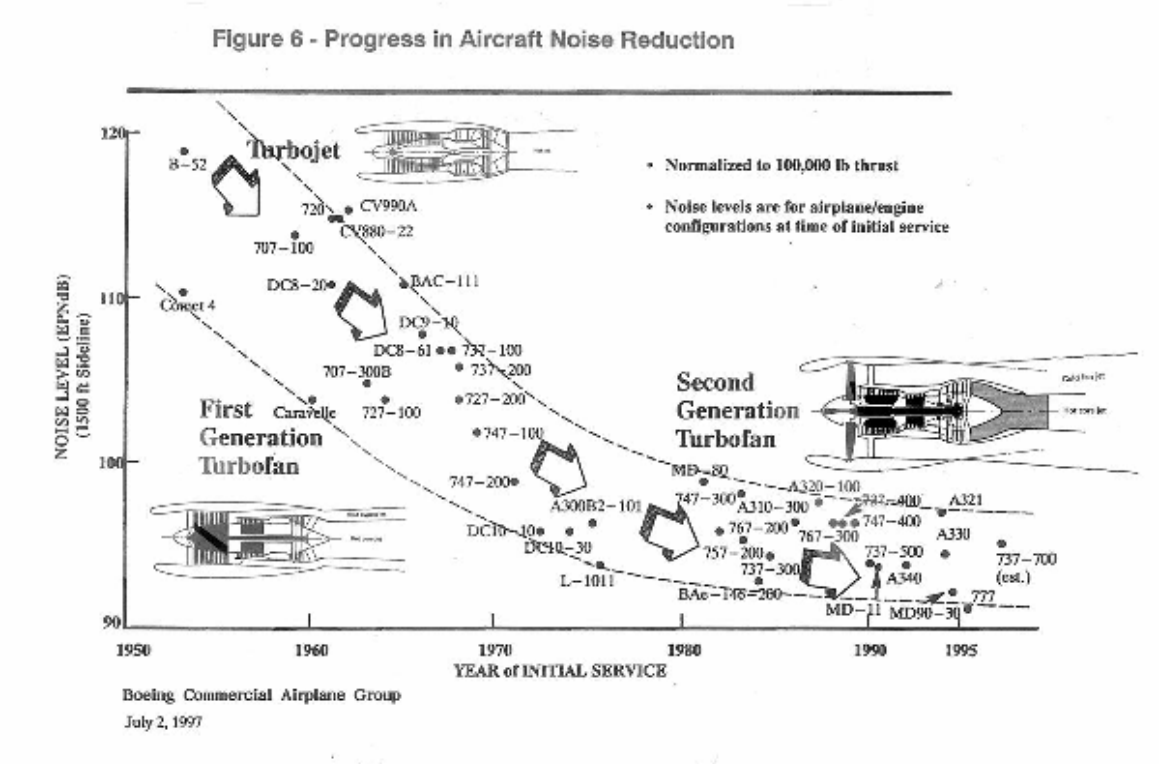
161 The third difficulty with sound insulation is that it does not deal with the outdoor noise environment. New Zealanders in general, enjoy an 'outdoor' type of lifestyle that includes barbecues and gardening. This is particularly the case in rural areas where people have more outdoor space and an expectation of enjoying it. Again, an unsatisfactory external noise environment is a potential source of residential complaint with demands to reduce noise, affecting airport operations. There has been a history in New Zealand of people moving into lifestyle blocks and complaining about noise from already existing activities within the rural zone e.g. bird scarers in vineyards. Minimising the number of people affected by airport noise by restricting residential development is the most effective form of mitigation available in this case.

162 As discussed earlier, sound insulation does not solve the problem for hospitals and education facilities as they are heavily reliant on open windows.

163 As discussed earlier, the New Zealand Standard refers to sound insulation as a fallback mitigation measure. In my opinion the Standard prefers to 'avoid' the effects of airport noise, ahead of mitigation. Table 2 in the Standard states that new residential inside the OCB "should be prohibited unless a district plan permits such uses, subject to a requirement to incorporate appropriate acoustic insulation."

164 In my opinion, the issues set out above, highlight why partial mitigation through sound insulation is a much less desirable option to avoiding the effects of airport noise through appropriate land use controls. Section 17 of the Resource Management Act states the duty to "avoid, remedy or mitigate" adverse effects. However, in my opinion, 'avoiding' is the preferable option in this case.

165 In terms of mitigation, it is worth noting that the airline industry as a whole, has spent billions of dollars mitigating noise from aircraft with the development of 'quiet technology' engines over the last 20 years. Figure 6 below, shows the reduction in noise level for the different aircraft types over time.



166 The question was asked at the Residential Hearing, "What has happened with aircraft noise reduction since 1997 (the extent of the above graph)?" Analysis of the ongoing noise monitoring at Auckland Airport shows that the recently released aircraft are not as quiet as had been anticipated – the A380 produces the same noise level as a B777 and the B787 Dreamliner produces approximately the same noise level as a B737. These newer aircraft carry more passengers for the same noise but it confirms the above 'curve' has flattened out.

167 It is interesting to note that despite this very significant noise reduction achieved over 40 years that during this time there has been a significant increase in the noise restrictions placed on airports and flight procedures as shown in Figure 7 below prepared by Boeing.

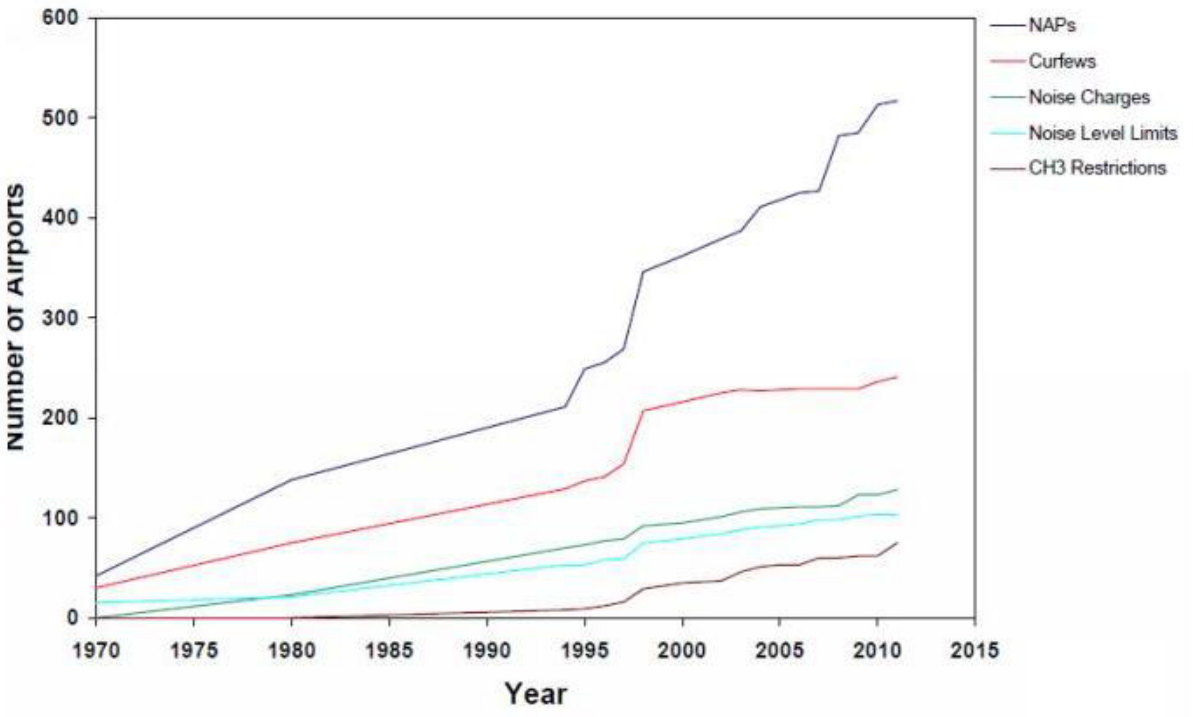


Figure 7 - Growth in Airport Noise Restrictions

AVOIDANCE OF NOISE SENSITIVE ACTIVITIES WITHIN THE ENGINE TESTING NOISE CONTOURS

168 I understand that CIAL has sought provisions which avoid noise sensitive activities within the 50 Ldn Air Noise Contour and the 50 Ldn Engine Testing Contour.

169 I understand that there is no express rule in the RPS for reverse sensitivity and amenity effects in respect of engine testing noise. However, in my opinion, the same principles should apply in relation to the noise generated from on-wing engine testing at Christchurch Airport as they do for the aircraft operational noise discussed at length above.

170 In my opinion, from an acoustic perspective, new noise sensitive activities should be avoided within the 50 Ldn Engine Testing Contour in the same way and for the same reasons as they should be avoided under the 50 Ldn Air Noise Contour.

EVIDENCE OF DR STEPHEN CHILES

171 Dr Chiles's evidence primarily deals with the engine testing noise issue and briefly discusses aircraft operational noise. Dr Chiles generally agrees with our approach to engine testing noise modelling and calculations of noise mitigation but disagrees with our method of assessment of noise effects from engine testing. I will discuss these differences under three main headings; Sleep Disturbance and Averaging, Existing Noise Environment and Cumulative Noise.

Sleep Disturbance and Averaging

172 Dr Chiles and I differ significantly on our assessment of the noise impact from the current engine testing operations. The basis behind Dr Chiles assessment is contained in his paragraphs 3.4 and 5.1 to 5.6. In paragraph 3.4 he implies that normal 'NZS 6802' outdoor night-time noise limits of 40/45 dB $L_{Aeq(15\ min)}$ are based on the *"30 dB guidance level recommended by the World Health Organisation for avoidance of sleep disturbance"* indoors (15 dB is normally allowed, for the difference between indoor and outdoor noise levels with windows ajar).

173 In my opinion this is a fundamental misinterpretation of the WHO guidelines and the New Zealand approach to noise control. The critical information that Dr Chiles has overlooked is that the WHO guidelines include significant averaging. The 1999 WHO 'Guidelines for Community Noise' (ref 7) uses 8 hour averaging for the night-time L_{Aeq} and the more recent 2009 WHO 'Night Noise Guidelines for Europe' (ref 8) uses one year averaging of the 8 hour night-time L_{Aeq}. The L_{dn} 7-day concept used in the CRDP engine testing rules lies somewhere between these two versions of averaging and is in my opinion, appropriate.

174 In my opinion, the NZS 6802 40/45 dB $L_{Aeq(15\ min)}$ is applicable to continuous noise and NZS 6802 uses L_{Amax} controls to avoid sleep disturbance from intermittent events. The 1999 WHO 'Guidelines for Community Noise' (ref 7) states on page xii of the Executive Summary, *"When noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided."* On-wing engine testing at Christchurch is not continuous noise.

175 Sleep disturbance involving awakenings is primarily controlled in New Zealand using the L_{Amax} parameter and most District Plans use an L_{max} limit of 70 or 75 dB. This approach is intuitive also – we are awoken by short startle events of moderate level, not a continuous level of for example, 35 dB from a heat pump.

176 The 70/75 dB L_{Amax} used in New Zealand is based on overseas research that suggests sleep is protected at 55 dB L_{Amax} in bedrooms depending on the number of events. The overall sleep disturbance over the night from 20 events at 60 dB is greater than only one event at 60 dB.

177 The engine testing records at Christchurch and our modelling show that the more stringent criteria of 70 dB L_{Amax} is not exceeded in the residential areas. While residents in the Bishopdale area are subject to moderate levels of operational noise and engine testing noise on an energy noise exposure basis (50 to 55 dB Ldn), it is my opinion, that sleep disturbance is not a significant issue for reasons described above, both currently and in the future with the proposed noise controls.

178 Dr Chiles statement in paragraph 3.10 that *"sometimes the engine testing results in sound levels at nearby houses that significantly exceeds thresholds for protection from sleep disturbance by over 20 dB"* is incorrect. As shown in the above discussion he does not take into account the averaging used in the WHO criteria and he does not consider the L_{Amax} sleep disturbance criteria used in New Zealand of 70/75 dB.

Existing Noise Environment

179 In paragraph 3.6 of his evidence, Dr Chiles is critical of my reference to the existing noise environment – moderate levels of airport noise. In my opinion any assessment of noise effects should consider the existing noise environment.

180 When looking at sleep disturbance, which appears to be the focus of Dr Chiles' concerns, it is important to look at the noise level from individual events that have the potential to cause awakenings (as discussed above). Mr Peakall has carried out calculations of aircraft departure noise as received in Bishopdale (position A1 as shown in Figure A paragraph 124).

181 In summary, jet aircraft taking off to the north on Rwy 02 produce L_{Amax} noise levels at position A1 of 68 dB for a Boeing B767 and 61 dB for an Airbus A320. During 2015 these events occurred on average six times per night (when RWY 02 is in operation). By comparison, Mr Peakall's analysis of the engine testing records shows typical engine testing activity produces the following noise environment at position A1;

- 50 dB for 15 minutes every night (ATR idle);
- 45 dB for 15 minutes once a week (A320 idle);
- 60 dB for 5 minutes once per week (ATR full power); and
- 65 dB for 5 minutes once every 6 weeks (A320 full power).

182 All these levels (operational noise and engine testing noise) are below the normal sleep disturbance criterion of 70 dB L_{Amax}. The regular idle testing is at a much lower sound level than the aircraft events and the infrequent full power test have a similar L_{Amax} to the aircraft departures.

183 The physical relationship of the noise receiver to the noise source also needs to be considered. The effects of aircraft operational noise go out as far as Kaiapoi (17 kilometres) and it is reasonable to expect that people who live in Bishopdale, one kilometre from an international airport, will experience moderate levels of operational noise and engine testing noise. However, the effects of this 'airport noise' are considerably less than it is at most other international airports.

Cumulative Noise

184 In paragraph 5.5 Dr Chiles discusses the cumulative effects of the combined operational noise and engine testing noise. In my opinion this is not a significant issue for the following two reasons.

185 First of all, the level of engine testing noise is slightly less than the level of operational noise in the Bishopdale area. Therefore the cumulative or combined noise level from both forms of airport noise would cause an increase in total noise of, at the most 1 to 2 dB. As discussed many times in the past, a change in noise level of 2 dB is not discernible.

186 The second reason is that if adopted, the combined levels would be incorporated/accepted in the various controls. In paragraph 5.5 Dr Chiles suggest that *"if engine testing were to be controlled using an L_{dn} criterion, I consider it should combine all operational airport and engine testing noise*." If this approach were to be adopted, then the combined noise contours would be slightly larger (by approximately 1 to 2 dB) and the land use planning and compliance controls would be based on these slightly larger contours. This is the approach recommended in NZS 6805 which says, broadly, 'take the existing level of airport activity, add growth and use this level of noise (shown as contours) for land use planning and noise control purposes.' Under this approach the existing level of engine testing noise would be deemed to be reasonable.

187 Dr Chiles appears to agree with this concept in his discussion on Helicopter noise. In paragraph 10.7 he discusses the cumulative effects of helicopter noise and fixed-wing operational airport noise. His final sentence says *"Therefore, if helicopter noise were to be included in the operational airport controls the operational airport contours would first need to be revised and enlarged."*

188 Thus it is my conclusion that the cumulative effects of engine testing noise, fixed-wing operational noise and helicopter noise are not a significant issue as they can be dealt with in a combined set of contours which allows the existing engine testing noise to continue or with specific engine testing rules, also based on the current levels of engine testing noise.

CONCLUSION

189 Christchurch Airport is in a unique position in that historically a buffer zone around the airport has been maintained to avoid the adverse effects of aircraft noise on people and secondly, to provide protection for the airport against reverse sensitivity effects.

190 However, it is not just the Airport that needs protection from reverse sensitivity effects – it is important to avoid unnecessarily exposing additional people to the adverse effects of airport noise.

191 In my opinion, the land use planning provisions in the Christchurch Plan should be maintained to ensure intensification inside the airport operational noise contours and the engine testing contours is not allowed to occur to achieve both these objectives.

192 The airport noise management procedures for aircraft operational noise should be maintained and new rules to control noise from engine testing are proposed.

Dated: 17 February 2016

Christopher William Day

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2. Bradley (1996) "Determining Acceptable Limits for Aviation Noise", Internoise 96.

3. Southgate (2000) "Rethinking Our Approach to Aircraft Noise Information – Going Beyond the ANEF" . Acoustics Australia Vol 28 (2000) N. 1-11

4. Meidema (1998). "Revised DNL – annoyance curves for transportation noise. In N.L. Carter & R.F.S. Job (Eds.) Noise as a Public Health Problem (Noise Effects '98) Vol. 1, pp. 491-496.

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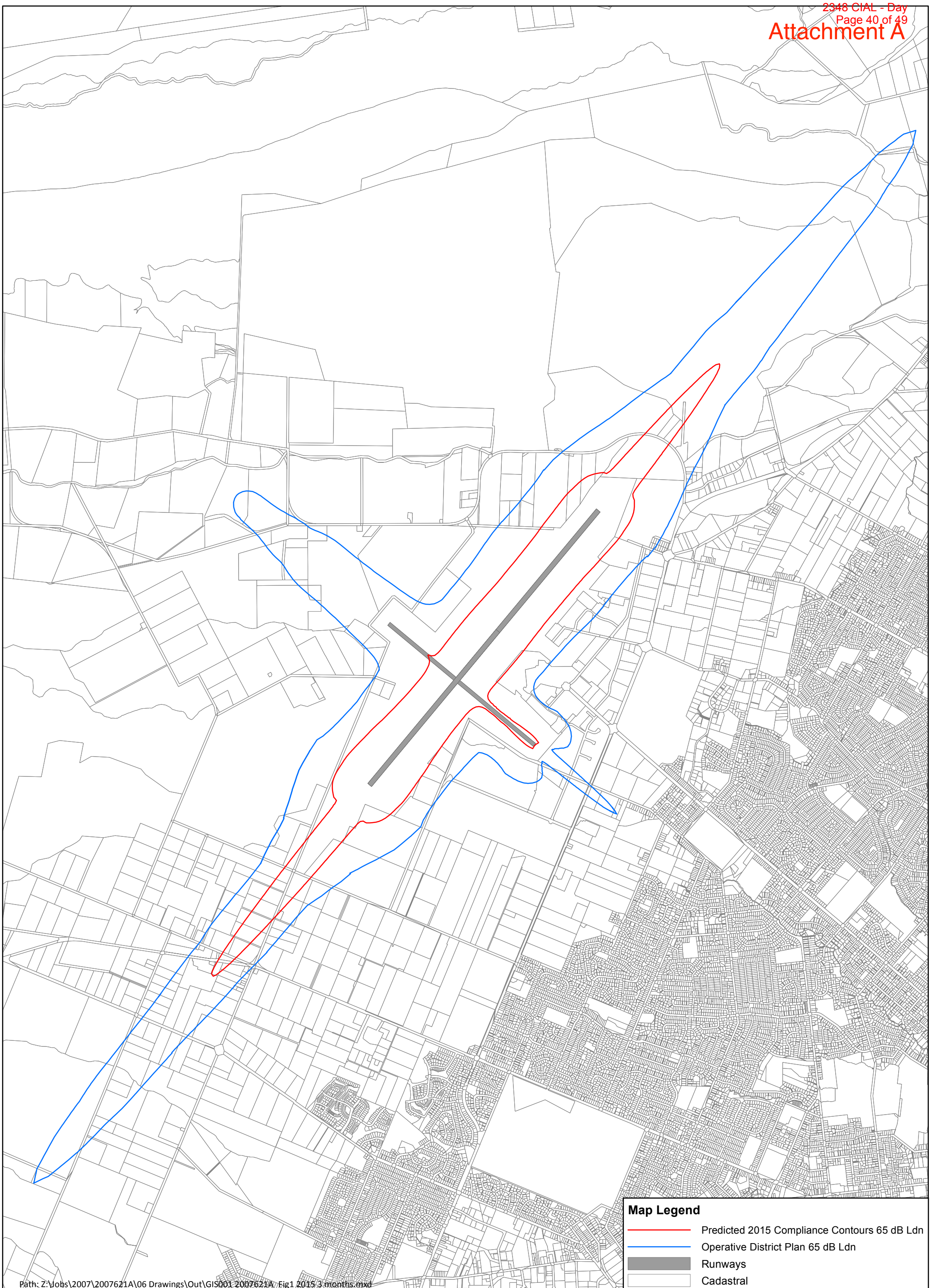
6. Miedema & Oudshoorn (2001); "Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals" Environmental Health Perspectives, Vol 109, 4, pp409-416

7. WHO (1999); "Guidelines for Community Noise". Edited by Berglund, Lindvall and Schwela.

8. WHO (2009); "Night Noise Guidelines for Europe"

Attachment A



MARSHALL DAY Acoustics

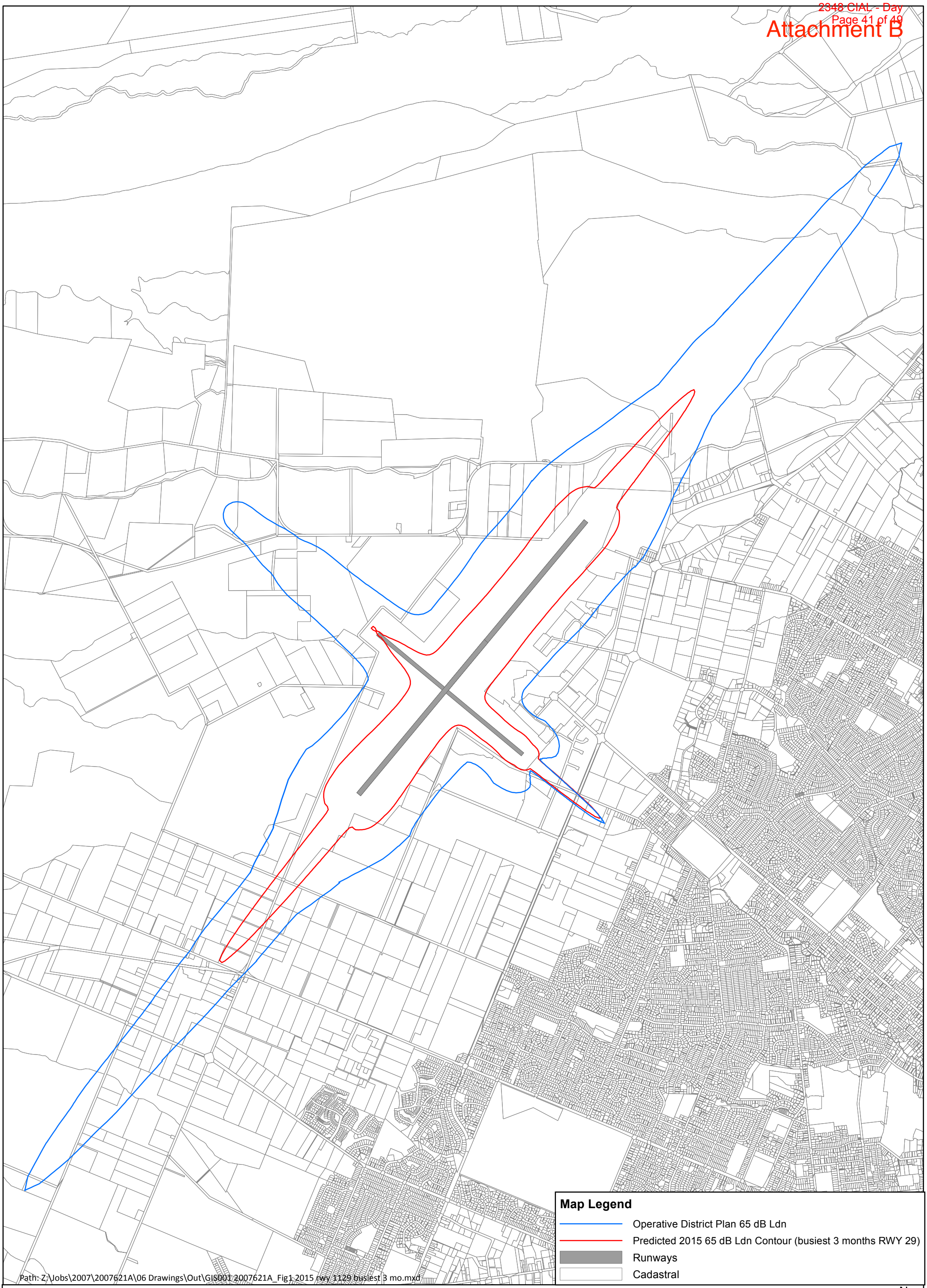
Christchurch Airport
2015 Annual Aircraft Noise Contours

Prepared By: SJP
Date: 10/02/2016
Time: 12:19:30 p.m.

Scale @ A3: 1:30,000
0 250 500 1,000 m

N

Attachment B



MARSHALL DAY Acoustics

Christchurch Airport

Annual Aircraft Noise Contours - Busiest 3 Months RWY 29

Prepared By: SJP
Date: 10/02/2016
Time: 12:10:56 p.m.

Scale @ A3: 1:30,000
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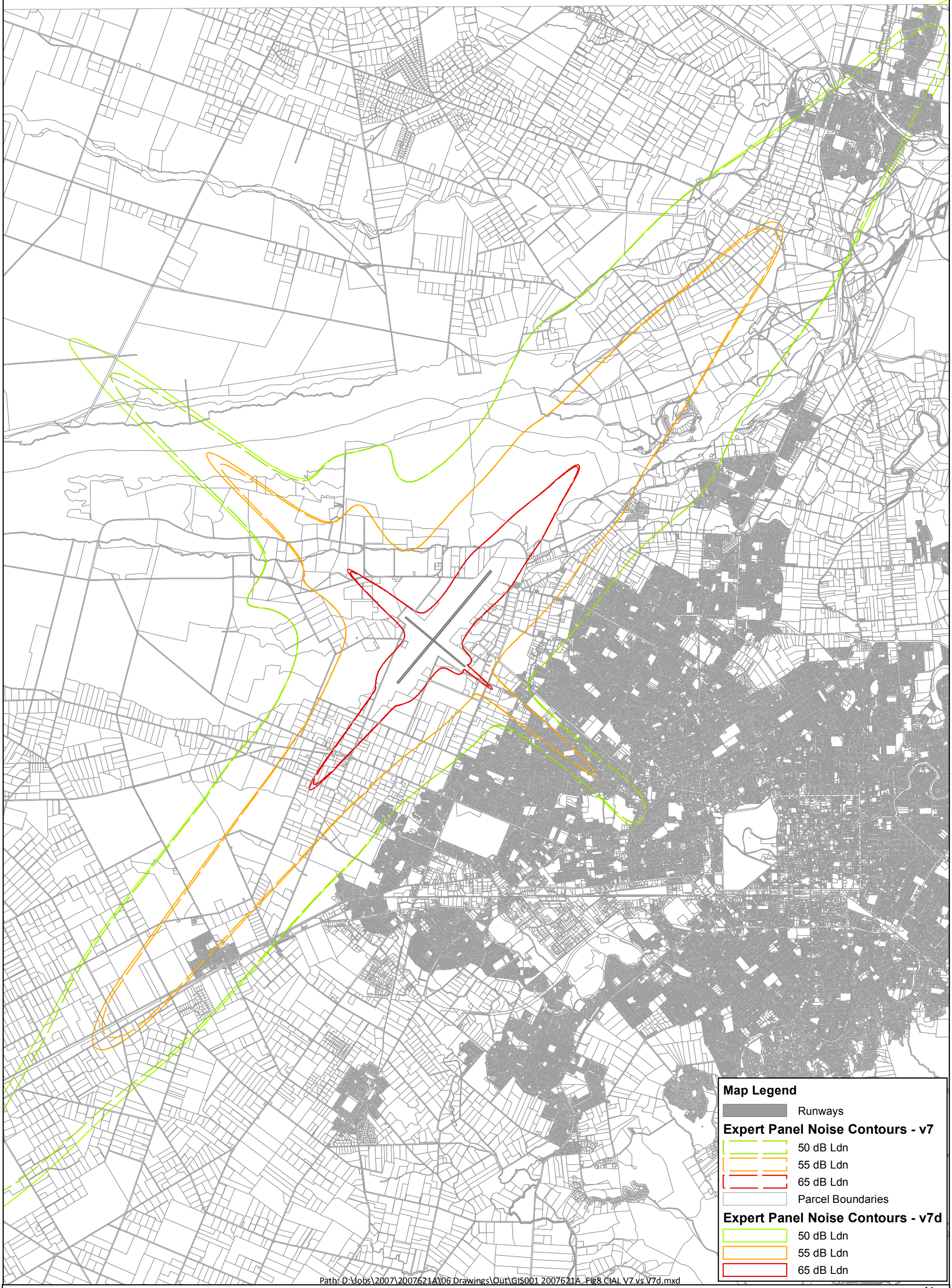
N

Attachment C



MARSHALL DAY Acoustics

Christchurch Airport - Expert Panel Noise Contours
INM v7 versus v7d

Prepared By: SJP
Date: 10/03/2015
Time: 3:46:08 p.m.

Scale @ A3: 1:75,000
0 1,000 2,000 4,000 m

N

50
55
65
65
55
50
87 Jessons Road
Harewood Golf Club Dwelling
7 Whitchurch Place
733 Harewood Road
655 Russley Road
560 Russley Road (north)
75 Stanleys Road
560 Russley Road (south)
750A Wairakei Road
117 Savills Road
50 Savills Road
559 Memorial Avenue
148 Grays Road
609 Avonhead Road
565 Avonhead Road
70 Grays Road
50
55
65
65
55
50

Map Legend

- Cadastral
- Building
- Engine Testing Complaince Monitoring Position (ETCMP)
- Selwyn/Waimakriri District Plan Boundaries (Expert Panel Contours)

Engine Testing Noise Level (dB $L_{dn\ 7day}$)

- 50 dB Ldn
- 55 dB Ldn
- 65 dB Ldn

The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

MARSHALL DAY Acoustics

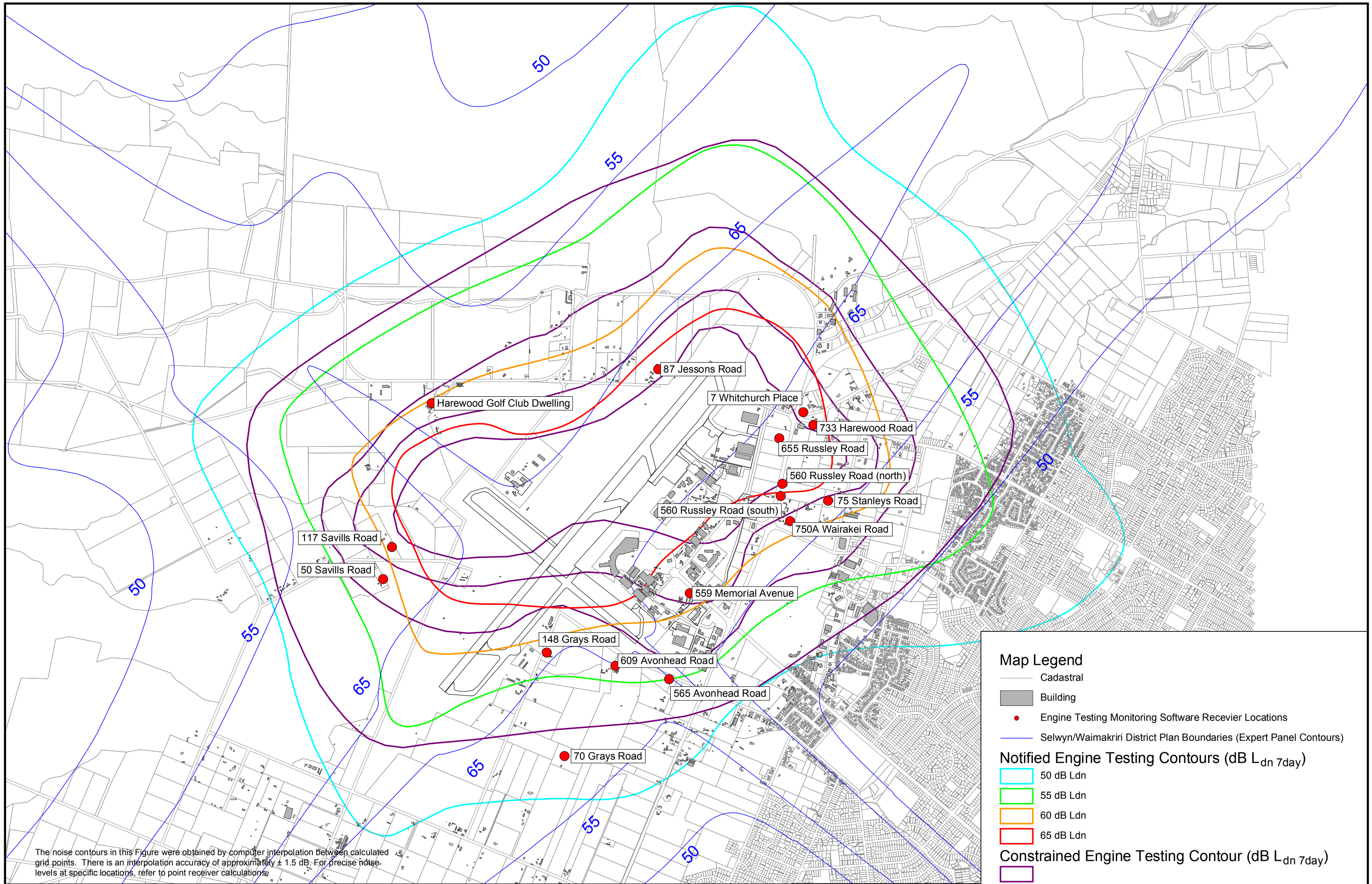
Figure M1 - Notified Engine Testing Noise Contours

Client: CIAL/Air New Zealand
Path: J:\JOBS\2012\2012503A\06 Drawings
Filename: 1512 Figure M1.SGS Result File: Sc3-9 - 10lg7 +2dB
Prepared by: sjp Date: 22/12/2015

Scale 1:27500

0 125 250 500 750 1000 m

N



The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

MARSHALL DAY Acoustics

Figure M3 - INDICATIVE Constrained Engine Testing Contour with Notified Engine Testing Noise Contour
WITHOUT PREJUDICE/CONFIDENTIAL

Client: Air New Zealand/CIAL
Path: J:\JOBS\2015\2015433A\06 Drawings
Filename: 1512 Figure M3 Constrained ET Contour.SGS Result File: Based on Sc17 - 10lg7
Prepared by: sjp Date: 17/12/2015

Scale 1:27500
0 125 250 500 750 1000 m

N

50
55
65
65
55
50
50
55
65
65
55
50

87 Jessons Road
Harewood Golf Club Dwelling
7 Whitchurch Place
733 Harewood Road
655 Russley Road
560 Russley Road (north)
75 Stanleys Road
560 Russley Road (south)
750A Wairakei Road
117 Savills Road
50 Savills Road
559 Memorial Avenue
148 Grays Road
609 Avonhead Road
565 Avonhead Road
70 Grays Road

Map Legend

- Cadastral
- Building
- Engine Testing Monitoring Software Recevier Locations
- Selwyn/Waimakriri District Plan Boundaries (Expert Panel Contours)

Notified Engine Testing Contours (dB $L_{dn\ 7day}$)

- 50 dB Ldn
- 55 dB Ldn
- 65 dB Ldn

Notified Engine Testing Contours (with enclosure) (dB $L_{dn\ 7day}$)

- 50 dB Ldn
- 55 dB Ldn
- 65 dB Ldn

The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

MARSHALL DAY Acoustics

Figure M4 - Notified Engine Testing Contour with Run-Up pad enclosure
North West Orientation
WITHOUT PREJUDICE/CONFIDENTIAL

Client: Air New Zealand/CIAL
Path: J:\JOBS\2012\2012503A\06 Drawings\OUT\Mediation
Filename: 1601 Figure M4 Mitigated ET Contour.SGS Result File: Sc35678 - 10lg7
Prepared by: sjp Date: 29/01/2016 2113-2118

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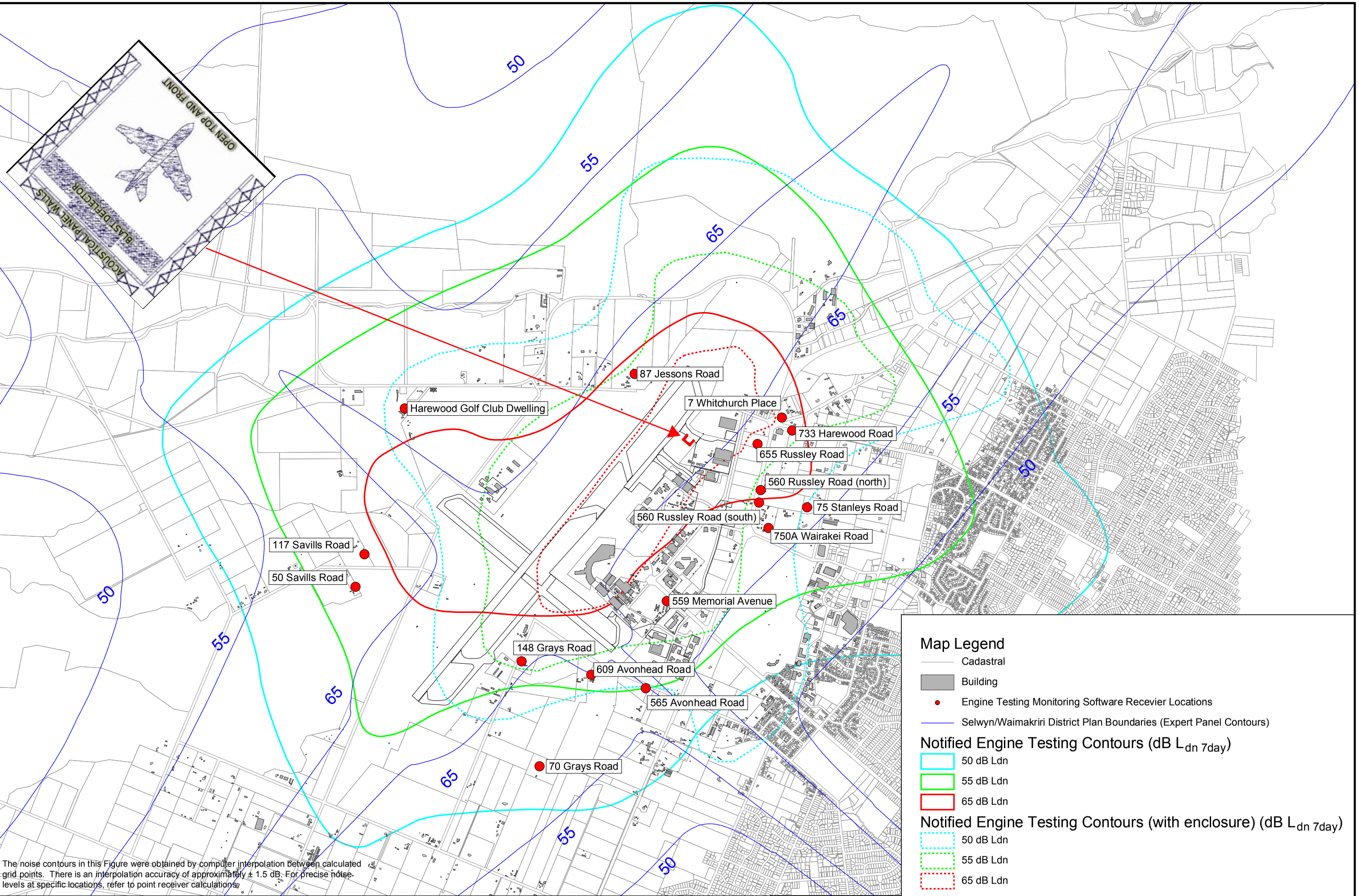

The noise contours in this Figure were obtained by computer interpolation between calculated grid points. There is an interpolation accuracy of approximately ± 1.5 dB. For precise noise levels at specific locations, refer to point receiver calculations.

MARSHALL DAY Acoustics

Figure M4a - Notified Engine Testing Contour with Run-Up pad enclosure
North East Orientation Test
WITHOUT PREJUDICE/CONFIDENTIAL

Client: Air New Zealand/CIAL
Path: J:\JOBS\2012\2012503A\06 Drawings\OUT\Mediation
Filename: 1601 Figure M4a Mitigated ET Contour.SGS Result File: Sc35678 - 10lg7
Prepared by: sjp Date: 29/01/2016 2213-2218

Scale 1:27500
0 125 250 500 750 1000 m

N

Attachment H – Terminology

The noise contours discussed in this evidence are contours of equal "Day/Night Sound Level" (L_{dn}). The following definitions may assist the understanding of L_{dn} contours.

Sound Level

L_A dB The A-weighted sound level is used for the measurement of most environmental sound. It is an attempt to quantify the 'loudness' of a sound by applying an A-weighting to the frequency response of the sound level meter that attempts to simulate the complex response of the human hearing system.

The A-weighted sound level in a typical urban environment will vary from a background noise level of around 45 dB with short duration peaks of 70 to 90 dB due to aircraft movements (depending on the location relative to the airport).

Noise Exposure

Overseas research has found the noise exposure or noise energy to correlate well with subjective response to noise or annoyance. It has been found that people are similarly annoyed by a high noise level operating for only a short period as they are by a moderate noise level operating for a longer period of time. L_{Aeq} and L_{dn} are both based on this 'noise energy' concept.

L_{Aeq} is the 'average' noise level over the measurement period (generally 1 hour for airport noise). Thus the noise from a number of single aircraft events is averaged to give a continuous 'equivalent' noise level, that has the same noise 'energy' as the total aircraft noise energy for the hour.

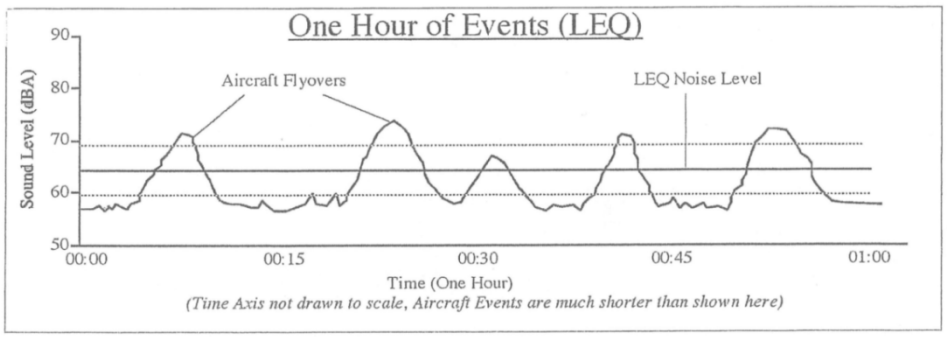

Figure A.1 - $L_{eq,1hr}$ from a number of aircraft noise events

L_{dn} The Day/Night Sound Level (L_{dn}) is calculated as the average of the 24, one hour L_{Aeq} with a 10 dB penalty applied during night time (10 pm to 7am).

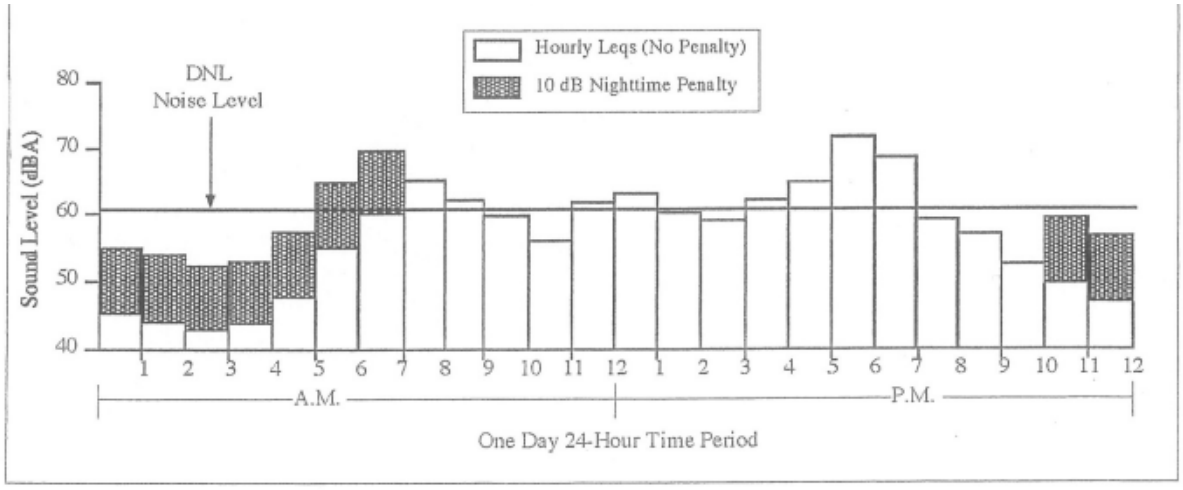

Figure A.2 – Calculation of L_{dn} from 24x $L_{eq,1hr}$

Single Event Noise

L_{AE} The Sound Exposure Level (L_{AE} or SEL) is a noise metric used to measure the noise energy of a single event such as the take-off of an aircraft. It is defined as the noise level of one second duration which would have the equivalent noise energy as the actual event. For example, if a noise source produced a steady A-weighted noise level of 75 dB for 10 seconds, the L_{AE} of that event would be 85 dB.

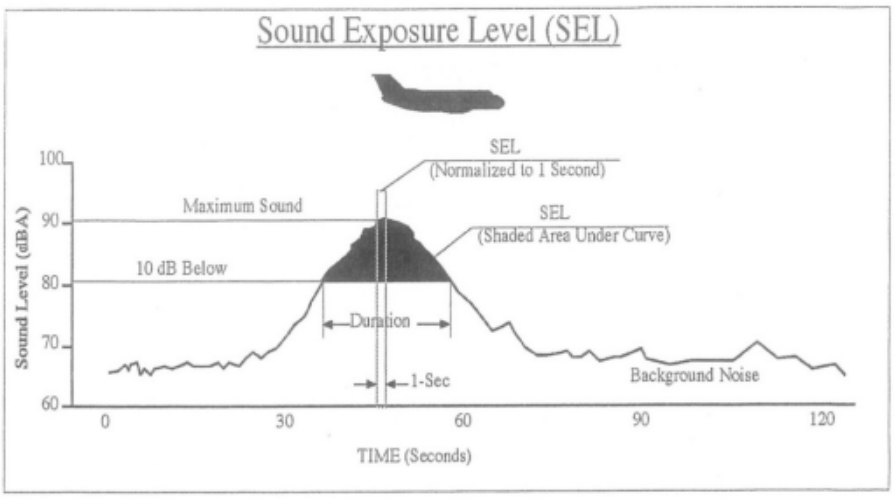

Figure A.3 - SEL and L_{max} for Single Event Noise

Attachment I - Miedema and Oudshoorn (2001)

Annoyance due to Aircraft Noise, Road Traffic Noise and Rail Noise