**Before the Queenstown Lakes District Council**

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| In the Matter of | the Resource Management Act |
| And | |
| In the Matter of | the Proposed Queenstown Lakes District Plan |
| | **Queenstown and Environs Planning Maps (Hearing Stream 13)** |

# Evidence of **Christopher William Day** for Queenstown Airport Corporation Limited (Submitter Number 433 and Further Submitter 1340)

Dated: 9 June 2017

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# INTRODUCTION

## Qualifications and Experience

1. My full name is Christopher William Day. I am a founding partner of Marshall Day Acoustics Limited.

2. 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.

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

4. 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.

5. I have been engaged by Queenstown Airport Corporation (**QAC**) 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 District Plan in the 1990s. MDA has carried out periodic noise monitoring at Queenstown Airport over the last five years, and carried out the recalculation of the noise contours for PC35, which involved a remodelling of future operations and subsequent noise contour modelling.

**Code of Conduct**

6. Although this is not an Environment Court hearing, I confirm 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 and 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 and that I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

## SCOPE OF EVIDENCE

7. My evidence will:

(a) Discuss community response to aircraft noise;

(b) Provide a summary of NZS 6805:1992 'Airport Noise Management and Land Use Planning';

(c) Describe land use planning principles around various New Zealand airports, including Queenstown Airport;

(d) Briefly discuss how the Queenstown Lakes District Plan addresses noise generally;

(e) Describe the formulation of the Queenstown Airport noise boundaries, including the PC35 noise boundaries;

(f) Discuss noise mitigation within an airport's noise boundaries, including why sound insulation alone does not resolve aircraft noise issues;

(g) Discuss noise reduction by aircraft technology:

(h) Discuss recent and forecast growth at Queenstown Airport and its relevance to land use planning around the Airport; and

(i) Discuss aircraft noise effects beyond the OCB.

(j) Explain the error in the notified aircraft noise boundaries.

## EXECUTIVE SUMMARY

8. A number of submitters have requested that specific land within the Outer Control Boundary (**OCB**) for Queenstown Airport be rezoned to enable residential or other noise sensitive activities to establish. I do not support these rezoning requests from a noise perspective because:

   (a) The New Zealand Standard NZS 6805 Airport Noise Management and Land Use Planning recommends that new noise sensitive activities inside the OCB should be prohibited, as a preferred starting position.

   (b) Community response surveys show that 12% to 15% of the population are highly annoyed by aircraft noise levels of 55 dB $L_{dn.}$

   (c) The noise rules contained in the Operative and Proposed Queenstown Lakes District Plans suggest that noise levels above 50 dB $L_{dn}$ are not a suitable residential noise environment.

   (d) The installation of sound insulation in buildings does not eliminate all the effects of aircraft noise. New Zealanders generally do not like living in enclosed air-conditioned houses without being able to open their windows. Opening the windows negates the effect of any noise mitigation installed.

   (e) New Zealand has an 'outdoor' culture, and sound insulation in buildings does not address outdoor amenity.

9. In my opinion, the recommendations of NZS 6805 should be upheld and new noise sensitive activities should not be allowed to establish within the OCB (55 dB $L_{dn}$ noise contour) for Queenstown Airport.

10. A number of submitters have requested that land just outside the OCB be rezoned for noise sensitive activities. I also do not support these rezoning requests because:

   (a) Noise effects do not stop suddenly at the Outer Control Boundary/55 dB $L_{dn}$ noise contour. The community response surveys and the QLDC noise rules show that there are adverse effects from noise between 50 dB and 55 dB $L_{dn}$.

(b) The current level of growth in aircraft operations at Queenstown Airport is significantly greater than the 3% annual growth used in the forecasting for PC35 based on forecasts produced in 2008. Current indications are that the airport will likely reach the PC35 noise boundaries well ahead on those initial predictions and it is likely these boundaries will need to be expanded sometime in the future.

(c) The properties just outside the OCB may in the long term, if currently expected growth transpires, be exposed to moderately high levels of aircraft noise.

11. In my opinion, these properties are marginal for noise sensitive activities and I consider a precautionary approach should be adopted when considering the appropriateness of new noise sensitive activities in these locations.

12. Finally, I note that the notified noise boundaries contain a small error, which should be corrected in accordance with QAC's submission on this issue.

## COMMUNITY RESPONSE TO AIRCRAFT NOISE

13. What level of airport noise is acceptable for residential and other noise sensitive activity? It is generally accepted that the adverse effects of airport noise below 45 dB $L_{dn}$ are not significant. Above 65 dB $L_{dn}$ the adverse effects are generally agreed to be significant or serious. Clearly there is not a sudden point at which noise effects 'switch' from being not significant to significant — it is a sliding scale. This sliding response is reflected in the research into community response to noise.

14. Individual responses to a certain level of aircraft noise vary greatly. A large number of studies have been carried out overseas in an attempt to determine a general relationship between community response and the level of noise being experienced. Some of this work formed the basis of NZS 6805:1992 Airport Noise Management and Land Use Planning when it was developed. I discuss this Standard in detail in the next section of my evidence.

15. In 1978 Shultz combined the results of eleven different studies to produce a 'curve' of the percentage of people highly annoyed (%HA) versus external noise level ($L_{dn}$), known as a 'dose response relationships'. The studies combined a number of different transportation noise sources including trains, road traffic and aircraft.

16. In 2001 Miedema and Oudshoorn[1] carried out a synthesis of a wider body of research and separated the results into response to aircraft, road traffic and rail noise as shown in Figure 1 below.

[1] Miedema and Oudshoorn (2001) "Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals.

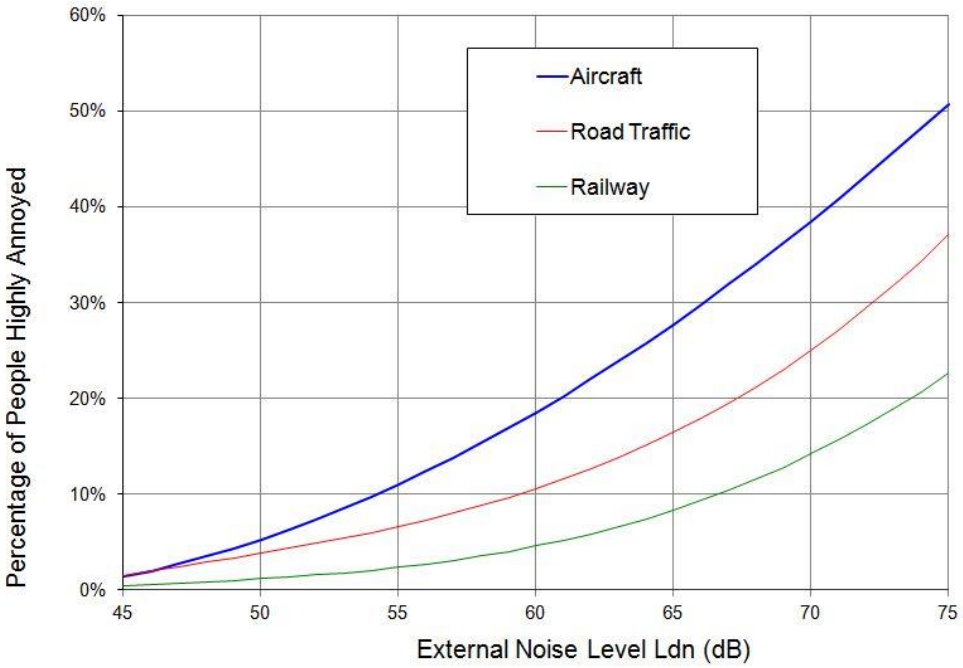


**Figure 1 Miedema & Ouldshoorn Dose-Response Relationship**

17. The Figure shows that the community is generally more annoyed by aircraft noise than other transport noise sources.

18. 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. The purpose of this exercise was to determine whether people in Christchurch were more or less sensitive to aircraft noise than the overseas studies indicated, and to assess whether the overseas studies have relevance in New Zealand. I was directly involved with the Taylor Baines Study and carried out further analysis of the data to enable a comparison with the overseas 'dose response' curves. The results from the Christchurch study are shown below in Figure 2 along with the Miedema study (and a similar study by Bradley).

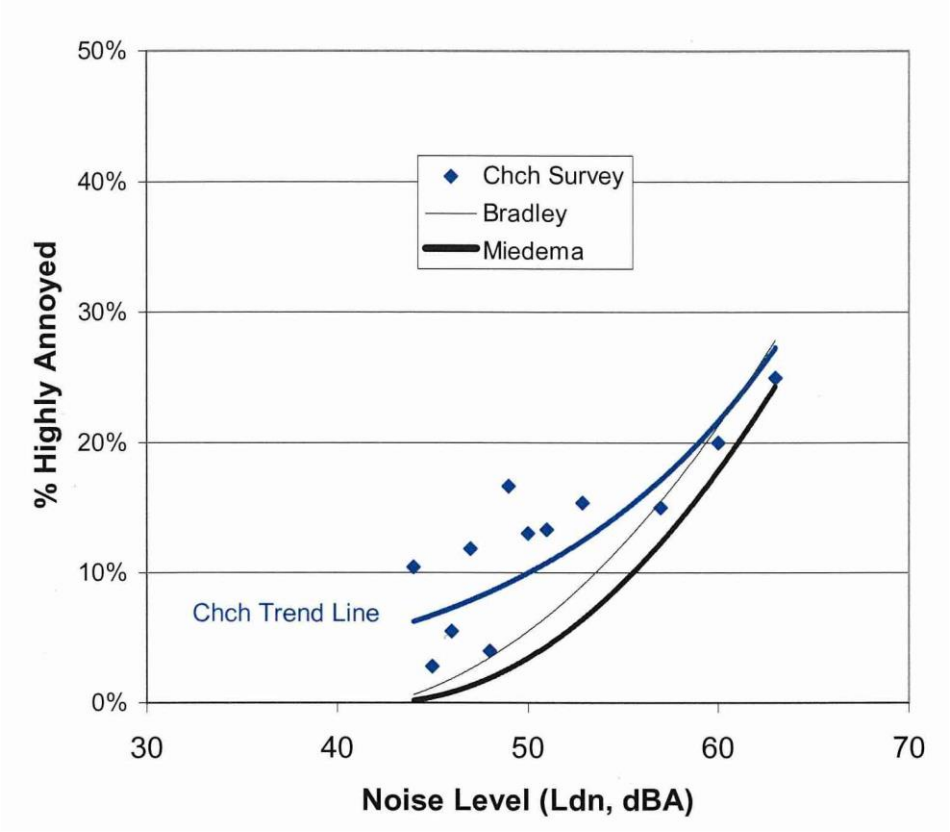


**Figure 2 - Community Response to Aircraft Noise (Christchurch)**

19. Figure 2 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.

20. This trend line suggests that Christchurch people in the lower noise areas ($L_{dn}$ 45 to 55 dBA) are more annoyed than the synthesis of surveys from overseas (Bradley and Miedema), suggests. For people living in Christchurch, the study shows 10% to 15% of people are highly annoyed in the 50 to 55 dB $L_{dn}$ aircraft noise area. By comparison, the overseas studies show 3% to 12% of the population is highly annoyed in this noise band.

## NEW ZEALAND STANDARD NZS 6805

21. In 1992 the Standards Association of New Zealand published New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning" (**NZS 6805** or **Standard**) with a view to providing a balanced approach to noise planning around New Zealand airports. The Standard was finalised after several years of preparation and consultation, and represented a consensus of opinion of many different groups including the

Ministry of Transport, the Department of Health, airline representatives, local authorities, residents action groups, acoustic consultants and others.

22. The Standard uses the "Noise Boundary" concept as a mechanism for local authorities to[2]:

    (i) "*establish compatible land use planning" around an airport*;

    (ii) "*set limits for the management of aircraft noise at airports*".

23. The Noise Boundary concept involves fixing an Outer Control Boundary (**OCB**) for an airport which is generally based on the future 55 dB $L_{dn}$ noise contour and a smaller, much closer Air Noise Boundary (**ANB**) which is based on 65 dB $L_{dn}$ noise contour.

24. Tables 1 and 2 of the Standard recommend criteria for land use planning within these noise boundaries.

25. These tables are reproduced in full in **Appendix A** however the key recommendation of relevance to this hearing is the Standard's recommendation that within the OCB (i.e. average noise levels greater than 55 dB $L_{dn}$):

    > *"New residential, schools, hospitals or other noise sensitive uses should be prohibited unless a district plan permits such uses, subject to a requirement to incorporate appropriate acoustic installation to ensure a satisfactory internal noise environment."*

26. The Standard recommends that inside the ANB (i.e. average noise levels greater than 65 dB $L_{dn}$):

    > "*New residential, schools, hospitals or other noise sensitive uses are prohibited"*.

27. The other 'arm' of the Standard recommends noise controls to ensure an airport does not exceed the noise levels upon which the ANB and OCB are based.

28. The Standard uses the Day/Night Sound Level ($L_{dn}$) parameter for the assessment of noise. $L_{dn}$ is a measure of noise exposure and uses the

[2] NZS6805:1992 Clause 1.1.2.

cumulative 'noise energy' that is produced by all flights during a typical day with a 10 decibel penalty applied to night flights (post 10pm) to allow for the increased sensitivity to noise at night (see **Appendix B** for a full list of noise terminology). $L_{dn}$ is used extensively overseas for airport noise assessment and it has been found to correlate well with community response to aircraft noise.

29. As noted above, the location of the ANB is usually based upon the projected 65 dB $L_{dn}$ noise contour, and the location of the OCB is generally based on the projected 55 dB $L_{dn}$ noise contour. The Standard recommends that these noise contours are calculated using the Integrated Noise Model (**INM**)[3] software and projections of future aircraft operations. The Standard recommends that a minimum of a 10 year period be used as the basis for the projections. In my evidence I generally refer to the ANB and the OCB as 'boundaries' (because they have been cadastralised) and the INM predictions (e.g. 55 dB $L_{dn}$) as 'contours' (because they are not cadastralised).

30. In my opinion, which is supported by the approach recommended in the Standard, land use planning is an important and effective way to reduce the population exposure to noise around airports. Aircraft technology and flight management, although an important component in abating noise, will not alone be sufficient to eliminate or adequately control aircraft noise. Uncontrolled development of noise sensitive activities around an airport can unnecessarily expose additional people to high levels of noise and may ultimately constrain, by public pressure as a response to noise, the operation of this significant resource.

31. The Standard (clause 1.4.1.1) recommends controls on land use to "*avoid, remedy or mitigate any adverse effects on the environment, including effects on community health and amenity values whilst recognising the need to operate an airport efficiently*". In my opinion, the best way to implement this objective is to adopt the land use planning controls recommended in Tables 1 and 2 of the Standard.

32. In addition to land use controls, controls on how an airport is operated can be employed to manage the level of noise impact around airports. These

[3] The FAA has rebranded the INM software and incorporated it into a broader software package called AEDT.

controls can take the form of preferential runway usage, noise abatement flight tracks, curfews, noise emission limits and others. Ms Tregidga details the measures adopted by QAC to control noise emissions at Queenstown Airport.

33. The NZS 6805 approach is to recommend maximum noise emission limits for airports. This procedure is consistent with the general approach to noise control in New Zealand, in that it is left to the airport operator to best decide how to manage its activities to comply with an agreed level of noise.

## LAND USE PLANNING AROUND AIRPORTS

34. As discussed, NZS 6805 lays out recommended procedures for land use planning around airports, in an effort to avoid adverse aircraft noise effects on noise sensitive activities and to protect airports from potential reverse sensitivity effects.

35. The various district plans around the country have implemented the recommendations in NZS 6805 in different ways. The process is influenced by a number of factors including the extent of existing residential development inside the relevant airports' noise boundaries, the demand for residential land in the area and the availability of land outside the noise boundaries to meet the demand for future residential development etc.

36. By way of example, in Christchurch a substantial noise buffer area has been established around the airport as there has been no shortage of residential land at other locations in and around Christchurch. The airport's OCB is based on a 50 dB $L_{dn}$ noise contour. The Christchurch City Plan rules discourage noise sensitive activities inside this noise boundary – 5 dB more protective than other airports.

37. In Wellington on the other hand, there is a shortage of undeveloped residential land in the vicinity and Wellington Airport has over 600 existing houses inside the ANB. These dwellings are to be acoustically treated. Additionally, the airport is subject to noise controls (e.g. a curfew). Thus, the planning response for Wellington Airport is at the other end of the scale to Christchurch Airport, which reflects the particular circumstances of the airport.

38. More relevantly, the Operative Queenstown Lakes District Plan, as amended by PC35, includes land use controls for six zones which are affected by the OCB and ANB for Queenstown Airport, as summarised in **Appendix C.**

39. In my opinion, these controls provide a reasonable level of protection for new noise sensitive activities from potentially adverse aircraft noise effects, and a reasonable degree of protection for Queenstown Airport from potential reverse sensitivity effects.

40. As an aside, it is of some relevance that all the noise experts involved in the PC19 proceedings agreed that new noise sensitive activities should be prohibited within the OCB in so far as it affects the PC19 land (noting the PC19 land was previously zoned rural).

41. It is also of some relevance to note that at times, people have suggested that Queenstown Airport should be moved to an alternative location because too many people are affected by noise. In my opinion, Queenstown Airport is relatively well located in terms of avoiding the adverse effects of noise on the wider community. The noise boundaries for Queenstown Airport fall largely over 'non noise sensitive' areas such as Lake Wakatipu, the river flats to the east and the generally non residential land to the north and south of the main runway.

42. The relatively small parts of Wakatipu Basin that are affected by aircraft noise are the long standing Frankton dwellings at the west end of the runway, the dwellings along the shores of Lake Wakatipu (to a much lesser extent), and parts of the residential developments more recently allowed to establish at Lake Hayes Estate and Remarkables Park.

43. It is important in my view, and consistent with NZS6805, to impose controls on land use that avoid additional noise sensitive activities[4] becoming exposed to aircraft noise.

44. I consider that the rezoning of land within Queenstown Airport's noise boundaries would represent a significant degradation of the land use planning approach adopted in PC35, and would be at odds with the New Zealand Standard.

[4] Noise sensitive activities include those activities listed in paragraph 24 and 25 above.

### Queenstown Lakes District Plan Noise Controls

45. To further illustrate why an aircraft noise environment of 55 dB $L_{dn}$ (and greater) is not satisfactory for residential development, it is of some assistance to examine how the Queenstown Lakes District Plan generally addresses noise in residential zones. I appreciate that it is not an easy task to directly compare different types of noise, but if we keep in mind that the studies show that aircraft noise is more offensive than most other sources, the comparison I am about to offer can be considered conservative.

46. The Operative District Plan rule 7.5.6.3 vii[5] sets "Residential Zone Noise Standards (for non residential noise sources) that equate to 50 dB $L_{dn}$.[6]

47. The Proposed District Plan rule imposes a similar Residential Zone noise standard.[7]

48. These rules provide an indication that noise levels greater than 50 dB $L_{dn}$ are generally not considered appropriate in the residential areas of the Queenstown Lakes District.

## QUEENSTOWN AIRPORT NOISE BOUNDARIES

49. In 1995 airport noise boundaries were introduced into the Queenstown Lakes District Plan with a view to establishing a compatible land use planning regime for land around the Airport and to set noise limits for the management aircraft noise. This approach was based on the recommendations in NZS 6805.

50. The noise boundaries at that time were based on future levels of airport operations using projected growth out to 2015. The hearings process included significant debate over whether the planning horizon was too long and the consequential noise contours too large. A compromise was negotiated with reductions in the size of the contours in some areas.

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5 Contained in Chapter 7 Residential Areas of the Operative District Plan.

6 Chapter 7, Rule 7.5.6.3(vii) of the Operative District Plan sets out that noise received in the Low Density Residential Zone, when receive at any point within the zone, should not exceed 50dB LAeq(15min) between 0800h and 2000h and 40dB LAeq(15min) between 2000h and 0800h.

7 Chapter 36 Rule 36.5.2 of the Proposed District Plan (Council's Right of Reply version dated 22 September 2017) sets out that noise received in the Low, Medium and High Density Residential zone, when assessed at any point within the site, should not exceed 50dB LAeq(15min) between 0800h and 2000h and 40dB LAeq(15min) between 2000h and 0800h.

51. Compliance monitoring carried out at the Airport over the following years showed that the Airport was operating near 'capacity' in terms of the District Plan's noise boundaries.

52. In 2007 MDA was engaged by QAC on a new commission to assist it with updating the airport noise boundaries and related provisions in the District Plan. This 'updating' was required as aircraft noise had, by then, reached the District Plan noise limits (i.e. the noise boundaries); new aircraft types had been introduced; growth had exceeded expectations and the INM software used to calculate the noise contours had been updated several times since 1995.

53. Aviation experts were engaged to forecast growth and aircraft types. New flight procedures such as GPS guided Required Navigational Performance (**RNP**) were included in the modelling. Three alternative locations for the General Aviation (**GA**) and Helicopter (**Heli**) operational base were also examined.

54. As a result of this work, new noise boundaries and related District Plan provisions were formulated, and ultimately adopted by the Council and notified as 'Plan Change 35' (**PC35**).[8] A notice of requirement (**NOR**) to modify the Airport's designation, which required QAC to provide noise mitigation due to the proposed increase in aircraft noise, was also publically notified at this time.

55. After a public hearing, the Council confirmed PC35 and recommended approval of the NOR. Both decisions were appealed to the Environment Court.

56. Following extensive evidence, conferencing and legal argument in the Environment Court, PC35 and the NOR were approved. PC35 introduced rules into the District Plan in respect of the establishment of noise sensitive activities around the Airport, while the NOR introduced obligations for QAC in respect of noise mitigation. QAC's mitigation obligations relate to existing dwellings within the updated (PC35) noise boundaries, for which QAC is required to provide acoustic treatment, including mechanical ventilation, for all critical listening environments.

[8] This included a combined 'outer extremity' noise boundary which would allow any one of the three GA locations to occur. The intent was that in future years the contours would be refined to the specific location where the GA is eventually accommodated.

57. The PC35 approach involves a sharing of the cost of the mitigation between QAC and affected property owners. QAC funds 100% of the mitigation required inside the ANB (being acoustic insulation and mechanical ventilation) and 75% of mitigation required inside 60 dB $L_{dn}$ noise contour (where only mechanical ventilation is required).

58. As an aside, I note that at some airports 65 dB $L_{dn}$ is used as the trigger for implementation of such mitigation measures, and at others, including Queenstown Airport, 60 dB $L_{dn}$ is the trigger.

59. The PC35 noise boundaries were based on future noise levels expected in the year 2037 (based on modelling undertaken at the time the Plan Change was formulated). However, the actual noise level will increase incrementally over the intervening period and existing dwellings will gradually become exposed to higher levels of noise. The implementation of noise mitigation will thus take place progressively over time as noise levels increase, but always prior to the relevant dwelling being exposed to the level of noise that triggers the need for the mitigation (i.e. 60 dB $L_{dn}$ for mechanical ventilation and 65 dB $L_{dn}$ for acoustic treatment and ventilation).

60. QAC has an Aircraft Noise Management Plan that details how the mitigation is to be rolled out to the noise affected dwellings. MDA has assisted with this programme and two trial houses were initially treated and then measured to establish the performance of the mitigation treatment. The programme has continued from there with 12 houses being offered mitigation so far.

61. QAC has also established an Airport Liaison Committee to receive feedback on how the mitigation programme is working and any other issues the community has.

## NEW RESIDENTIAL ACTIVITY INSIDE AIRPORT NOISE CONTOURS

62. Some advocates for the establishment of new residential development in areas affected by aircraft noise have argued that acoustic treatment fitted to dwellings is sufficient on its own to avoid the adverse effects of aircraft noise on residents of the dwelling and to prevent reverse sensitivity effects on the Airport. In my opinion, this assertion - that acoustic treatment is all that is required to avoid these adverse effects - is incorrect for a number of reasons.

63. Firstly, the level of acoustic treatment required for dwellings within the 50 - 60 dB $L_{dn}$ noise contours to mitigate noise to a reasonable internal level (40 dB $L_{dn}$, being the World Health Organisation satisfactory internal noise level) is generally provided by a standard house construction. No additional construction techniques or materials are required for dwellings located in this noise environment. However, 5% to 18% of the population is still typically highly annoyed by aircraft noise in this environment, according to the community response studies.

64. Secondly, houses exposed to aircraft noise need to keep their windows closed in order to achieve a satisfactory internal noise level (i.e. 40 dB $L_{dn}$), particularly at night. Three scenarios are then likely:

    (a) the windows are kept closed resulting in an unsatisfactory level of fresh air internally; or

    (b) a ventilation system or air-conditioning system is installed to improve air quality at significant cost to the homeowner; or,

    (c) the windows are left open resulting in an unsatisfactory internal noise environment.

65. Each of these scenarios can result in complaints from the residents.

66. The third difficulty with acoustic treatment 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, for example. 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 complaint, and may result in demands to reduce noise, which ultimately has the potential to affect airport operations. By way of analogous example, I have been involved in cases where residents have moved to, then complained about noise from lawfully established existing activities within the rural zone, such as bird scaring devices in vineyards.

67. I therefore consider that minimising the number of people exposed to aircraft noise by restricting residential development from establishing in areas affected by aircraft noise is an effective form of mitigation. It is also consistent with the New Zealand Standard.

68. Specifically, as stated earlier, the New Zealand Standard refers to acoustic treatment as a fall-back measure, with a preference that noise sensitive activities be precluded from establishing in the first instance. Table 2 of the Standard states that new noise sensitive uses inside the OCB *"should be prohibited unless a district plan permits such uses, subject to a requirement to incorporate appropriate acoustic insulation."* I interpret these words as demonstrating a preference that new noise sensitive activities should be prohibited inside the OCB, while permitting such activities subject to a requirement to incorporate acoustic insulation is clearly the less preferred (and in my view, inferior) option.

69. It is sometimes argued by parties (i.e. those that seek to establish new noise sensitive uses within the OCB) that Table 2 (cited above) should be interpreted to mean that with acoustic insulation, new noise sensitive activities should be permitted to establish inside the OCB. I consider that if this was the intent of the Standard, it would simply say as much. i.e. 'noise sensitive uses within the OCB should be fitted with acoustic insulation'. I consider the inclusion of the words "*should be prohibited"* provides a clear indication that noise sensitive activities should be prohibited within the OCB, as the preferred starting point.

70. The issues set out above highlight why mitigation of aircraft noise through acoustic treatment is only a partial and much less desirable option to prohibiting the establishment of new noise sensitive activities within an airport's noise boundaries.

## NOISE REDUCTION BY AIRCRAFT TECHNOLOGY

71. In terms of aircraft noise mitigation, it is worth noting that the airline industry as a whole has spent billions of dollars mitigating noise from aircraft over the last 50 years with the development of 'quiet technology' engines. Figure 6 below shows the reduction in noise level for the different aircraft types over time.

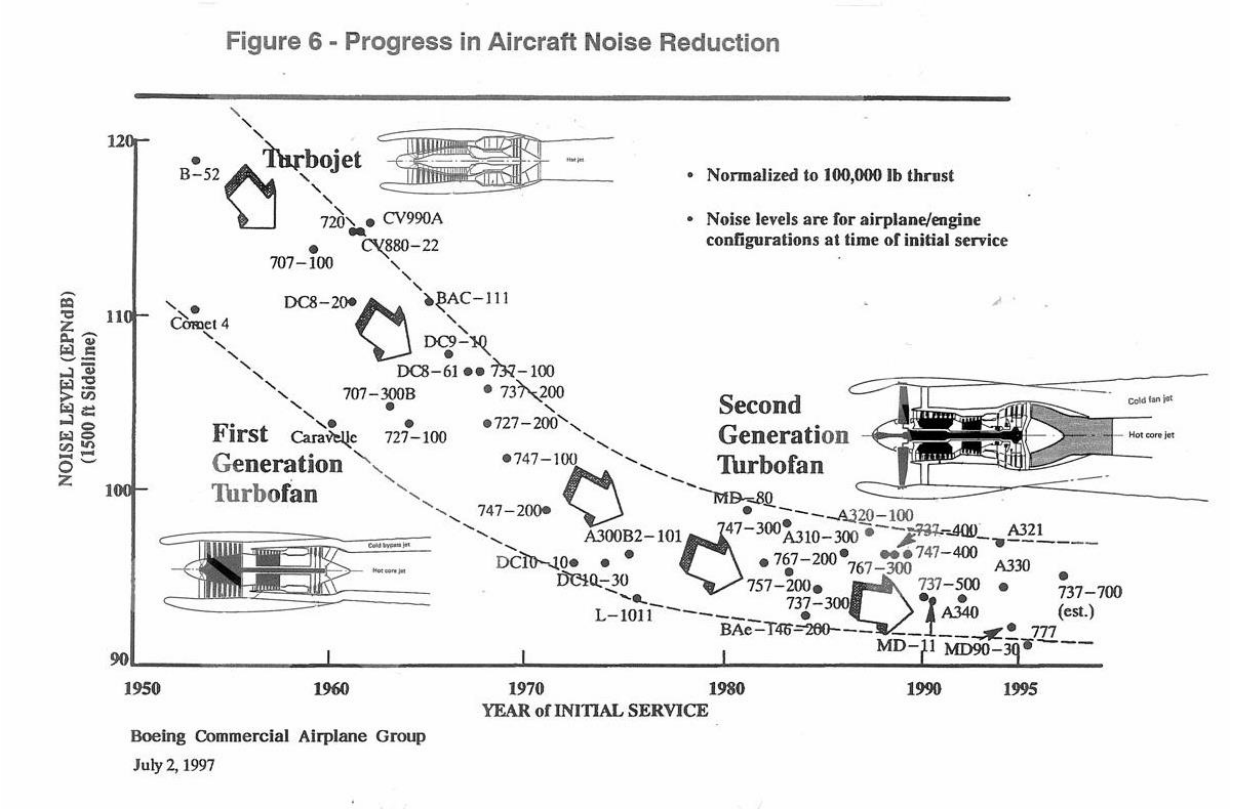



**Figure 6 – Progress in Aircraft Noise Reduction**

72. The question is often asked, “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 Airbus A380 produces the same noise level as a Boeing B777 and the B787 Dreamliner produces approximately the same noise level as a B737. These newer aircraft carry more passengers for the same ‘noise output’ but it confirms the ‘curve’ in Figure 6 has flattened out.

73. It is interesting to note that despite the very significant reduction in noise from aircraft achieved over the past 40 years, 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).

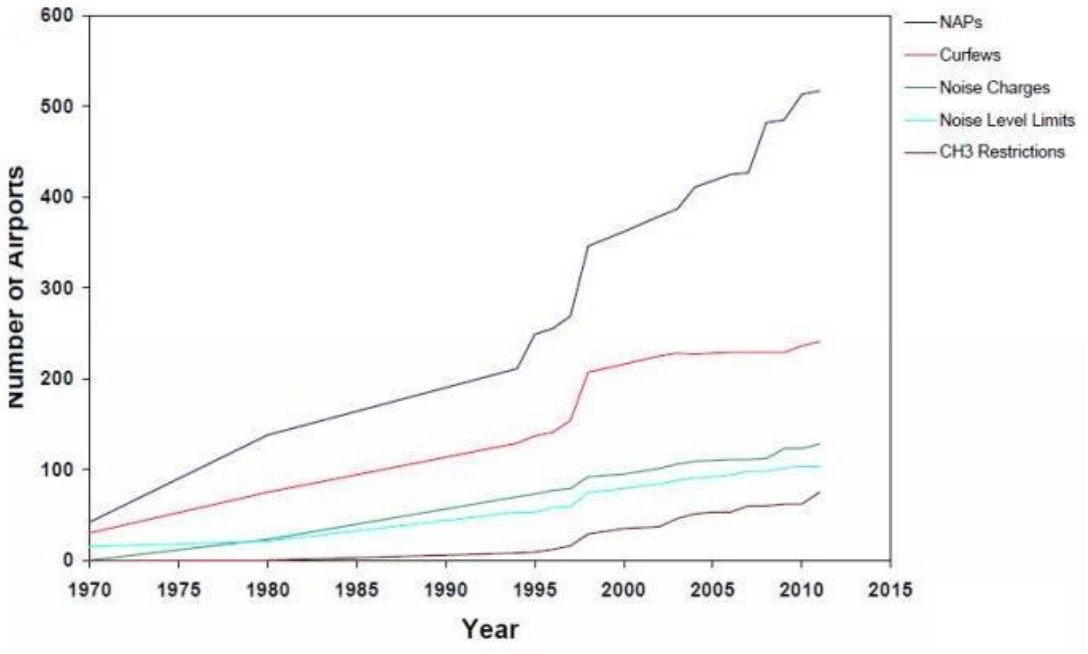



**Figure 7 - Growth in Airport Noise Restrictions[9]**

74. These figures show that reductions in aircraft noise due to technology will not solve the land use incompatibility issues at Queenstown Airport. Other measures, such as restricting the establishment of new noise sensitive activities, are required.

## FUTURE GROWTH

### Noise Monitoring

75. QAC is required, under its designation, to monitor actual noise at Queenstown Airport to check compliance with the noise boundaries, including by undertaking a noise monitoring programme every three years. MDA is engaged by QAC to assist with this noise monitoring and to undertake noise modelling to calculate the annual noise contours based on the actual aircraft activity over the previous year.

76. The results for 2016 monitoring have just been prepared. The monitoring confirms what the growth numbers suggest - current indications are that the Airport will likely reach the PC35 noise boundaries well ahead of the initial predictions and it is likely these boundaries will need to be expanded sometime in the future.

[9] NAP are flight noise abatement procedures (throttle back early on departure etc). CH3 relates to noise rating of aircraft types. Chapter 3 is quieter than Chapter 2 and ICAO policy is to eliminate older noisier Ch1 and Ch2 aircraft.

**QAC Statement of Intent**

77. Ms Tregidga states in her evidence (dated 9 June 2017) that *"[c]urrent demand forecasts predict that annual passenger numbers have the potential to increase from 1.8 million in 2017 to 3.2 million by 2025. As stated previously, QAC is mindful that it needs to manage this growth sustainably and in line with key stakeholders' and community expectations."*

78. Information on QAC's website and from Annual Reports demonstrate the level of growth experienced at Queenstown Airport over recent years. The number of passengers increased by 14% in 2015FY and by 18% in 2016FY, and the number of 'scheduled aircraft movements' increased by 7% in 2015 and by 14% in 2016. This level of growth is significantly greater than the 3% annual growth used in the forecasting for the PC35 noise contours produced in 2008.

79. Ms Tregidga also states that QAC has commissioned master planning work for the airport which takes a 30 year planning horizon, and aims to provide QAC with a recommended road map to implement airport developments "*that continue to serve the local community and region and deliver a unique visitor experience, maximise asset value, and generate sustainable growth in returns and value to the community and QAC's partners*". MDA is engaged to carry out a review of the noise boundaries in light of the draft master plan's passenger growth forecasts. This work is yet to be completed.

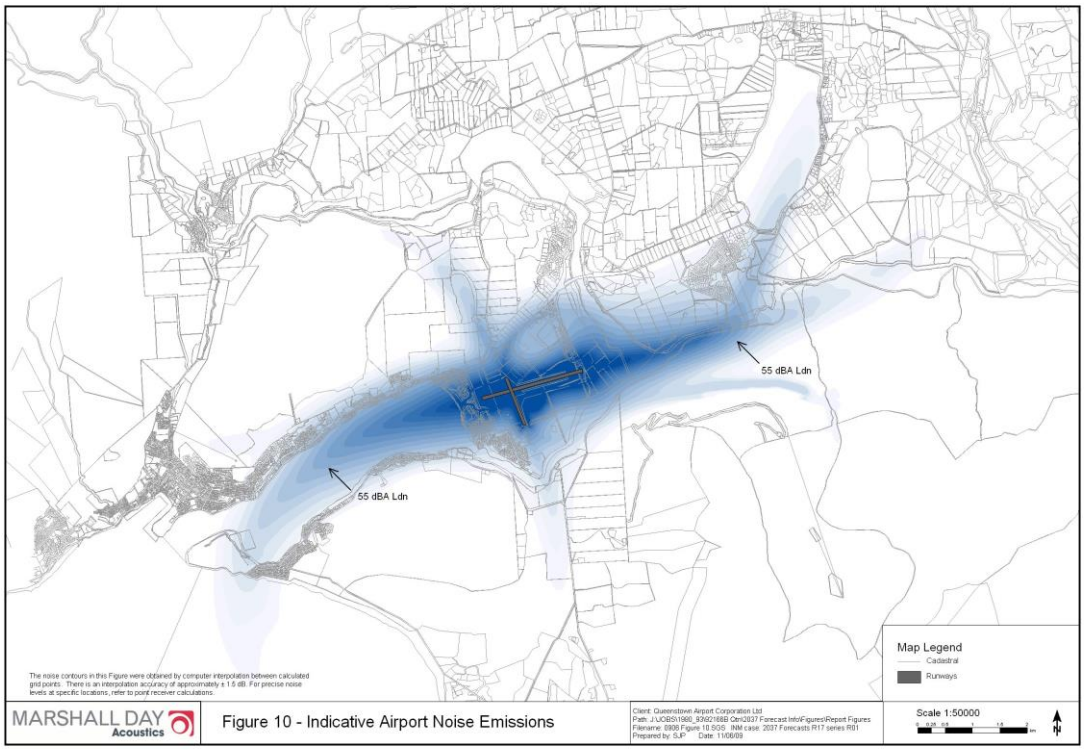
**Future Noise Contours**

80. The exceptional growth and the recent noise monitoring carried out at Queenstown Airport currently suggest that the noise contours would need to be larger than the PC35 contours in order to accommodate forecast growth. Accordingly, it is my current view that it is likely that the noise boundaries in the District Plan will need to be expanded sometime in the future, if forecast growth is to be accommodated.

**Noise Outside the OCB**

81. In addition to the issues above, it is important to be aware that noise does not stop at the Airport's noise boundaries. While defined 'boundaries' are required for planning purposes, it should be remembered that the noise environment at a property 100 metres outside the OCB will not be perceptibly different to the noise environment 100 metres inside the OCB.

82. The figure below shows a graduated noise diagram going from high noise levels (dark blue) to moderate noise levels (in light blue), based on the PC35 noise contours.




83. The above Figure is also enlarged in **Appendix D**, with the location of the various rezoning requests in respect of which QAC has further submitted marked in colour. It shows which rezoning requests lie within an aircraft noise affected area.

84. For the reasons I have given above, and noting again the results of the recent noise monitoring and QAC's growth forecasts, I do not support enabling new noise sensitive activities just outside the current OCB, generally within the blue areas in the Figure above and in Appendix C.

85. Rezoning these areas would allow the establishment of noise sensitive activities, largely irreversibly, in locations that may in the long term, if currently expected growth transpires, be exposed to moderately high levels of aircraft noise.

86. I consider that a precautionary approach is warranted in these circumstances and properties just outside the OCB should not be rezoned at this stage.

## ERROR IN NOTIFIED NOISE BOUNDARIES

87. Finally, I note that the noise boundaries contained in the Proposed District Plan as notified are incorrect in that they contain a small error.

88. The error arises because when MDA provided to the Council the digital PC35 noise boundaries (at the Council's request, prior to notification of the Proposed District Plan) an error occurred in transmission. This error only became apparent to MDA when the Proposed Plan was notified.

89. I understand that QAC made a submission in respect of this error requesting that it be corrected, and attached a copy of the correct PC35 noise boundaries to its submission.

90. I can confirm that the noise boundaries appended to QAC's submission are an accurate representation of the PC35 noise boundaries.

## CONCLUSIONS

91. In my opinion, the recommendations of NZS 6805 should be upheld and new noise sensitive activities should not be allowed to establish within the OCB (55 dB $L_{dn}$) or ANB (65 dB $L_{dn}$) for Queenstown Airport (unless there is an existing expectation to develop a dwelling in a residential zone).

92. Land just outside the OCB is in my opinion marginal for noise sensitive activities and for the reasons expressed in this evidence I recommend that a precautionary approach be adopted, and rezoning requests for noise sensitive activities in this location are declined.

**Christopher William Day**
**9 June 2017**

## Appendix A – NZS 6805 Table 1 & 2



Table 1
RECOMMENDED NOISE CONTROL CRITERIA FOR LAND USE PLANNING INSIDE THE AIRNOISE BOUNDARY

| Sound exposure $Pa^2s$ (1) | Recommended control measures | Day/night level Ldn (2) |
|---|---|---|
| >100 | New residential, schools, hospitals or other noise sensitive uses are prohibited. Steps shall be taken to provide existing residential properties with appropriate acoustic insulation to ensure a satisfactory internal noise environment. Alterations or additions to existing residences or other noise sensitive uses shall be permitted only if fitted with appropriate acoustic insulation. | >65 |
| >350 | Consideration should be given to purchasing existing homes, or relocating residents, and rezoning the area to non-residential use only. | >70 |
| >1000 | There is a high possibility of adverse health effects. Land shall not be used for residential or other noise sensitive uses. | >75 |

NOTE –

(1) Night-weighted sound exposure in pascal-squared-seconds or "pasques".

(2) Day/night level (Ldn) values given are approximate for comparison purposes only and do not form the base for the table.

Table 2
RECOMMENDED NOISE CONTROL CRITERIA FOR LAND USE PLANNING INSIDE THE OUTER CONTROL BOUNDARY BUT OUTSIDE THE AIR NOISE BOUNDARY

| Sound exposure $Pa^2s$ (1) | Recommended control measures | Day/night level Ldn (2) |
|---|---|---|
| >10 | New residential, schools, hospitals or other noise sensitive uses should be prohibited unless a district plan permits such uses, subject to a requirement to incorporate appropriate acoustic insulation to ensure a satisfactory internal noise environment.<br><br>Alterations or additions to existing residences or other noise sensitive uses should be fitted with appropriate acoustic insulation and encouragement should be given to ensure a satisfactory internal environment throughout the rest of the building. | >55 |

NOTE –

(1) Night-weighted sound exposure in pascal-squared-seconds or "pasques".

(2) Day/night level (Ldn) values given are approximate for comparison purposes only and do not form the base for the table.

## Appendix B – Acoustic 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

**$L_A$** The A-weighted sound level (in dB) 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.

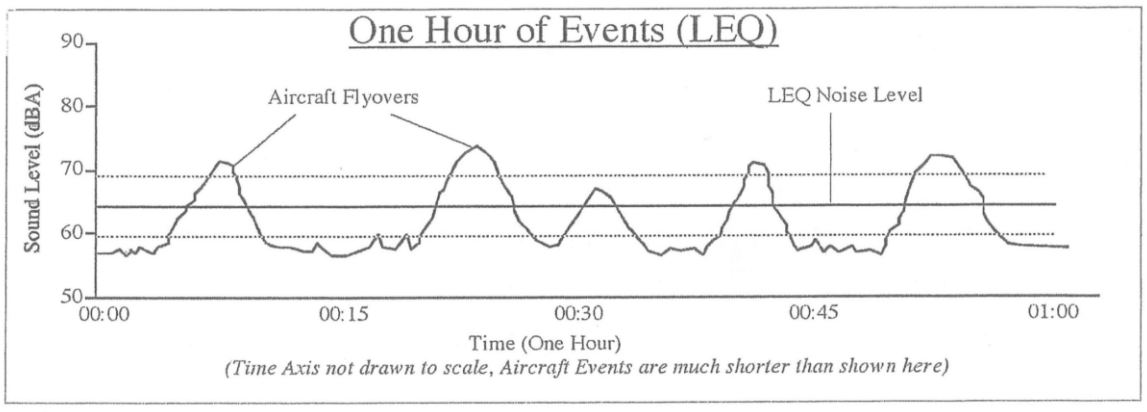



**Figure A.1 - $L_{eq,1hr}$ from a number of aircraft noise events**

**$L_{dn}$** 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).

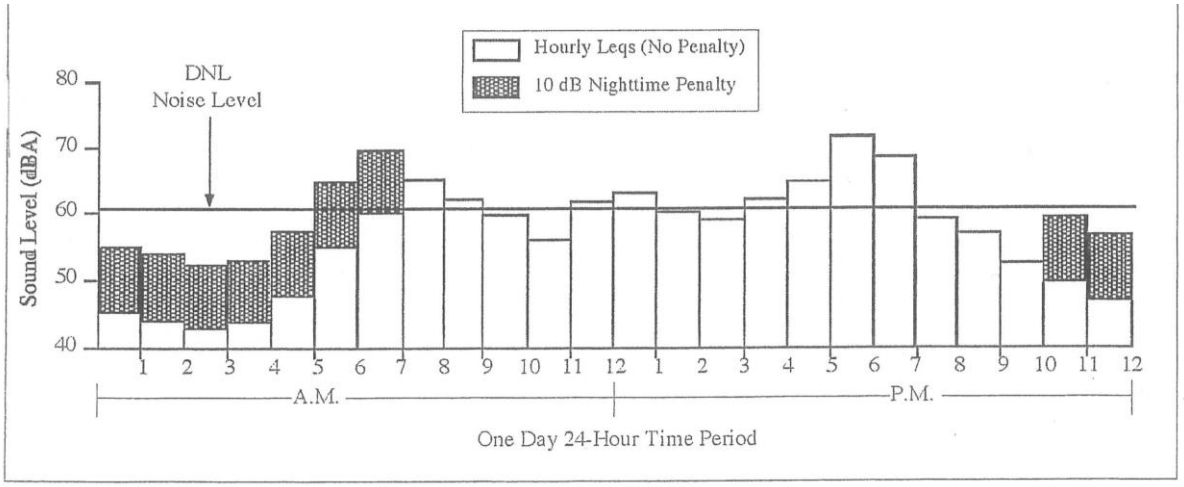



**Figure A.2 – Calculation of $L_{dn}$ from 24x $L_{eq,1hr}$**

**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.

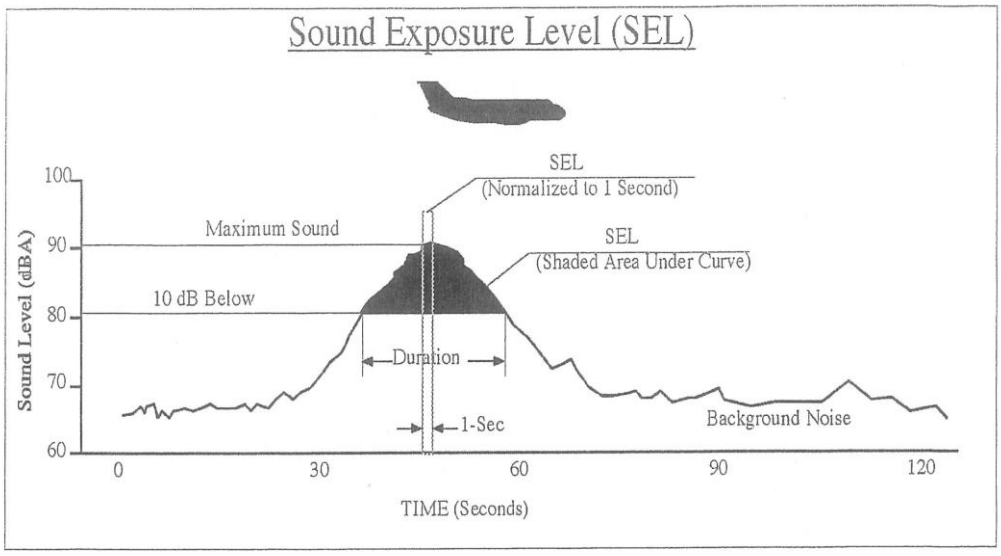



**Figure A.3 - SEL and $L_{max}$ for Single Event Noise**

## Appendix C – Summary of PC35 Provisions

| Zone | Location | Proposed Activity | PC35 Activity Status |
|---|---|---|---|
| **RURAL** | Within OCB or within the ANB | New ASAN | Prohibited |
| | Within ANB | Additions and Alterations to existing buildings containing ASAN | Permitted subject to compliance with the acoustic insulation and mechanical ventilation standards otherwise Non-Complying. |
| | Between ANB and OCB | Additions and Alterations to existing buildings containing ASAN | Permitted subject to compliance with the mechanical ventilation standards otherwise Non-Complying. |
| **AIRPORT MIXED USE** | Anywhere within the zone | New ASAN | Prohibited |
| **RESIDENTIAL** Residential Activities and Visitor Accommodation | Within ANB | New ASAN | Permitted subject to compliance with the acoustic insulation and mechanical ventilation standards otherwise Non-Complying. |
| | | Alterations and additions to existing buildings containing an ASAN | |
| | Between ANB and OCB | New ASAN | Permitted subject to compliance with the mechanical ventilation standards otherwise Non-Complying. |
| | | Alterations and additions to existing buildings containing an ASAN | |
| **RESIDENTIAL** Non-Residential Activities (other than Visitor Accommodation in the High Density Residential Zone) | Within ANB | New ASAN | Permitted subject to compliance with the acoustic insulation and mechanical ventilation standards otherwise Non-Complying. |
| | | Alterations and additions to existing buildings containing an ASAN | |
| | Between ANB and OCB | New ASAN | Permitted subject to compliance with the mechanical ventilation standards otherwise Non-Complying. |
| | | Alterations and additions to existing buildings containing an ASAN | |

| | | | |
|---|---|---|---|
| **INDUSTRIAL** | Within OCB | New ASAN | Prohibited |
| | Between ANB and OCB | Additions and Alterations to existing buildings containing ASAN | Permitted subject to compliance mechanical ventilation standards otherwise non-complying |
| **REMARKABLES PARK** | Within the yellow areas on Remarkables Park Zone Figure 2 – Airport Measures in the District Planning Maps | All buildings | Controlled having regard to amongst other things, Queenstown Airport and to achieve insulation from aircraft noise. |
| | | Design and construction of residential activities | Controlled having regard to amongst other things, Queenstown Airport and to achieve insulation from aircraft noise. |
| | | Any building or part of a building, or any alteration or addition to an existing building or part of an existing building, to be used for Residential activities or Visitor Accommodation | Permitted subject to compliance with the following rules otherwise Non-complying.<br><br>Shall be acoustically insulated from aircraft noise so as to achieve an Indoor Design Sound Level of 40dB Ldn based on the 2037 Noise Contours, except for non-critical listening environments where no special sound insulation is required.<br><br>Where the building is located between 58 and 60 dB 2037 Noise Contours, this control shall be met in either of the following two ways:<br><br>EITHER: By installation of mechanical ventilation to achieve the requirements of Table 2 at Appendix 13. OR: By submitting a certificate to Council from a suitably qualified acoustics expert stating that the Indoor Design Sound Level will be achieved by the proposed building design including certification from a suitably qualified ventilation expert that adequate ventilation will be achieved with the extent of open windows specified by the acoustics expert. |
| | Within the yellow areas on Remarkables Park Zone Figure 2 – Airport Measures in | Residential Activities | Controlled |
| | | Community Activities | Non-Complying |

| | | | |
|---|---|---|---|
| | the District Planning Maps (AA7 only) | | |
| | Within the red hatched area indicated on Remarkables Park Zone Figure 2 – Airport Measures in the District Planning Maps and labelled "NO BUILDINGS AREA" (AA8) | Buildings | Prohibited |
| | Within the [blue] areas indicated on Remarkables Park Zone Figure 2 – Airport Measures in the District Planning Maps and labelled "NO RESIDENTIAL, VISITOR ACCOMMODATION OR COMMUNITY ACTIVITIES AREA" (AA5, AA6, AA7) | Residential, Visitor Accommodation and Community Activities | Prohibited |
| | Within the green areas shown on Remarkables Park Zone Figure 2 - Airport Measures in the District Planning Maps | Educational Facilities | Permitted subject to compliance with the following rules, otherwise Discretionary.<br><br>No classrooms, halls or any other buildings which are used as internal teaching areas are to be located within that area.<br><br>Outdoor areas are not to be regularly used for high quality listening or communication, such as occurs in academic teaching. This standard shall not preclude recreation and recreation related activities e.g. sports coaching.<br><br>All buildings (except Non Critical Listening Environments) shall be designed to achieve an Indoor Design Sound Level of 40 dB Ldn, based on the 2037 Noise Contours and if that Indoor Design Sound Level cannot be met with windows open, then those |

| | | | |
|---|---|---|---|
| | | | buildings shall be fitted with mechanical ventilation* |
| **FRANKTON FLATS** | Within OCB | ≤ 70 Units associated with Visitor Accommodation;<br><br>1 Health Care facility (including but not limited to doctors and/or dentists surgery but excluding hospitals) ≤ gross floor area of 900m$^2$; and<br><br>1 Educational Facility ≤ an internal gross floor area of 450m$^2$ and associated outdoor space of 450m$^2$. | Discretionary Activity subject to compliance with the following rules otherwise Non-complying.<br><br>Shall be acoustically insulated from aircraft noise so as to achieve an Indoor Design Sound level of 40dB Ldn based on the 2037 Noise Contours, except for non-critical listening environments where no special sound insulation is required.<br><br>Where the building is located between 58 and 60 dB 2037 Noise Contours, this control shall be met in either of the following two ways: EITHER: By installation of mechanical ventilation to achieve the requirements of Table 2 at Appendix 13. OR: By submitting a certificate to Council from a suitably qualified acoustics expert stating that the above Indoor Design Sound Level will be achieved by the proposed building design including certification from a suitably qualified ventilation expert that adequate ventilation will be achieved with the extent of open windows specified by the acoustics expert. |
| | Within ANB | Residential and Educational Activity | Discretionary |
| | Within OCB | ASAN other than those listed above | Prohibited |

## Appendix D – Location of Rezoning Submissions