IN THE MATTER	**of the Resource Management Act 1991**
AND	
IN THE MATTER	**of the Proposed Queenstown Lakes District Council Proposed District Plan**
AND	
IN THE MATTER	of submissions and further submissions by **BOARD OF AIRLINE REPRESENTATIVES NEW ZEALAND INC ("BARNZ"):**
	S271.11 - 14
	S271.18
	FS 1077 to S433.60.

EVIDENCE OF ERIC MORGAN FOR BARNZ IN RELATION TO CHAPTER 7

30 SEPTEMBER 2016

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1. QUALIFICATIONS AND EXPERIENCE

1.1 My full name is Eric Llewellyn Morgan.

1.2 I am a self-employed aviation consultant with my company ELM Associates Limited. I provide, or have provided, aviation related consultancy services to various airlines and airports relating to customer self-service, process re-engineering, operations, facilitation, airport terminal planning, design and development, and airport noise related matters in New Zealand and a number of offshore locations. I am authorised to make this statement on behalf of behalf of BARNZ.

1.3 I am a graduate of the University of California, Los Angeles (UCLA) Executive Management Certificate program.

1.4 I have been involved in aviation for close to 50 years. In that time I have held a variety of senior roles within the aviation industry including at Air New Zealand where I was;

- Regional Airports Manager Northern - responsible for all of Air New Zealand Limited's airport operations at Auckland and a number of regional airports.
- Vice President Airports, The Americas – based in Los Angeles and responsible for Air New Zealand's operations in the USA, Chile, and Canada.
- Vice President Network Logistics - responsible for Air New Zealand's domestic and international jet aircraft operations, crew, and aircraft operations planning and co-ordination.

1.5 I have also provided aviation related submissions on behalf of a number of clients including Air New Zealand Ltd for airport and district plan related noise matters. This includes submissions on Air New Zealand's behalf for Queenstown related Plan Changes 19, 34, and 35.

1.6 I am also advising Marlborough and Waitaki District Councils on aviation related matters and recently made submissions on behalf of clients for the Auckland Unitary Plan and the Christchurch Proposed Replacement District Plan processes.

1.7 I have 10 years' experience as an active member on behalf of BARNZ on the air noise committees at Wellington and Auckland.

1.8 I confirm that I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014. I have complied with the Code of Conduct in preparing this evidence and I agree to comply with it while giving oral evidence before the Hearings Panel. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

2. SCOPE OF EVIDENCE

2.1 My evidence addresses factors relevant to Topic 06 Chapter 07 and covers the following matters:

(a) NZS 6805:1992 and its relevance to the issue of land use planning and lot size in the LDRZ;

(b) Forecast growth and what it means for flight activity at Queenstown Airport;

(c) Runway utilisation and the associated reverse sensitivity and annoyance effects;

(d) The intent of recent plan changes 19 and 35;

(e) My response to the Council's section 32, 32AA and 42A reports; and

(f) The potential reverse sensitivity and annoyance effects that require consideration.

3. BACKGROUND

Queenstown Airport was established in 1935. Scheduled passenger operations commenced in 1951 and scheduled jet services commenced in 1989. International jet services commenced in 1995 and scheduled passenger aircraft movements at Queenstown have increased substantially since that time. 1.68 million passengers used Queenstown

Airport in the year to date August 2016, boosting tourism and the local economy.

3.1 Since 1935 residential property expansion in the Queenstown area has also been a continuing and expanding activity. The vintage of dwellings within the low density residential zone ("LDRZ") varies in design and construction consistent with the passage of time.

3.2 It is realistic to suggest that the majority of dwellings have been constructed since the inception of the airport and that decisions regarding acquisition and construction since 1935, and especially since 1951 have been made cognisant of the airport's existence and the potential for activity growth given the steady increase in popularity of Queenstown as a location and a tourist destination.

3.3 The potential for consequential reverse sensitivity responses has increased with the increase in aviation activity and number of dwellings in the vicinity of the airport.

3.4 The Council recognised that issue and the potential consequences during the Plan Change 19 Frankton Flats ("PC19") process by adopting a definition for Activities Sensitive to Aircraft Noise ("ASAN") and then again with revised land use rules applicable to the expanded noise boundaries and the concurrent implementation of noise mitigation by Queenstown Airport Corporation ("QAC") in Plan Change 35 ("PC35").

3.5 The proposed District Plan incorporates the decisions from PC19 and 35, which I further refer to in section 7 of my evidence.

4. NZS 6805:1992 AIRPORT NOISE MANAGEMENT AND LAND USE PLANNING

4.1 The opening paragraph of the Foreword to NZS6805:1992 Airport Noise Management and Land Use Planning ("NZS6805 or the Standard") states the following;

> This Standard is concerned with land use planning and the management of aircraft noise in the vicinity of an airport, or aerodrome, for the protection of community health and amenity values. It is intended to be applicable to all airports and aerodromes as defined in Civil Aviation Regulations 1953 Regulation 4, to ensure communities living close to the airport are properly protected from the effects of aircraft noise whilst recognizing the need to be able to operate an airport efficiently.

4.2 The underlying principles of the Standard:

- Are "for use by territorial or regional government for the control of airport noise" through the inclusion of appropriate land use controls in their district plans;
- Are for the establishment of maximum acceptable levels of aircraft noise exposure "around airports for the protection of community health and amenity values while recognizing the need to operate the airport efficiently";
- Utilise a methodology that includes practical land use planning controls and airport management techniques.
- Provide "the <u>minimum</u> requirement needed to protect people from the adverse effects of airport noise." (emphasis added)

4.3 The Standard builds on the overarching purpose of the RMA and advises local authorities that noise control measures including land use rules are necessary where maximum levels of aircraft noise exposure exceed 65 [1]dBA[2] Ldn[3] measured as daily sound exposure over a 24 hour period and averaged over a 3 month period.

4.4 The limits of the land area exposed to current or future high levels of aircraft noise that are sufficiently high to require appropriate land use controls is defined by a control line or air noise boundary ("ANB"). The Standard recommends the limit of this high noise area should be

[1] The decibel (dB) is commonly used as a unit of measurement for sound pressure levels.
[2] A-weighting is applied to instrument-measured sound levels with the objective of accounting for the relative loudness perceived by the human ear due to the human ear being less sensitive to low audio frequencies.
[3] Ldn (day/night level) is defined in *NZS6805:1992 Airport Noise Management and Land Use Planning* as the time-average sound level in decibels over a 24 hour period (from midnight to midnight) with the addition of a 10 dB to night time levels during the period from midnight to 07:00 hours and from 22:00 hours to midnight to take account of the increased annoyance caused by noise at night. Note: In aircraft noise considerations the day/night level is based on an average day over an extended period.

defined at 65 dBA Ldn. The Standard also recommends the establishment of a second noise exposure boundary at 55 dBA Ldn to protect amenity values outside the ANB. This is referred to as an "outer control boundary" ("OCB").

4.5 The Standard describes amenity values as follows;

> "… those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes"[4]

4.6 NZS6805 contains the following advice for land use planning;

> ***1.8 Explanation of tables***
>
> ***C1.8.1***
>
> All considerations of annoyance, health and welfare with respect to noise are based on the long term integrated adverse responses of people. There is considerable weight of evidence that a person's annoyance reaction depends on the average daily sound exposure received. The short term annoyance reaction to individual noise events is not explicitly considered since only the accumulated effects of repeated annoyance can lead to adverse environmental effects on public health and welfare. Thus in all aircraft noise considerations the noise exposure is based on an average day over an extended period of time - usually a yearly or seasonal average. (Further details may be obtained from US EPA publication 500/9-74-004 "Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety").
>
> ***1.8.2***
>
> Table 1 enumerates the recommended criteria for land use planning within the air noise boundary i.e. 24 hour average night-weighted sound exposure in excess of 100 Pa^2s (65 Ldn).
>
> ***1.8.3***
>
> Table 2 enumerates the recommended criteria for land use planning within the outer control boundary i.e. 24 hour average night-weighted sound exposure in excess of 10 Pa^2s.

[4] Definitions, *NZS6805:1992 Airport Noise Management and Land Use Planning*.

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*

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.* *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*

Additionally, to recognise the potential increased annoyance of noise at night the Standard also recommends that the measurement of night time sound (between 22:00 and 07:00 hours) should be weighted by a

factor of 10. Calculations of night time noise are usually based on this recommendation.

4.7 Queenstown Airport currently has approvals to operate between 06:00 and 22:00 hours.

4.8 Evident in the Standard is a strong guiding principle that new residential use within the ANB should be prohibited. That contrasts with the more modified approach to the treatment of ASAN between the ANB and the OCB which is to recommend prohibition of those activities, while recognising that there may be circumstances where it is appropriate for a district plan to modify its treatment of new ASAN through requirements to incorporate appropriate acoustic insulation.

4.9 It is important to recognise that NZS6805:1992 does not recommend acoustic treatment as a default position for new noise sensitive activities inside the ANB. If that was the case then all that the Standard would require was a given internal sound level (e.g 40 dBA Ldn) for all new activities. In recognition that nothing can be done about aircraft noise in the external environment and the amenity issues that arise as a result, it recommends a land use planning approach.

4.10 I am also familiar with noise management at several US airports and the approach adopted in the New Zealand Standard is broadly consistent with the methodologies applied in the USA.

5. FORECAST GROWTH

5.1 The air noise boundaries included in the District Plan maps are the output of complex computer modelling by specialist acoustic engineers. The modelling outputs are based on known aircraft sound signatures and forecast aircraft movements estimated over an extended period. In New Zealand the computer model used has typically been the internationally recognised US Federal Aviation Administration Integrated Noise Model (INM).

5.2 At Queenstown the Air Noise Boundary and Outer Control boundaries were amended through the adoption of Plan Change 35 by QLDC. The

final definition of the boundaries is subject to confirmation by the Environment Court pending a decision of the QAC Notice of Requirement to acquire Lot 6 land.

5.3 The modelling for PC35 was undertaken by Marshall Day Acoustics and reflected growth forecasts developed for QAC in 2009 by Airbiz, an aviation consultancy.

5.4 The following Table outlining the base assumptions for the PC35 noise modelling is extracted from the Marshall Day PC35 report. The full report is contained at Appendix 1 of this submission

.APPENDIX C: SUMMARY OF AIRCRAFT MOVEMENTS (*Abridged*)						
Scenario	Total	Scheduled	Corporate	Flightseeing	GA	Heli
2008 Compliance Contours	58780	9065	758	6365	19914	22678
Updated 2037 Contours	**94600**	**21300**	**1200**	**20500**	**16200**	**35400**
Source: Marshall Day Acoustics Report/Appendix 7/Plan Change 35						

6. RUNWAY UTILISATION

6.1 Key components of the modelling used in calculating the noise boundaries are the airport configuration and the flight tracks of aircraft using the airport.

6.2 Queenstown Airport has two runways, a main runway (05/23) serving commercial regular passenger transport operations and a short secondary runway (14/32) supporting flight seeing aircraft types. The runway usage splits in Table 2 below were adopted by Marshall Day in developing the PC35 noise boundaries and are contained in their report attached at Appendix 1.

Table 2 - APPENDIX D: INM INPUT - PERCENTAGE RUNWAY USE				
Fixed Wing Arrivals				
Runway	**Scheduled (%)**	**Corporate (%)**	**Flightseeing (%)**	**General Aviation (%)**
5	26	30	39	12
23	74	70	21	43
14	-	-	24	40
32	-	-	16	5
APPENDIX D: INM INPUT - PERCENTAGE RUNWAY USE				
Fixed Wing Departures				
Runway	**Scheduled (%)**	**Corporate (%)**	**Flightseeing (%)**	**General Aviation (%)**
5	31	30	66	65
23	69	70	6	12
14	-	-	7	20
32	-	-	21	3
Source: Marshall Day Acoustics Report/Appendix 7/Plan Change 35				

6.3 Utilising these runway splits converted to the 2037 annual movement forecasts from Table 1 (paragraph 5.4) an estimated 46,700 (79%)[5] fixed wing aircraft movements annually will utilise Runway 05 and 23 crossing over the LDRZ within the OCB during the course of either landing or taking off.

6.4 The ANB and OCB adopted through PC35 reflect this increase in main runway activity mostly by regular passenger transport jets and turboprops. The relative increase in noise exposure, especially at the western end of the main runway (in McBride St) is recorded in Table 6-2 of the Marshall Day report attached as Appendix 1.

6.5 It was not possible to establish the actual helicopter arrival and departure routings used in the model from the PC35 supporting documentation; however I am aware that a proportion of helicopter movements do operate to and from Queenstown Airport over the low density residential area.

[5] Source data Marshall Day Report at Appendix 1 and submission tables. Calculation based on all forecast PC35 2037 jet movements (21300) + corporate (1200) + Flightseeing/GA fixed wing aircraft (13671) using runway 05/23 as a percentage of totals (59200) fixed wing movements. Runway usage derived from the percentage runway usage used in PC35.

6.6 There is a curfew at Queenstown Airport between 22:00 and 06:00 hours. Indirectly a benefit of this is that any night time sleep disturbance that would typically be experienced at many airports is mitigated through the lack of operations in night time hours except for the commencement of any operations at 06:00, one hour inside the night time period.

6.7 NZS6805 states that the noise effects are averaged over both day and night (Ldn) and that insulation of dwellings inside the 65 dBA Ldn boundary is necessary regardless of time of day to achieve acceptable internal listening amenity. This is achieved via a variety of solutions including additional insulation and linings, window seals, and (occasionally) additional glazing and ventilation systems.

6.8 There are a number of existing dwellings in the ANB and there are provisions in the plan for QAC to provide mitigation packages in recognition of the potential noise impacts.

6.9 Unfortunately mitigation of aircraft noise and management of external environmental amenity near airports is limited primarily to aircraft noise abatement measures that do not impinge on safety of operation. The options available for noise abatement measures at Queenstown are limited especially in the LDRZ which lies under the approach and take-off paths in close proximity to the main runway threshold where such procedures are not possible.

6.10 This means that outdoor living, which is a desirable way of life for many New Zealanders, especially during the summer months, is invariably impacted by aircraft noise in the proximity of airports.

6.11 From the foregoing it can be seen that main runway activity will increase substantially over the period, with a forecast 96% increase in annual jet movements between 2015[6] and 2037[7].

6.12 Information regarding annoyance effects and the potential for reverse sensitivity impacts are contained in the Marshall Day report at Appendix

[6] Page 32 (5994 landings+5994 departures = 11988 movements) Queenstown Airport Corporation Ltd, Disclosure Financial Statements for FY 30 June 2015.
[7] Para 5.4, 2037 Forecast Scheduled plus Corporate movements (23,500 movements).

1. Any reduction in lot size and introduction of new ASAN will create the potential for an increase in reverse sensitivity impacts.

6.13 The evidence of Mr Beckett outlines some examples of reverse sensitivity effects in the context of airport operations.

7. QUEENSTOWN PLAN CHANGES 19 AND 35.

7.1 On behalf of Air New Zealand I co-ordinated and made submissions in the two Queenstown PC19 and 35 plan changes, appeared at the related hearings and was involved in the appeals processes.

7.2 **Plan Change 19**, known as "Frankton Flats B" focussed on a comprehensive re-zoning of land between Queenstown Airport and SH 6 for mixed use including industrial, visitor accommodation, commercial, residential, business, and educational activities. This QLDC plan change was being heard almost simultaneously with the QAC private plan change 35 to amend the airport noise boundaries.

7.3 In their submissions for PC19 both QAC and Air New Zealand sought that activities sensitive to aircraft noise (ASAN) be prohibited within the whole of the land area subject to the PC19 re-zoning.

7.4 In reaching their decision to prohibit ASAN within the OCB, the commissioners recognised the vulnerability of potential reverse sensitivity on the airport's activity noting that the "well respected and sound scientifically based"[8] controls in NZS6805 provided adequate protections within those parts of the zone covered by the noise boundary and additional controls were unnecessary beyond the OCB.

7.5 The key message from the PC19 commissioner's decision is that the guidance from NZS6805 is of sufficient robustness as to be relied upon when making land use decisions. That conclusion is as relevant to the current plan process as it was in PC19.

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[8] Plan Change 19 – Frankton Flats(B) Report, Reasons and Recommendations, Independent Commissioners(3) Para 3.5.33 "We are satisfied that controls based on an OCB modelled on the 55dBA Ldn noise contour are appropriate because the standard imposing that level is well respected, of long term use, and is soundly scientifically based. We do not consider that there are any reasons in relation to the proposed Plan Change area to deviate from a set of controls based on that standard."

7.6 QAC and Air New Zealand also sought the inclusion of a definition for activities sensitive to aircraft noise (ASAN) in the District Plan which was supported by the PC19 commissioner's recommendation and adopted by QLDC. The PC19 clause wording was subsequently amended in PC35 recommendations and the proposed plan reflects the definition taken from PC35. The **PC35** purpose was to amend the Queenstown Airport noise boundaries and introduce land use planning rules to allow and protect for growth to 2037.

7.7 PC35 was undertaken simultaneously with a designation change by QAC to provide for a mitigation package, noise management plan and an airport/community noise liaison committee.

7.8 The Hearing Commissioner's recommendation and QLDC's PC35 decision reflected the following objective and policies;

> ***Objective 7 – Queenstown Airport - Noise Management***
>
> *Maintain and promote the efficient operation of Queenstown Airport and set appropriate noise limits in order to protect airport operations and to manage the effects of aircraft noise.*
>
> ***Policies***
>
> *7.1 To ensure appropriate noise boundaries are established and maintained to enable operations at Queenstown Airport to continue and expand over time.*
>
> *7.2 To manage the adverse effects of noise from aircraft on any activity sensitive to aircraft noise within the airport noise boundaries whilst at the same time providing for the efficient operation of Queenstown Airport.*

7.9 The amended PC35 ANB sits over part of the LDRZ. I acknowledge that PC35, did not seek to prohibit new ASAN's or alterations to existing ASAN's within the ANB. As a consequence there was, and still is, the potential for reverse sensitivity impacts on the airport.

7.10 Notwithstanding the NZS6805 guidance on the prohibition of new ASANs within an ANB it also appears that QAC, promoting Plan Change 35 recognised that the amended ANB overlaid the LDRZ and that existing development opportunities within the context of the

operative district plan should be "grandfathered" within the revised boundary. That position was informed by the operative plan's minimum net lot size of 600m^2.

7.11 In my opinion, the operative plan, as amended by PC35, is inconsistent with best practice in the application of sound land use planning principles relative to aircraft noise impacts. This inconsistency arises because new residential dwellings within the ANB have been permitted subject to insulation or ventilation requirements. Conversely, new ASAN are Prohibited in the Rural and Industrial zones overlaid by the OCB.

7.12 As I discuss below, the S42A recommended changes to the Proposed Plan continue that inconsistency[9] with potentially negative consequences for the airport and community health and welfare if the proposals to reduce lot size are adopted.

8. THE COUNCIL REPORTS

8.1 In assessing retention of Rule 7.4.11 and the density proposals within the ANB, the Section 32 Report, noted that limiting "intensification within the Air Noise Boundary will contribute to protecting the airport from reverse sensitivity effects. This will support the efficient operation of the airport with associated economic benefits to the district". [10]

8.2 Conversely, in recommending deletion of Rule 7.4.11 the section 32AA report has not identified any costs at all. Instead it notes a benefit of allowing the "development of one residential unit per 450m2 net site area as being consistent with the density that the ODP and Plan Change 35 allows".[11]

8.3 The failure to identify any cost whatsoever associated with removal of Rule 7.4.11 ignores the potential cost to the airport and the wider community if exposure of aircraft noise to a greater number of people results in reverse sensitivity effects and results in constraints on the airport's operations. There is neither any calculation of this cost in the context of the Airport's contribution to the economy, nor explanation as

[9] Noting that the Industrial Zone Chapter has yet to be notified for the Proposed Plan.
[10] Page 38
[11] Section 42A Report, Appendix 4, Section 32AA Assessment p60/192

to why the rationale for the rule's initial inclusion in the plan, to address reverse sensitivity effects, has changed.

8.4 I have therefore calculated the potential number of properties affected within the ANB by amending the rules, which I attach as Appendix 2.[12] I have assessed the additional numbers of dwellings enabled by:

(a) Retaining Rule 7.4.11 (one dwelling per site) and its impact on currently vacant lots;

(b) Reducing density from 450m^2 to 300m^2 (without Rule 7.4.11 or a minimum lot size of 600m^2))

(c) Retaining the minimum lot size of 600m^2

8.5 I have included properties in the ANB with constraints (e.g. subject to a designation, utilised for community purposes, or owned by QAC) and excluded those from the figures I refer to. In summary, within the ANB**:**

(a) Applying a density limit of 1 dwelling per 450m^2 without retaining Rule 7.4.11 would potentially enable an additional eighteen dwellings;[13]

(b) Applying a density limit of 1 dwelling per 300m^2 without retaining Rule 7.4.11 would potentially enable an additional forty six dwellings;[14]

(c) Applying Rule 7.4.11 in conjunction with a minimum lot size of 600m^2 would result in an additional 6 dwellings.[15]

8.6 There are presently 73 total existing dwellings in the ANB. Recognising that a vacant lot holding has a right of reasonable use, any increase in dwellings above that baseline within the ANB conflicts with the NZS6805 guidance and the objectives of protecting community health and welfare with respect to noise. To put this in the context, an increase of fifty dwellings represents a 63% increase in the numbers of

[12] The information in Appendix 2 is sourced from the Council's GIS maps, District Plan maps, Google maps and ground truthing.
[13] Appendix 2, Column 5. This is also what is provided for under the PC35.
[14] Appendix 2, Column 6.
[15] Appendix 2, Column 4 + Column 7 (4 + 2 = 6). In column 7 I have excluded 56-58 to Douglas Street given the existing development intensity.

dwellings where people are exposed to noise. An additional 18 dwellings is a 23% increase.

8.7 Under any of the density scenarios identified the numbers of additional dwellings that the plan could enable within the ANB are negligible in the scheme of providing the estimated 10,000 to16,000 new dwellings required in the district by 2045.[16] By contrast, the exposure of additional residents to aircraft noise significantly increases the potential risk for impact on airport operations, as I have explained. The merits of an increased number of dwellings within the ANB must be considered weighing the health and welfare of the resident community, potential reverse sensitivity impacts on significant infrastructure, against the quantum of contribution to the overall housing supply requirements and the lost opportunity gains to a relatively few property owners. In my view, the potential risk outweighs the potential gain and so the number of additional dwellings within the ANB should be minimised to the greatest extent feasible.

8.8 I note also that the S42 Report[17] considers that notification to QAC for any developments that do not comply with Rules 7.5.3 or 7.5.4 is unnecessary.[18] I disagree with the recommendation. In my experience council planning officers can, and do, easily overlook the wider implications of developments near airports. Mr Beckett also discusses an example where this has occurred with implications for BARNZ and the airport in question.[19] The issues arising can be readily resolved by a notification requirement that engages the airport in the planning process. Aside from noise related matters there is a safety of operation perspective that needs to be monitored by the airport. I make the point that this is not about the airport approving activity but about being informed and the avoidance of unanticipated consequences compromising airport operations.

[16] EIC Philip Osborne – Hearing Stream 06 - para 2.6
[17] S42 Chapter 7 Low Density Residential, para 12.17.
[18] BARNZ FS 1077 to QAC
[19] EIC John Beckett – Hearing Stream 06 para 5.16(d)

9. REVERSE SENSITIVITY AND ANNOYANCE EFFECTS

9.1 The term reverse sensitivity is used to describe the impacts arising from the introduction of new activities on existing uses. In the case of Queenstown Airport this encapsulates the introduction of new ASAN from aircraft and airport related activities.

9.2 As discussed in the evidence of Mr Beckett, the expectation of acceptable amenity from new ASAN's has the potential to result in demands that impose operational limitations or a greater economic burden on users of the airport that may affect its long term viability.

9.3 The typical response is to establish land use controls that prohibit ASAN's within the ANB and impose insulation requirements on existing developments. Insulation of existing residential properties is usually paid for by the airport operator with the costs being levied on the airlines using the airport. Additional controls such as limits on lot size and insulation requirements are also typically applied to the area between the ANB and OCB.

9.4 Generally the individual response to aircraft noise varies across the community from those not affected to those who are highly annoyed. There has been considerable research undertaken into the effects of transportation noise with a respected aircraft specific study by Miedema and Ouldshoorn published in 2001.

9.5 Acoustic engineering is outside my area of expertise and rather than repeat the research Appendix 1 of this submission contains a copy of the Marshall Day Report 1992301A 002 R09 which includes expert advice on noise annoyance effects. This document was included as Appendix 7 of the PC35 proceedings and is also the underlying basis for the development of the now approved Queenstown air noise boundaries.

9.6 I note also that this same report includes an estimate of the increase from 42 to 219 in the overall number of people likely to be highly annoyed as a result of the revised contours in PC35. Within the

amended 65 dBA Ldn (ANB) it was noted that of the 187 people in 72 dwellings, 56 (30%) were likely to be annoyed.

9.7 For completeness I also note from the Marshall Day report that 17% of the 958 residents within the area between the 55 dBA Ldn (OCB) and 65 dBA Ldn (ANB) boundaries are likely to be highly annoyed. An increased number of dwellings (resulting from this plan change) within this area will also increase the potential numbers of people highly annoyed. At the time of the PC35 lodgement land use controls were based on the existing noise boundaries and the permitted lot size of 600m^2. The forecast effects on the resident population were related to those factors. A reduction in lot size and consequential increase in ASAN within the ANB as noted above will have the potential to substantially increase reverse sensitivity impacts, the very opposite of the available guidance and intent when PC35 was decided.

9.8 Diminishing the lot size and decreasing the allowable density limits within the LDRZ will increase the demand for sub-division, and consequentially within the ANB the demand for introduction of more ASAN, the reverse outcome from that targeted by the establishment of an ANB and the typical prohibitions or controls constraining residential development (ASAN) within an ANB.

10. SUMMARY

10.1 Queenstown Airport is nationally significant infrastructure that supports the delivery of strong economic benefits to the region.

10.2 Scheduled aircraft movements are forecast to double between 2015 and 2037. Seventy-nine percent of this activity will occur on the main runway, either landing or taking off over the LDRZ at the western end of the airport.

10.3 The District Plan framework must be structured to reinforce regional objectives while balancing the needs and aspirations of residents not only in the vicinity of the airport but also across the region.

10.4 NZS6805 defines the maximum acceptable levels of aircraft noise exposure and the minimum requirement needed to protect people from the adverse effects of aircraft noise.

10.5 NZS6805 is also well accepted as a robust approach to the management of aircraft noise utilising a control boundary concept to inform efficient land use planning, protect the airport from reverse sensitivity impacts and protect community health and amenity values. NZS6805 has a clear guiding principle that ASAN should be prohibited in the ANB: acoustic treatment is not a default position.

10.6 PC35 amended the airport's noise boundaries to accommodate anticipated growth and introduced a noise mitigation requirement for new ASAN within the LDRZ areas overlaid by both ANB and OCB, Contrary to the NZS6805 guidance however new ASAN were permitted in the LDRZ but prohibited within the Rural and Industrial zones overlaid by the OCB.

10.7 This inconsistent approach prioritises existing development opportunity over that of community welfare and amenity values and in so doing exposes the airport to the potential for increased reversed sensitivity effects.

10.8 The S42 amendments recommend retention of the 600m^2 minimum lot size but a removal of the limitation of one dwelling per site (7.4.11) within the LDRZ. The 600m^2 minimum lot size should be retained however deletion of Rule 7.4.11 continues the misalignment with NZS6805. It enhances the potential for increased levels of annoyance and reverse sensitivity impacts, potential constraints on airport growth, and significantly overlooks the key objectives in aircraft noise management of protecting community health and amenity values from the effects of aircraft noise within the LDRZ where it is overlaid by the noise boundaries. Rule 7.4.11 should also be retained.

10.9 There are currently 73 dwellings ASAN) within the high noise ANB area. An analysis of the benefit in dwelling numbers arising from the two options (300m and 450m^2) under consideration (without the retention of proposed Rule 7.4.11) suggests a possible opportunity increase of

either 18 or 46 units. Put into context this represents an increase of 23% or 63% in the number of dwellings (ASAN) within the ANB, the highest noise impact area. Retention of the minimum lot size of 600m^2 would result in an additional 6 dwellings (ASAN).

10.10 Yet there is an intention to prohibit new ASAN within the Rural and Industrial zones overlaid by the OCB. Consistency and the principal noise management objectives of NZS6805 suggests that new ASAN within the ANB should actually be prohibited if it is considered essential.[20] new ASAN in Rural and Industrial zone areas should be prohibited inside the OCB

10.11 On that basis the minimum lot area within the LDRZ, where residents are exposed to higher levels of noise in the areas overlaid by the ANB should, at least, remain at 600m^2 with Rule 7.4.11 being retained in the plan. Ideally the 600m2 minimum lot area should be adopted for the OCB given the exposure of residents of Rural and Frankton zones. .

10.12 Whatever the outcome of the plan process, it is also my opinion that where new ASAN's are contemplated within the ANB that QAC should be notified as a matter of policy for the reasons outlined in this submission.

10.13 In my opinion when determining the necessity or otherwise of allowing increased ASAN inside the ANB in the LDRZ the Panel needs to strike a balance between ideal amenity and the environmental characteristics associated with the location of the airport. Increasing the volume of ASAN within the ANB and OCB increases the risk of reverse sensitivity outcomes due to the loss of amenity that arises from increased and larger aircraft frequency over time. In essence the doubling of jet frequency at Queenstown beyond the life of the proposed plan is a significant factor that requires careful consideration.

Eric Morgan

30 September 2016

[20] Acknowledging that this relief was not sought.

APPENDIX 1 – MARSHALL DAY REPORT

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Attention: Steve Sanderson

DATE: 6 July 2009

PROJECT: **Queenstown Airport – Updated Airport Noise Contours and Assessment of Noise Effects**

REPORT NO.: 1992301A 002 R09

PREPARED BY: Steve Peakall

REVIEWED BY: Christopher Day

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1.0 INTRODUCTION

Marshall Day Acoustic (MDA) has been engaged by Queenstown Airport Corporation Ltd (QAC) to prepare revised airport noise contours for Queenstown Airport. The purpose of the preparation of revised airport noise contours is to include more up to date operational data and thus to provide revised noise control boundaries that could be used in a Plan Change or Variation application.

The Queenstown Lakes District Council (QLDC) Partially Operative District Plan (District Plan) contains Airport noise contours and noise rules based on the approach recommended in New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*". The objective of this Standard is to develop a set of noise boundaries around the Airport which are designed to protect both the surrounding residents by setting a maximum noise limit for the Airport and to protect the Airport from reverse sensitivity effects by restricting development of new noise-sensitive activities. The existing airport noise rules are contained in Appendix A and the District Plan land-use planning and noise control provisions are discussed in Sections 7 and 8. An explanation of NZS 6805 is contained in Appendix B and a glossary of technical terms is provided in Appendix H.

The noise contours in the partially Operative District Plan were developed through a detailed study carried out in the 1990's which included advice from aviation experts on future growth, aircraft utilisation and flight tracks. These various inputs were collated by Marshall Day Acoustics and used as input into the INM computer program to produce airport noise contours. The INM (Integrated Noise Model) is an internationally recognised computer program developed by the Federal Aviation Authority (FAA) of America for calculating equal loudness noise contours around airports.

Following significant scrutiny at various Hearings, the noise contours were adopted in the District Plan along with a noise rule for the airport (Appendix A) and a set of land use planning rules (refer Section 7.1) for the surrounding land.

NZS 6805 recommends that the noise contours are based on future aircraft operations. The previous study utilised anticipated annual growth rates to determine expected levels of future operations at the airport. Such projections inherently contain a level of uncertainty and in reality will not be exactly correct. Ten years 'down the track' provides an appropriate time to review the noise boundaries versus reality and to look at updating these projections as required.

Marshall Day Acoustics and Airbiz were engaged in 2007 by Queenstown Airport Corporation (QAC) to update the projected airport operations at Queenstown and recalculate the noise contours based on the updated information and upgraded versions of the INM program. Marshall Day Acoustics was also engaged to monitor current noise levels at the Airport and this was carried out for three months during 2007.

This report provides a record of the noise monitoring survey, a summary of the updated aircraft projections, details of the INM procedures to calculate updated noise contours

and provides a set of noise boundaries and rules which are proposed for inclusion in the Plan Change application.

The QAC also requested an assessment of the noise effects from the proposed increased number of future movements and the possible inclusion of 'night arrivals' of a small number of jets between 10pm and midnight.

2.0 NOISE MONITORING

Noise monitoring of aircraft activity was undertaken at several locations around Queenstown Airport between 7 May, 2007 and 13 August, 2007. The noise monitoring had two main objectives:

- To undertake an assessment of compliance with the airport noise provisions within the QLDC District Plan (Appendix A);
- To undertake an assessment of the accuracy of the INM model compared to noise level measurements of specific aircraft operations at Queenstown.

2.1 Methodology

A sophisticated Bruel & Kjaer noise monitoring terminal (NMT) was positioned at three relevant locations in close proximity to Queenstown Airport with consideration to the objectives outlined above. The three positions were close to the current District Plan Airnoise Boundary (ANB); as shown in Figure 1, Appendix G. The location of the NMTs are described in Table 2-1 below.

Table 2-1: Noise Monitoring Station Locations

Location	ID	Period	NZMG Co-ordinates	
			Easting	Northing
Sideline South – 'Met Station'	NMT 1	07/05/07 -11/06/07	2174635	5567714
Sideline North – 'Paddock'	NMT 2	12/06/07 – 09/07/07	2174710	5568102
Centreline West - 82 McBride St	NMT 3	09/07/07 – 13/08/07	2173802	5567643

The noise monitor was located for approximately one month at each location, with the microphone on a mast at a height of 6.5m above ground level. Calibration of the monitoring station was carried out both at the start and end of each monitoring period.

The noise monitor is capable of continuously measuring the noise level received over one second logging periods, as well as having internal event recognition software that automatically activates during aircraft events. This event recognition software enables discrete noise level measurements of each aircraft event that occurs. In addition the instrumentation makes a short digital audio recording during each aircraft event

which allows later subjective and objective analysis. The monitoring terminal was able to be controlled and observed from Auckland via GSM modem.

Measured noise levels from the monitoring station were verified by operator-attended noise level measurements undertaken at the same location as the noise monitor. The variation in noise level between the automatic noise monitor and the operator-attended measurements was less than one decibel, and hence it is concluded that the automatic noise level measurements are accurate.

The overall daily L_{dn} from aircraft events was calculated from the individual events for comparison with the District Plan noise criteria. The software is optimised so that only measured aircraft events are included in the noise calculations and extraneous events, such as nearby traffic, fire alarms or industrial activity are excluded.

Extensive visual aircraft activity records were collected on-site during the period of the noise monitoring. The observation detailed aircraft type, aircraft operation (arrival or departure), runway usage and time of day. Further, these records ensured that measured noise levels could be accurately correlated with aircraft activity and ensure the measured L_{dn} was specifically from the airport.

2.2 District Plan Compliance

The measured L_{dn} noise levels at each monitoring location have been averaged over the monitoring period and are presented in Table 2-2 below for comparison with the District Plan limit of 65 dBA.

Table 2-2: Monitoring Results (one month average)

Monitor Location	Measured Noise Level (L_{dn} dBA)	Peak Load Factor	Load Adjusted Noise Level (L_{dn} dBA)
Sideline South - Met Station - NMT1	60.0	10%	60.4
Sideline North - Paddock - NMT2	62.1	20%	62.9
Centreline - 82 McBride Street - NMT3	61.5	20%	61.9
Centreline at ANB (McBride+0.8dB)	62.3	20%	62.7

Table 2-2 also shows the measured level adjusted for a 'peak load' factor. This adjustment is as a result of aircraft activity during the month that was monitored, being potentially lower than other months, resulting in a correspondingly lower measured noise level. To give an indication of what the noise level might be in the busier months the 'peak load adjustment' was calculated as detailed below.

The Airways/QAC records of aircraft arrivals were analysed to determine the busiest 90 day period. The number of scheduled movements in this period was compared with the number of scheduled movements during the month monitored, to obtain the peak

load factor. The scheduled movements (excluding General Aviation and flight-seeing) were used as they provide the dominant contribution to the noise contours.

As can be seen from Table 2-2, measured noise levels at all locations comply with the District Plan noise limit of 65 dBA, as do the Peak Load Adjusted noise levels.

The monitoring position at 82 McBride Street is not exactly on the Airnoise Boundary in the District Plan – it is approximately 50m outside. The INM was used to calculate the increase in noise level by moving 50m closer to the ANB as +0.8 dB. Thus the measured noise level corrected to centerline at the ANB would be 62.7 dBA, which is still compliant with the limit of Ldn 65 dBA.

2.3 Compliance Contours

The Queenstown Airport Noise Management Plan (NMP) lays out procedures for carrying out compliance monitoring using the recorded number and type of aircraft operation and the INM program used to calculate 'compliance contours'. This was carried out in 2006, 2007 and2008. The 2008 contours are shown in Figure 2 Appendix G.

In summary, the predicted 2008 activity L_{dn} 65 dBA contour does not exceed the ANB at any location, but the predicted 2008 activity L_{dn} 55 dBA contour does exceed the Outer Control Boundary (OCB) in some locations.

The areas of exceedance of the OCB are not considered significant. The reason for this is that they are small and the extent of exceedance is only one decibel. In addition, it is noted that the INM does not take account of the noise attenuation effects of nearby buildings (screening). This would be noticeable in the Frankton area near the existing helicopter operations.

It is noted that due to the current airport noise emissions being shown to be close to the District Plan noise contours, an update to the District Plan contours is timely.

3.0 INM VERIFICATION AND ADJUSTMENTS

Marshall Day Acoustics has been involved in noise monitoring at a number of New Zealand airports over several years. By far the largest sample of data is from Auckland Airport, where four noise monitoring terminals (NMT) operate continuously. This monitoring has enabled a comparison of the INM predicted noise level with measured noise levels from actual aircraft events. As with any computer modelling program it is not expected to be absolutely precise and thus it is important to verify the level of accuracy of the software. A general trend has appeared from the extensive monitoring carried out to date. The INM is generally reasonably accurate on runway centreline (within 1 dB) however, on sideline it has been found to be under predicting by up to three decibels for different aircraft types.

The INM was primarily developed for the prediction of noise levels at large airports. Queenstown Airport is unusual in that it is a relatively small airport in terms of jet operations and in addition, it has a residential area very close to the western end of

the runway. For this reason it is particularly important to assess the validity of the INM predictions for Queenstown Airport.

3.1 Evaluation of Typical Day

To provide an initial check on the overall INM accuracy, a typical day of noise monitoring was summed to provide a measured 24-hour Day/Night Sound Level (L_{dn}). Details of the individual aircraft operations (type, runway, direction etc) were visually recorded by on-site personnel. These details enabled the operations for that day to be entered into the INM model and the noise level predicted for comparison with the measured noise level.

This analysis showed that on sideline (NMT 2 - paddock), the INM predicted L_{dn} was found to be approximately 2 dB lower than the measured levels. At the position in McBride Street (west end main runway centreline), the INM prediction matched the measured level reasonably well for the overall Day/Night Sound Level (L_{dn}).

3.2 Individual Event Analysis

The difference in predicted noise level to the measured noise level could be due to specific aircraft being inaccurate by a large amount or a number of aircraft being inaccurate by a small amount. To determine this effect and enable modifications to be made to the INM, it was necessary to analyse individual noise events in detail by correlating measured noise events with visually observed aircraft identification. This necessarily involves a large amount of data analysis and so the study focussed on the key aircraft that contribute most significantly to the noise contours. Using the INM, it was found that the larger jets (B737-800 and the Airbus A320) and the ATR-72 are the main contributors to the L_{dn} noise contours.

The four operations of each of these aircraft were analysed in detail, i.e. departure on runway 05, departure on runway 23, arrival on runway 05 and arrival on runway 23. The measured noise level was averaged for each of these specific operations and then compared with the INM predicted sound level for each individual event.

As a result, discrepancies were found with different aircraft operations. In summary, the results showed that for Queenstown the INM is generally under predicting the noise levels from jets on side-line. For the ATR-72, the INM is over predicting on approach and under predicting on departure.

Marshall Day Acoustics proceeded to make a number of sophisticated modifications to the INM to improve the correlation between the computer model and the measured levels. The proposed modifications did not make the INM exact, however, in our opinion they provide an improvement in the INM accuracy that would be important if the fleet mix changes significantly in the future.

New noise contours were produced using these 'modifications' and were published as 'Draft' and also sent to the USA for peer review by Professor J-P Clarke. Professor Clarke was of the opinion that the INM should not be modified in the case of Queenstown. Details of the INM corrections and the J-P Clarke review are contained in a separate report.

While Marshall Day disagrees with the J-P Clarke approach in principle, it was decided to check how much difference to the predicted noise contours the INM modifications have.

This study showed that the 'over' and 'under' predictions tend to balance each other out and the overall difference in the combined L_{dn} contours is not all that large. In order to avoid a contracted technical argument, it was decided to accept the contours without INM adjustments as the basis for the proposed District Plan boundaries.

4.0 UPDATED MODELLING

The following section outlines the methodology and results of the re-modelling study to update the noise contours for the year 2037. The noise contours have been predicted using the following modelling data and assumptions.

4.1 Introduction to the INM

Several computer based models have been developed to predict aircraft noise in the vicinity of an airport. The most widely used of the models (and the model recommended in NZS 6805) is the Integrated Noise Model (INM) developed by the US Federal Aviation Authority. The INM calculation procedures use an energy averaging technique to calculate the noise exposure in terms of L_{dn}.

The INM calculates the noise level at a large number of grid points by summing the 'noise energy' from each aircraft movement during a 'typical' day's operation. The 'noise energy' is calculated using the hourly L_{eq} value, night-weighted by +10 dBA and then averaged over 24 hours to give the daily L_{dn} value at each grid point. The grid points with equal noise level are then joined graphically to give a plot of L_{dn} noise contours. The INM predicts the noise level from aircraft operations in take-off and landing and excludes engine testing and taxi-ing.

The original airport noise contours used to develop the District Plan airport noise boundaries were generated in 1995 using INM version 5.1. Since this time there have been a number of upgrades to the INM program which produce slightly different results. The current version used for this updated set of contours is INM v7a.

This software includes revised lateral attenuation algorithms to more accurately predict lateral attenuation of sound for propeller-driven aircraft and helicopters. In previous versions of the noise model these algorithms were developed using data relating to jet aircraft and therefore were not as accurate for propeller driven aircraft or helicopters.

Version 7a of the INM also enables a calculation that allows for variation in surrounding topography. This is regarded as important for Queenstown and has been used in the updated contours.

4.2 Projected Aircraft Activity

Future aircraft activity has been projected for the year 2037 by AirBiz Limited and is shown in Appendix C. The adoption of the 2037 planning horizon takes into account such issues as;

- The forecast intentions of airport based operators
- Visitor arrivals for the Queenstown area
- Local business activities and growth
- Airline planning and marketing initiatives
- Airport planning and development proposals
- Airline and other operator's choice of aircraft type, size, frequency and schedules

Therefore the subsequent noise contours represent a reasonable worst case scenario, in terms of noise and provides robust protection of the Airport's ability to operate.

Movement data has been provided for each different aircraft type for different periods of the day. This movement data has been modified to include revised jet movements in the fleet mix following the J-P Clarke peer review to more accurately account for the type of aircraft likely to be operating in the future.

This movement data has also been assigned to differing flight tracks as a percentage of the overall movements. NZS 6805 states that projections should be based on an average day calculated from all operations during the busiest three months of the year. Therefore, operations that are atypical, such as airshow flights, have not been included in the projections

For each aircraft movement, including departures, arrivals and training circuits, the following information was provided for input in the model:

- Aircraft type
- Time of day (day 0700-2200 or night 2200-0700)
- Runway usage
- Departure, arrival or training circuit tracks
- Stage length at take-off

The table in Appendix C presents a summary of the projected aircraft movement data provided by AirBiz for the year 2037.

4.3 Flight tracks

The flight tracks and the percentage of aircraft using each track for Queenstown have been updated to provide a more accurate representation of actual movements. Queenstown Airport Corporation, in conjunction with AirBiz have provided flight track details. Updated helicopter flight tracks have also been included in the model. Runway usage for different aircraft types are shown in Appendix D, and the tracks are show on Figures 3 to 7, Appendix G.

As can be seen, all tracks for all runways have been included to more accurately predict aircraft noise emissions for Queenstown. The tracks utilised include the various international and scheduled tracks and the general aviation circuits, in addition to all standard arrival and departure tracks.

4.4 Terrain

Since the existing noise contours were implemented in the District Plan, the INM noise model has been updated several times. The latest version of the INM has the ability to include terrain effects in the noise contour calculation procedure. In summary, the effects of terrain are the screening it provides and the change in distance between aircraft noise sources and receivers on the ground.

Terrain data for Queenstown has been derived from NASA topographical data.

However, analysis of the calculated attenuation due to screening for Queenstown shows some anomalies. Therefore, the specific screening effects of terrain have not been included in the noise model and subsequent results. It is believed that these anomalies have occurred in this case due to the close proximity of the noise contours to the airport and the sensitivity of the screening algorithms in the INM when aircraft are on the ground and at lower altitudes. The reasons for the anomalies are being investigated, in consultation with the US FAA.

Notwithstanding this, the other terrain effect (i.e. the effect of the change in distance between noise sources (aircraft) and receivers on the ground) has been taken into account.

Good agreement between actual measured noise levels and predicted noise levels (with distance corrections, but without screening effects) has been demonstrated and therefore the adopted approach is considered to be accurate.

4.5 Peak Load

A seasonal loading, or 'Peak Load' has been applied to the future movement projections to account for the potential busiest three month period within a year, as recommended by NZS 6805. This peak load has been derived from data provided by AirBiz of recorded monthly movements at Queenstown since October 2004.

The applied Peak Load Factor varies, dependent on the aircraft type, and is presented in Table 4-1.

Table 4-1: Peak Load Factors

Aircraft Type	Applied Peak Load Factor
Scheduled	10%
Corporate	60%
Flight-seeing	60%
General Aviation	30%
Helicopters	20%

4.6 Night Time Operations

The current airport planning provisions in the District Plan make no allowance for scheduled night-time aircraft operations between 10.00 pm and 6.00 am. It is understood that the airport company now anticipates a potential future demand for a small number (11 per week) of jet arrivals between 10.00 pm and midnight. These flights have been included in the 2037 L_{dn} noise contours.

4.7 Helicopters

Due to the distinctive character of helicopter noise, and the nature of helicopter operations, New Zealand Standard NZS 6807:1994 "*Noise Management and Land Use Planning for Helicopter Landing Areas*" has been developed specifically to deal with noise from helicopter landing areas.

NZS 6807 is similar to NZS 6805 in that it recommends controlling noise and the use of land around helicopter landing areas by establishing a 'helinoise boundary', defining an area of land within which, no new incompatible land uses are recommended unless adverse effects are mitigated.

The helinoise boundary is generally defined at L_{dn} 50 which is 5dB more stringent than the L_{dn} 55 contour used for the fixed wing Outer Control Boundary, recommended in NZS 6805. The land use planning measures recommended inside the helinoise boundary are the same as those recommended in NZS 6805 for areas within the outer control boundary, ie. new noise sensitive activities are prohibited unless a District Plan permits such uses subject to appropriate sound insulation.

NZS 6807 recommends that where an area is subject to planning measures in accordance with NZS 6805 as well as in accordance with NZS 6807, the position of the OCB should take into account the position of the helinoise boundary. Due to the complexities of applying two separate standards to mixed use airports, MDA typically recommends assessing fixed wing and rotary aircraft together in accordance with NZS 6805.

4.8 General Aviation and Helicopter Location

It is recognised that there is the potential for the current general aviation and helicopter operations that occur at the airport to be relocated to the north or to the south of the main runway. Therefore, the predicted noise contours include provision for these operations to occur either in the current location or in the two potential locations. For the northern area, the boundaries allow for the operation to be located anywhere between the eastern end of the main runway and the cross-wind runway intersection.

4.9 Predicted 2037 Noise Contours

4.9.1 Chronology of Predicted Noise Contours

Several sets of predicted contours have been produced (and consulted on) since the updated noise contour process was initiated by QAC.

In summary, these are:

May 2008 – Initial Noise Contours, inclusive of INM modifications (refer section 3.2)

November 2008 – Revised Noise Contours (removal of INM modifications and incorporating minor revisions to fleet mix) – following J-P Clarke peer review

The final updated noise contours included as part of this report now reflect the full set of finalised flight tracks, which take into account aircraft using new 'Required Navigational Performance' (RNP) technology, in addition to all scheduled, general aviation and helicopter tracks.

4.9.2 Final Version of Predicted Noise Contours

The updated noise contours calculated using the procedures outlined in Section 4.1 – 4.6 are presented in Figure 8, Appendix G. As can be seen, in general the predicted 2037 noise contours are wider and longer than the current District Plan contours, with the exception of a small area to the south of the crosswind runway on centreline.

5.0 PROPOSED NOISE CONTROL BOUNDARIES

Based on the predicted noise contours, the recommended noise control boundaries are presented in Figure 9, Appendix G. In summary, these are:

- The Outer Control Boundary (OCB)
- The Sound Insulation Boundary (SIB)
- The Airnoise Boundary (ANB)
- The Night-time Noise Boundary (NNB)

The Outer Control Boundary and Airnoise Boundary are similar in concept to those already contained in the District Plan and are effectively direct replacements. However it is anticipated that the land use planning controls associated with the noise control boundaries would be revised through a Plan Change. Recommended land use planning and airport noise controls associated with the proposed boundaries are detailed in Section 7 and 8.

5.1 Outer Control Boundary

NZS 6805 recommends the L_{dn} 55 contour be used for the OCB. This approach has been adopted for the existing District Plan noise boundaries and is also proposed for this revision of the boundaries. The proposed OCB is shown on Figure 9, Appendix G.

Refer to Section 7 and 8 for details of the land use planning and airport noise control recommendations associated with the OCB.

5.2 Sound Insulation Boundary

A Sound Insulation Boundary (SIB) is proposed based on the L_{dn} 58 dBA contour. The SIB would delineate the area within which noise sensitive activities should be sound insulated to mitigate the effects of aircraft noise. The background to this is that an extensive sound insulation survey was carried out in Manukau City of houses under the Auckland Airport flight path. One of the interesting findings was that the typical New Zealand home can achieve a noise reduction from outside to inside of 17 to 18 dBA with the windows ajar. This means that a house at L_{dn} 57 dBA requires no special sound insulation treatment to achieve the desired internal noise level of L_{dn} 40 dBA. Thus sound insulation is proposed to be a requirement for new or altered properties inside L_{dn} 58 dBA.

Refer to Section 7 for details of the land use planning recommendations associated with the SIB.

5.3 Airnoise Boundary

NZS 6805 recommends the L_{dn} 65 contour be used as the basis for the Airnoise Boundary (ANB). This approach has been adopted for the existing District Plan noise boundaries and is also proposed for this revision of the boundaries. The proposed ANB is shown on Figure 9, Appendix G.

Refer to Section 7 and 8 for details of the land use planning and airport noise control recommendations associated with the ANB.

5.4 Night Noise Boundary

The current airport planning provisions in the District Plan make no allowance for night-time aircraft operations as there has historically been no expectation or capability for night-time flights at Queenstown. It is understood that the airport company now anticipates a potential future demand for a small number of night-time scheduled aircraft arrivals.

The effect of these operations is proposed to be included in the airport planning provisions of the District Plan. These flights have been included in the 2037 L_{dn} noise contours and they do not change the predicted contours significantly. However, these night flights may result in sleep disturbance effects for some parts of the community.

NZS 6805 recommends an assessment of individual maximum noise levels from aircraft operating at night time, but does not define limits of acceptability. At other airports in New Zealand the Single Event Level (SEL) 95 dBA contour has been adopted as the limit which defines the onset of significant sleep disturbance. SEL is a measure of the total sound energy of an individual aircraft movement.

Figure 8, Appendix G shows the worst case SEL 95 dBA contour for Queenstown Airport, calculated based on the noise emissions from both a B737-800 and A320 arrival. It is recommended that this contour provide the basis for a Night Noise Boundary (NNB), as shown in Figure 9, Appendix G.

Like the ANB concept, the NNB defines an area within which residential activity is adversely affected due to single event noise levels at night which may result in sleep disturbance. It is therefore recommended that land use controls which prohibit new noise sensitive activities in Rural areas (similar to those within the ANB) and subject to appropriate sound insulation in other zones should be imposed within the NNB to protect the potential for night-time operations at the airport.

Refer to Section 7 and 8 for details of the land use planning and airport noise control recommendations associated with the NNB.

6.0 ASSESSMENT OF NOISE EFFECTS

The effects of the proposed revised noise boundaries on the surrounding community have been assessed by considering the change in noise level, annoyance effects and sleep disturbance effects.

6.1 Change in Noise Level

The proposed revised airport noise boundaries represent a change in aircraft noise levels compared with the current noise exposure and the District Plan noise boundaries. The effect of this change on the surrounding community has been assessed.

The three airport operating scenarios which have been examined are:

- The level of activity in 2008, i.e. the current level of noise
- The level of airport activity anticipated by the operative District Plan
- The proposed updated future noise boundaries (Figure 9, Appendix G)

The change in noise level varies depending on the location around the airport so four representative locations have been selected as shown in Figure 8. The INM was then used to calculate the noise level at each of these positions for each of the three

operational scenarios. Table 6-1 shows the predicted change in noise exposure for the revised noise boundaries compared with the current noise exposure.

Table 6-1: Predicted Noise Levels – 2037 vs 2008

Location	Noise Level L_{dn} dBA		Change in Level (2037-2008)
	2008	2037	
R1 -82 McBride St	62	67	5
R2 -29 Robertson St	49	56	7
R3 -13 Copper Beech Ave	52	54	2
R4 –DP 20596 Lot 1	54	56	2

The subjective response to a change in noise level is widely variable from individual to individual and is also different for a change that occurs immediately, compared with a change that occurs slowly over many years – as will be the case for Queenstown Airport.

However, to give an indication of the meaning of the changes in noise level tabled above, the following general response to an immediate change in noise is typical;

- An increase in noise level of 10 dB sounds subjectively about 'twice as loud';
- A change in noise level of 5 to 8 dB is regarded as noticeable;
- A change in noise level of 3 to 4 dB is just detectable;
- A change in noise level of 1 to 2 dB is not discernible.

The predicted change in noise level of two decibels from 2008 to 2037 for some locations around Queenstown Airport would be imperceptible for residents. A change of five to seven decibels would be noticeable if it occurred overnight. However as this increase is predicted to occur slowly over 30 years, it would not be as noticeable. The predicted increase in noise level is considered to be reasonable in this situation, taking into account the importance of airport growth to the region and the realistic expectations of residents living adjacent to a regional airport.

It is also useful to compare the difference between the proposed revised noise boundaries and the existing District Plan boundaries. Table 6-2 below lists the calculated difference for the same four assessment locations.

Table 6-2: Predicted Noise Levels – 2037 vs Current District Plan

Location	Noise Level L_{dn} dBA		Difference in Level (2037-DP)
	District Plan	2037	
R1 -82 McBride St	62	67	5
R2 -29 Robertson St	50	56	6
R3 -13 Copper Beech Ave	57	54	-3
R4 –DP 20596 Lot 1	57	56	-1

Table 6-2 shows that two receiver locations experience an increase in noise level relative to the current District Plan contours and the other two would experience a decrease. The increase would generally occur in the Frankton residential area to the west of the state highway and the decreases would be experienced off the ends of the cross-wind runway.

The reason for the increase is a greater number of the large scheduled aircraft and helicopter movements, compared to that anticipated in the existing District Plan boundaries. However, as discussed above, the predicted increase in noise level is considered to be reasonable in this situation

The reason for the decrease is a combination of changes to flight tracks and a reduction in the forecast general aviation activity compared with that included in the current District Plan boundaries.

6.2 Annoyance Effects

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 of response to noise of a residential community as a whole. Much of this formed the basis of NZS 6805 when it was developed.

In 1978 Shultz[1] 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}). The studies involved a number of different transportation noise sources including trains, road traffic and aircraft.

Since this time dose response relationships specific to aircraft noise have been developed by Miedema and Oudshoorn[2], as shown in Figure 6.1 below. This relationship

1 Schultz T J (1978) *"Synthesis of social surveys on noise annoyance"* J.Acoust. Soc. Am. 64, 2, 337-405.
2 Miedema, H M E and Oudshoorn, G M (2001) *"Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals."* Environmental Health Perspectives 109 (4) 409 – 416.

is similar to other relationships by Bradley[3] and Miedema and Vos[4] and provides similar results.

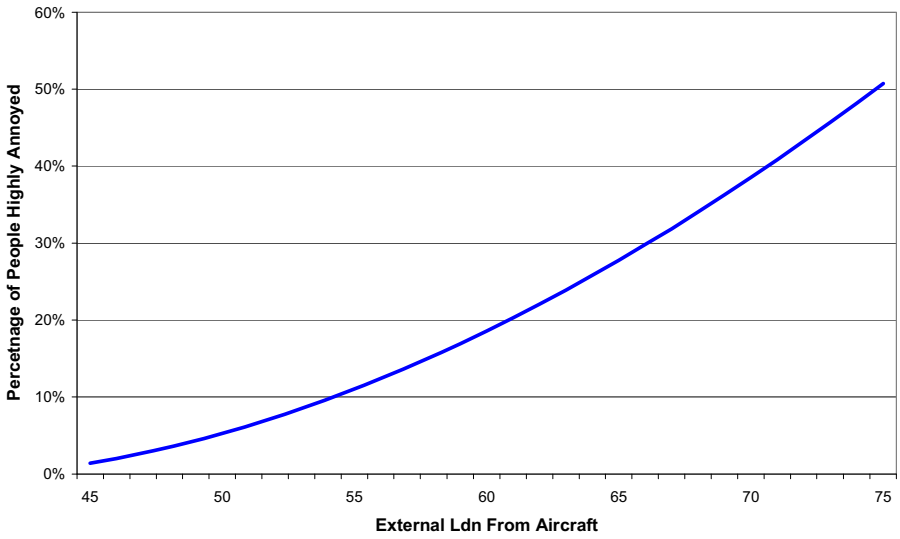


Figure 6-1 Miedema & Ouldshoorn Dose-Response Relationship

The dose response relationship indicates that for aircraft noise environments of L_{dn} 65 dBA, 28% of the population are likely to be highly annoyed. For aircraft noise environments of L_{dn} 55 dBA, 11% of the population are likely to be highly annoyed by the noise.

An analysis has been carried out for the Queenstown situation to predict the number of people likely to be highly annoyed by aircraft noise under three different operating scenarios as follows:

- The level of activity in 2008, i.e. the current level of noise
- The level of airport activity anticipated by the operative District Plan
- The proposed updated future noise boundaries (Figure 9, Appendix G)

Details of the analysis are provided in Appendix E and the results are summarised in Table 6-3.

3 Bradley, J S (1996). *"Determining acceptable limits for aviation noise"*. Proceedings of Internoise 1996.

4 Miedema, H M E and Vos, H (1998). *"Exposure-response relationships for transportation noise"*. J. Acoust. Soc. Am. 104 (6) 3432 – 3445.

Table 6-3: People Highly Annoyed

	55–60 dBA # Houses	60–65 dBA # Houses	> 65 dBA # Houses	# People Highly Annoyed
Compliance Contours 2008	73	26	0	42
District Plan Noise Boundaries	85	67	0	71
Proposed Noise Boundaries	268	108	72	219

The proposed revised noise boundaries represent an appreciable increase in the number of people likely to be highly annoyed compared with both the current situation and the existing District Plan boundaries.

It is noted that annoyance effects are not confined to noise levels in excess of L_{dn} 55 dBA. Although the L_{dn} 55 contour forms the basis of the OCB, and the outer extent to which land use planning and airport noise controls are proposed, there may be some annoyance effects for a small percentage of people in areas outside the OCB. This is because aircraft movements outside of the OCB would still be audible.

To give an indication of this, Figure 10, Appendix G is an indicative aircraft noise emission plot which demonstrates the noise impact relative to proximity to the airport and flight paths. The figure shows the extent of aircraft noise in the community out to L_{dn} 50 dBA. It needs to be understood that aircraft noise would be audible well beyond the OCB however the extent of noise effects resulting from lower levels of exposure are generally considered to be acceptable. As such, land use planning and airport noise controls commence at exposure levels of L_{dn} 55 dBA as recommended in NZS 6805.

It is noted that there are approximately 72 dwellings inside the ANB. The recommended noise control criteria for land use planning inside the ANB is that new noise sensitive uses be prohibited, that steps be taken to ensure a satisfactory internal noise environment for existing dwellings, and alterations or additions be permitted only with appropriate acoustic insulation. This confirms that in general, noise levels in excess of L_{dn} 65 dBA are unsuitable for residential activity.

The 72 dwellings inside the ANB are predicted to experience levels of L_{dn} 65 – 67 dBA in the future. To mitigate the effects on residents QAC will offer over time sound insulation treatment to ensure a satisfactory internal noise environment as recommended in NZS 6805. Section 6.4 details the proposed mitigation measures.

6.3 Sleep Disturbance Effects

The proposed revised noise boundaries include an allowance for a small number of weekly scheduled jet arrivals between 10pm and midnight. Despite the ten decibel penalty applied at night, this small number of movements has little effect on the

extent of the L_{dn} contours. Nonetheless, each individual noise event may result in sleep disturbance effects on residents.

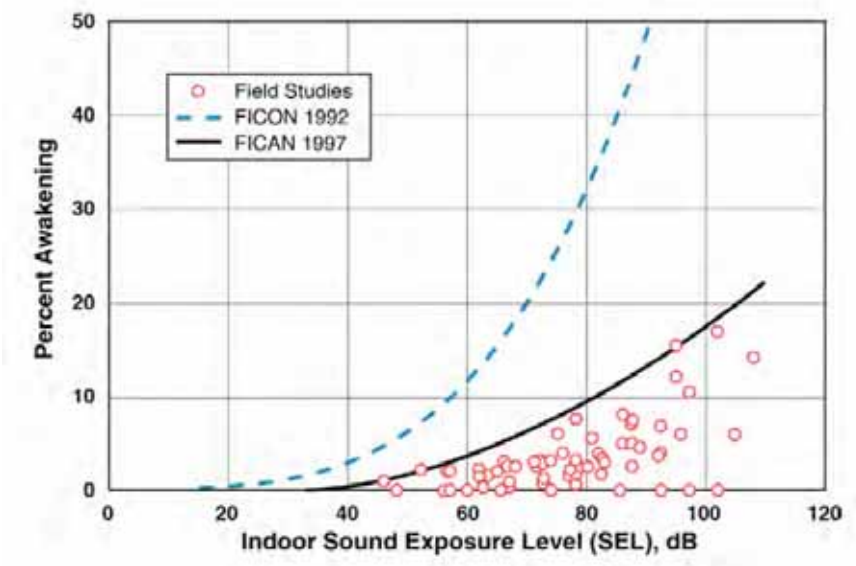
There have been many studies on the effects of noise on sleep carried out both in the laboratory and in the field. The term sleep disturbance itself has various connotations and can include a range of aspects from awakenings to affects on the depth of sleep in various stages and creating difficulty with falling asleep.

NZS 6805 recommends an assessment of individual maximum noise levels from aircraft operating at night time, but does not define limits of acceptability. The findings of relevant studies, relate sleep disturbance to either the SEL or L_{max} noise level in the bedroom. L_{max} is the maximum noise level occurring during a measurement period. SEL is a measure of the total noise energy of an individual aircraft movement.

Historically, Marshall Day has come to the position that the sleep disturbance effects below SEL 85 dBA are low and that SEL 95 dBA (outdoors) defines a point of significant sleep disturbance.

The sleep disturbance effects at this recommended threshold level are likely to vary depending on the number of night time events and the timing of the events. However the effects can be quantified in general terms by applying a dose-response relationship. A relationship developed in 1997 by FICAN[5] (shown in Figure 6.2) predicts the maximum percentage of an exposed population[6] expected to be behaviourally awakened for a given indoor SEL exposure.

Figure 6.2 FICAN Sleep Disturbance Dose-Response Relationship



5 Federal Inter-agency Committee on Aviation Noise (1997). *"Effects of Aviation Noise on Awakenings from Sleep"*.

6 The study recommends that this relationship applies to adults residing in aircraft noise affected areas.

This relationship predicts a maximum of six percent of the population being awakened by events of SEL 70 dBA (indoor level) and ten percent awakened by events of SEL 80 dBA received in the bedroom. With windows ajar for ventilation, SEL 80 dBA indoors is approximately equivalent to SEL 95 dBA outdoors.

The Queenstown Airport NNB shown in Figure 9 Appendix G, is based on the SEL 95 dBA contour for arrival of A320 and B737-800 aircraft. Approximately 35 houses at the western end of the main runway are located inside the NNB and these houses are predicted to experience SEL 95 – 100 dBA (outdoors) during the proposed night time movements.

In order to mitigate potential sleep disturbance effects on these residents, MDA recommends that sound insulation treatment packages for dwellings inside the NNB be offered prior to the commencement of night flights. In addition, these events would be occurring in the 'shoulder' periods – thus avoiding the critical sleep period from midnight to 6am.

In our opinion, the potential sleep disturbance effects from the proposed night time aircraft arrivals, is considered reasonable based on the low number of movements (11 per week), the timing of the events (i.e. before midnight and after 6.00 am) and the provision of sound insulation treatment for the most affected dwellings. Refer to section 6.4 for details of the proposed mitigation measures.

6.4 Mitigation of Effects

NZS 6805 recommends that the mitigation of aircraft noise effects be achieved through a combination of:

- Aircraft noise management measures;
- Restriction on development of noise sensitive activities;
- Sound insulation treatment measures.

This is the approach previously adopted in the District Plan and it is considered appropriate that this approach be maintained. Sections 7 and 8 review the relevant controls currently in the District Plan and outline recommended changes where appropriate.

Further to land use planning and airport noise management controls, sound insulation treatment for the most affected existing dwellings is recommended. A number of dwellings are located inside the proposed ANB (L_{dn} 65 dBA) and NNB (SEL 95 dBA) which delineate areas that are unsuitable for residential activity.

Therefore, to mitigate annoyance and sleep disturbance effects on these dwellings as far as is practicable; it is recommended that a sound insulation treatment programme be offered. Retrofit sound insulation treatment could be offered to residents once their property is exposed to L_{dn} 65 dBA or when night time operations commence (whichever occurs first).

While sound insulation does not completely mitigate noise effects, particularly for outdoor environments and when windows and doors are open, it is considered that providing an acceptable internal noise environment is the best practicable option in this case.

7.0 LAND USE PLANNING RECOMMENDATIONS

NZS 6805 lays out recommended criteria for Land Use Planning around airports, which is discussed in more detail in Appendix B. In summary, Tables 1 and 2 of the Standard recommend that;

- Inside the ANB, new noise sensitive uses should be prohibited and existing residential buildings and alterations should have appropriate sound insulation, and
- Between the ANB and OCB, new noise sensitive uses should be prohibited unless a District Plan permits such use subject to appropriate sound insulation and alterations should include appropriate sound insulation.

The various local authority District Plans around the country have implemented these recommendations from NZS6805 in different ways. The process is influenced by a number of factors including, the extent of existing residential development inside the noise contours, the availability of land outside the noise contours for future residential development etc.

By way of example, Christchurch has an established green belt around the airport and a low shortage of other residential area for future development. The land use rules are thus quite restrictive inside the noise contours. Wellington on the other hand has over 600 existing houses inside the ANB and shortage of residential land in the area. Very little is provided in terms of land use controls around Wellington Airport – the issues are sound insulation and noise controls.

7.1 Current Land Use Rules

The Partially Operative Queenstown Lakes District Plan includes land use controls for six zones which are affected by the Outer Control Boundary and Air Noise Boundary of Queenstown Airport. Table 7-1 summarises the activity controls and standards for each of the affected zones.

Table 7-1: Summary of Current Land Use Controls in Airport Noise Affected Areas

Zone	Activity	Status	Insulation Standard
Residential	New residential activities in the OCB	Permitted	Internal design criterion of 40 dBA L_{dn}
	visitor accommodation, and community activities in the OCB	Controlled	Internal design criterion of 40 dBA L_{dn}
Rural	New residential, visitor accommodation, and community activities in the OCB	Prohibited	Not applicable
	Additions/alterations to residential, visitor accommodation and community activities in the OCB	Controlled	Internal design criterion of 40 dBA L_{dn}
Frankton Flats	Visitors accommodation, community and residential activities inside the OCB	Discretionary	Internal design criterion 40 dBA L_{dn} & 55 dBA L_{max}
	Commercial activities, services activities and recreational activities inside the OCB	Discretionary	Internal design criterion 60 dBA L_{dn} & 75 dBA L_{max}
	Offices inside the OCB	Discretionary	Internal design criterion 50 dBA L_{dn} & 65 dBA L_{max}
Remarkables Park	Residential activities, visitor accommodation and community activities inside specific Airport Measures Area	Varies within the zone	Internal design criterion of 40 dBA L_{dn}
Industrial	Additions/alterations to existing residential activities in the OCB	Controlled	Internal design criterion of 40 dBA L_{dn}
	New residential, visitor accommodation, and community activities in the OCB	Prohibited	N/A

7.2 Proposed Land Use Rules

Mitchell Partnerships has prepared detailed wording for the proposed land-use planning provisions. The full text of the District Plan noise rules and conditions that are proposed for Queenstown Airport is contained in the proposed Plan Change and Notice of Requirement documentation. However, the derived 'Acceptable Constructions' tables associated with the proposals and proposed definitions are

provided in Appendix F for reference. A summary of the proposals is presented below, with some additional recommendations included:

Between OCB and SIB

- New noise sensitive activities shall be prohibited in the Rural Zone, Industrial Zone and Frankton Flats (B) Zone
- Alterations, additions or replacement buildings do not need special sound insulation treatment

Between SIB and ANB

- New noise sensitive activities shall be prohibited in Rural Zone, Industrial Zone and Frankton Flats (B) Zone
- New noise sensitive activities in residential areas, or alterations and additions to noise sensitive activities in all zones, need sound insulation treatment to achieve appropriate indoor sound levels.
- Sound insulation shall be achieved at the same time as maintaining appropriate levels of ventilation. This means a forced ventilation or airconditioning system will be required.
- Appropriate sound insulation shall be determined by using the 'acceptable constructions' included in the Plan or by obtaining a certificate from a person suitably qualified in acoustic engineering. It is therefore recommended that an internal noise criterion of L_{dn} 40 dBA be provided in the appropriate rules.

Inside the ANB and NNB

- New noise sensitive activities shall be prohibited in Rural areas
- New noise sensitive activities, or alterations and additions to noise sensitive activities, in the residential zone needs sound insulation treatment to achieve appropriate indoor sound levels.
- Sound insulation shall be achieved at the same time as maintaining appropriate levels of ventilation. This means a forced ventilation or airconditioning system will be required.
- Appropriate sound insulation shall be determined by using the 'acceptable constructions' included in the Plan or by obtaining a certificate from a person suitably qualified in acoustic engineering. It is therefore recommended that an internal noise criterion of L_{dn} 40 dBA in habitable rooms and SEL 65 to 70 dBA in bedrooms be provided in the appropriate rules.
- Existing houses; The QAC should provide sound insulation and ventilation packages to achieve appropriate indoor sound levels (based on L_{dn} 40 dBA in habitable rooms and SEL 65 to 70 dBA in bedrooms). The package should be provided when the L_{dn}

65 dBA Annual Aircraft Noise Contour (AANC) reaches the individual property or before the commencement of night time jet arrivals occurs (10pm to midnight). Refer Section 8 for the proposed implementation of this control.

8.0 AIRPORT NOISE CONTROL RECOMMENDATIONS

8.1 Airport Noise Management

The current District Plan rules controlling airport operations to L_{dn} 65 dBA and L_{dn} 55 dBA at the ANB and OCB respectively are recommended to be maintained.

However, improved wording is proposed for this rule to clarify procedures for assessing compliance. To this end, a requirement to publish Annual Aircraft Noise Contours (AANC) has also been added.

An additional noise control rule is proposed to be added to ensure that single event noise received at night is no greater than the SEL contour included in the proposed plan change.

The full text of the recommended airport noise controls and proposed definitions are detailed in Appendix F.

In summary, MDA recommends that:

- The Airport should be managed so that the noise from aircraft operations does not exceed a Day/Night Level of L_{dn} 65 dBA outside the proposed Air Noise Boundary (ANB) and L_{dn} 55 dBA outside the proposed Outer Control Boundary (OCB).
- To ensure compliance with the above, calculation of Annual Aircraft Noise Contours (AANC) using the Integrated Noise Model (INM) program and records of actual aircraft activity at the Airport is recommended.
- Noise monitoring should be undertaken to check the compliance contours are accurate. It is recommended that this should include at least the following level of monitoring over a three year period; a minimum of one month summer and one month winter at each of two measurement locations.
- No scheduled aircraft operations should take place between midnight and 06.00 am. All scheduled aircraft operations that take place between 10.00 pm and midnight shall be certified in advance to have an SEL 95 dBA noise contour that does not exceed the Night Noise Boundary (NNB).

8.2 Engine Testing

The running of aircraft engines in-situ is essential following maintenance work for safety and regulatory reasons. In addition, turbo-prop engines are run in-situ for the purpose of cleaning. At the Airport there is no large-scale maintenance facility, but low level engine run-ups are undertaken regularly and unscheduled maintenance work is occasionally carried out, which requires engines to be tested prior to being returned to service.

The testing of aircraft engines is an activity which is vital to the operational viability of a commercial airport, but like aircraft movements, cannot be accommodated within standard district plan noise rules. As such engine testing often requires a specific noise control. MDA recommends that the following condition be included in the District Plan Designation for the Airport:

All scheduled engine testing is to be carried out so that the following noise limits are not exceeded at or within the boundary of any land zoned Residential, Frankton Flats or Remarkables Park, and at the notional boundary of any dwellings in the Rural zone:

(7am – 10pm)	*55 dBA L_{eq} (15 hours)*
(10pm – 7am)	*45 dBA L_{eq} (9 hours)*
	85 dBA L_{max}

For the purposes of essential unscheduled maintenance an allowance is made for engine testing to take place with relaxed noise limits on not more than 18 occasions per year. All unscheduled engine testing is to be carried out so that the following noise limits are not exceeded at or within the boundary of any land zoned Residential, Frankton Flats or Remarkables Park, and at the notional boundary of any dwellings in the Rural zone:

(7am – 10pm)	*65 dBA L_{eq} (15 hours)*
(10pm – 7am)	*60 dBA L_{eq} (9 hours)*
	85 dBA L_{max}

9.0 CONCLUSION

Marshall Day Acoustics has prepared revised airport noise boundaries for Queenstown Airport. The revised boundaries represent future forecast aircraft movements to the year 2037.

It is recommended that the revised Outer Control Boundary and Air Noise Boundary replace the equivalent airport noise boundaries in the Queenstown Lakes District Plan. It is also recommended that an additional Sound Insulation Boundary and Night Noise Boundary be implemented.

An assessment of noise effects resulting from the proposed noise boundaries has been carried out. The change in noise level due to growth in air traffic would be noticeable for most of the community but not significant and this change is expected to occur over an extended period of time.

Sleep disturbance and annoyance effects for existing dwellings could be adequately mitigated through the Airport funded sound insulation treatment programme for dwellings inside the ANB and NNB.

A comparison has been made between the proposed noise boundaries and the existing District Plan noise boundaries. It was found that the proposed airport noise

boundaries represent an increase in the land area and number of people and dwellings affected compared with the current boundaries.

The airport noise management and land use planning controls proposed to be included in the District Plan have been reviewed and some minor adjustments recommended.

It is the opinion of MDA that the proposed land use and airport noise controls are appropriate and reflect the intentions of NZS 6805.

APPENDIX A: EXISTING DISTRICT PLAN AIRPORT NOISE RULES

The Queenstown Lakes District Plan contains the following rules relating to Queenstown Airport:

"Designation D.2 Air Noise Boundary Controls

Noise

The Airport shall be managed so the noise does not exceed a day/night level (L_{dn}) of 65 outside the Air Noise Boundary and 55 dBA outside the Outer Control boundary. Aircraft Noise shall be measured in accordance with NZS 6805:1992 Airport Noise Management and Land Use Planning and calculated as a 90 day rolling average or calculated from a record of the individual aircraft movements and single event noise levels obtained from a detailed noise monitoring study for a minimum of 3 months.

Aircraft operations which will involve:

(a) aircraft landing in an emergency

(b) aircraft using the Airport as a planned alternative to landing at a scheduled airport

(c) military aircraft movements shall be excluded from the calculation of the three month average.

A noise monitoring regime is to be established and implemented by Queenstown Airport Corporation, the purpose of which is to meet the minimum reporting requirements set out in Clause 2.3.3.1 of NZS 6805:1992. This regime is to be recorded in a noise management plan, a copy of which is to be lodged with the Council not later than six months after the date this designation is included in the District Plan.

The data recorded and evaluated is to be reported at not more than 90 day intervals and a copy of the report forwarded to the Queenstown Lakes District Council not later than 20 working days after the expiry of the 90 day interval.

Queenstown Airport Corporation is to convene a standing Airport Liaison committee comprising at least one representative each from aircraft and airline operators, Airways Corporation of New Zealand, Queenstown Lakes District Council and the local community. The purpose of the committee is to foster a co-operative approach to the management of airport noise and other environmental effects"

It can be seen that the aircraft operations should not exceed L_{dn} 65 dBA outside the ANB and L_{dn} 55 dBA outside the OCB.

Further, the Noise Management Plan (NMP) for Queenstown Airport (July 2005) sets out the procedure to be followed for compliance monitoring. In Section 3.4 of the NMP, Threshold Criteria are given which should not be exceeded. These are:

- Where the calculated noise contour at any point on the ANB is L_{dn} 68 dBA or above
- Where the calculated noise contour at any point on the OCB is L_{dn} 58 dBA or above

APPENDIX B: SUMMARY OF NZS 6805:1992

In 1991 the Standards Association of New Zealand published New Zealand Standards 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. The Standard has two majors aims:

(i) to establish compatible land use planning around an airport; and

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

B1 – Noise Boundaries

The Standard recommends two noise boundaries be developed to achieve its aims. This involves fixing an Outer Control Boundary (OCB) and a smaller, much closer Airnoise Boundary (ANB) around the airport. These boundaries represent noise limits which the airport must not exceed, as well as guidelines for land use planning.

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 provided with sound insulation. The ANB is also nominated as the location for future noise monitoring of compliance with an L_{dn} 65 dBA limit.

The Standard is based on the Day/Night Sound Level (L_{dn}) which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10 dB penalty applied to night flights (see Appendix A for an explanation of 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.

When establishing the location of the Noise Boundaries, an allowance for the expected growth of the airport can be made and NZS 6805 recommends a minimum 10 year projection should be made of future aircraft operations. The L_{dn} contours for the airport can be calculated using a computer programme called the Integrated Noise Model (INM).

The location of the ANB is then based upon the projected L_{dn} 65 dBA contour and the OCB on the projected L_{dn} 55 dBA. NZS 6805 also recommends that, where appropriate, night time single event noise levels should be considered in the location of the ANB.

B2 – Land Use Planning

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 constrict, by public pressure as a response to noise, the operation of the airport.

NZS 6805 lays out recommended criteria for Land Use Planning around airports. In summary, Tables 1 and 2 of the Standard recommend the following:

Inside the ANB

(i) New noise sensitive uses (including residential) should be prohibited;

(ii) Existing residential buildings and subsequent alterations should have appropriate sound insulation.

Between ANB and OCB

(i) New noise sensitive uses (including residential) should be prohibited unless a District Plan permits such use subject to appropriate sound insulation.

(ii) Alterations or additions to existing noise sensitive uses (including residential) should include appropriate sound insulation.

B3 – Airport Noise Management

In addition to land use controls, noise controls can be used to manage the level of noise impact around airports. These controls can take the form of preferential runway usage, noise abatement flight tracks, curfews, noise emission limits and others. NZS 6805 proposes maximum noise emission limits for the airport. This procedure is consistent with the general approach to noise control in New Zealand, in that it is left to the operator to best decide how to manage its activities to comply with an agreed level of noise.

The Standard proposes that the Day/Night Sound Level (L_{dn}) produced by the Airport should not exceed 65 dBA at or outside the ANB (or L_{dn} 65 dBA contour). A measurement would involving monitoring the hourly noise levels over a period of typically 3 months and obtaining the L_{dn} by averaging the daytime and weighted night-time noise levels.

The location of the L_{dn} 65 and 55 dBA contours determines the extent of the noise emission from the airport and thus the extent to which the airports future operations are constrained. Therefore when calculating the contours and locating the ANB and OCB it is vital that the future expansion of the airport be taken into account.

APPENDIX C: SUMMARY OF AIRCRAFT MOVEMENTS

Scenario	Total	Scheduled	Corporate	Flightseeing	GA	Heli
2008 Compliance Contours	**58780**	9065	758	6365	19914	22678
District Plan Contours[1]	**108175**	15465	-	19645	53794	19272
Updated 2037 Contours	**94600**	21300	1200	20500	16200	35400

[1]Corporate movements accounted for in GA movement numbers

(source: AirBiz Aviation Consultants – 2008)

APPENDIX D: INM INPUT – PERCENTAGE RUNWAY USAGE

Fixed Wing Arrivals

Runway	Scheduled (%)	Corporate (%)	Flightseeing (%)	General Aviation (%)
05	26	30	39	12
23	74	70	21	43
14	-	-	24	40
32	-	-	16	5

Fixed Wing Departures

Runway	Scheduled (%)	Corporate (%)	Flightseeing (%)	General Aviation (%)
05	31	30	66	65
23	69	70	6	12
14	-	-	7	20
32	-	-	21	3

Helicopters

Helicopter Track	Arrivals (%)	Departures (%)
A	25	6
B	4	6
C	15	18
D	19	21
E	10	10
F	5	6
G	8	28
H	13	6

APPENDIX E: COMMUNITY RESPONSE – NUMBER OF PEOPLE HIGHLY ANNOYED

Scenario	Level (dBA L_{dn})	No. Houses	No. People	No. People Highly Annoyed
Current Noise Contours	55-60	73	186	27
2008 Actual Operations	60-65	26	66	15
	>65	0	0	0
Current TOTAL				**42**
District Plan Noise Boundaries	55-60	85	217	32
	60-65	67	171	39
	>65	0	0	0
District Plan TOTAL				**71**
Updated Noise Contours	55-60	268	683	100
	60-65	108	275	63
	>65	72	187	56
Updated TOTAL				**219**

Assumptions;

No. People per house = 2.6 (source – Statistics NZ census data)

Percentage of people highly annoyed is based on the Miedema & Ouldshoorn relationship:
L_{dn} 55-60dBA 15% HA
L_{dn} 60-65dBA 23%
L_{dn} >65 30% (based on L_{dn} 66)

No. of Houses inside L_{dn} 55 – 65 dBA is based on an analysis of cadastral boundaries. The number inside L_{dn} 65 dBA is based on site visits and photographic evidence undertaken by Maltbys Ltd, quantity surveyors.

APPENDIX F: PROPOSED 'ACCEPTABLE CONSTRUCTIONS' TABLES AND AIRPORT NOISE CONTROL PROVISIONS

Section AF1.1 contains the 'Acceptable Constructions' tables referenced in the proposed Plan Change and Notice of Requirement documentation.

Section AF1.2 contains proposed Airport Noise Controls, relating to noise emission from airport operations.

Section AF1.3 contains the proposed definitions that would apply.

AF1.1 Proposed Sound Insulation Construction Tables

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:	*75mm thermal insulation blanket/batts*	
	Frame:	*Two layers of 9mm gypsum or plasterboard (or an equivalent combination of exterior and interior wall mass)*	
Windows/Glazed Doors	*6mm glazing with effective compression seals or for double glazing 8mm-12mm airgap-6mm*		
Pitched Roof	*Cladding:*	*0.5mm profiled steel or masonry tiles or 6mm corrugated fibre cement*	
	Insulation:	*100mm thermal insulation blanket/batts*	
	Ceiling:	*2 layers 9mm gypsum or plaster board*	
Skillion Roof		*Skillion Roof Option 1*	*Skillion Roof Option 2*
	Cladding:	*0.5mm profiled steel or 6mm fibre cement*	*0.5mm profiled steel or 6mm fibre cement*
	Sarking:	*20mm particle board or plywood*	*None Required*
	Insulation:	*100mm thermal insulation blanket/batts*	*100mm thermal insulation blanket/batts*
	Ceiling:	*1 layer 9mm gypsum or plasterboard*	*2 layers 9mm gypsum or plaster board*
External Door	*Solid core door (min 24kg/m^2) with weather seals*		

Note: The specified constructions in this table are the minimum required to meet the acoustic standards. Alternatives with greater mass or larger thicknesses of insulation will be acceptable. Any additional construction requirements to meet other applicable standards not covered by this rule (eg fire, Building Code etc) would also need to be implemented

Table 2: 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*	

Note: The specified constructions in this table are the minimum required to meet the acoustic standards. Alternatives with greater mass or larger thicknesses of insulation will be acceptable. Any additional construction requirements to meet other applicable standards not covered by this rule (eg fire, Building Code etc) would also need to be implemented.

Table 3: Ventilation Requirement

Room Type	*Outdoor Air Ventilation Rate (Air Changes per Hour)*	
	*Low Setting **	*High Setting **
Principle living areas	*1-2 ac/hr*	*Min. 15 ac/hr*
Other habitable areas	*1 2 ac/hr*	*Min. 5 ac/hr*

** Each system must be able to be individually switched on and off and when on, be controlled across the range of ventilation rates by the occupant with a minimum of 3 stages.*

Each system providing the low setting flow rates is to be provided with a heating system which, at any time required by the occupant, is able to provide the incoming air with an 18 degC heat rise when the airflow is set to the low setting. Each heating system is to have a minimum of 3 equal heating stages.

If air conditioning is provided to any space then the high setting ventilation requirement for that space is not required.

AF1.2 Proposed Airport Noise Controls

The Airport shall be managed so that the noise from aircraft operations does not exceed a Day/Night Level (L_{dn}) of 65 dBA outside the Air Noise Boundary (ANB) and 55 dBA outside the Outer Control Boundary (OCB) as shown on the District Plan Maps.

Compliance with this rule shall be determined by the calculation of Annual Aircraft Noise Contours (AANC) using the Integrated Noise Model (INM) program and records of actual aircraft activity at the Airport. The same version of the INM and the same methodology used for the District Plan contours shall be used for the AANC. A report, prepared by a suitably qualified acoustic consultant, shall be provided annually to the Council. The report shall contain the AANC and the methodology used in the preparation of the contours.

The Airport shall carry out noise monitoring to check the AANC are within 2 dB of the measured levels. The monitoring program should include at least the following level of monitoring over a three year period; a minimum of one month summer and one month winter at each of two measurement locations.

No scheduled aircraft operations shall take place between midnight and 7.00 am. All scheduled aircraft operations that take place between 10.00 pm and midnight shall be certified in advance to have an SEL 95 dBA noise contour that does not exceed the Night Noise Boundary (NNB).

AF1.3 Proposed District Plan Definitions

Air Noise Boundary (ANB) – means a boundary as shown in Figure 31A, the location of which is based on the predicted day/night sound level of L_{dn} 65 dBA from future airport operations.

Night Noise Boundary (NNB) – means a boundary as shown in Figure 31A, the location of which is based on the sound exposure level (SEL) 95 dBA contour for the arrival of a Boeing 737-800 and Airbus A320, adjusted for reverse thrust as used at Queenstown Airport.

Sound Insulation Boundary (SIB) – means a boundary as shown in Figure 31A, the location of which is based on the predicted day/night sound level of L_{dn} 58 dBA from future airport operations.

Outer Control Boundary (OCB) - means a boundary as shown in Figure 31A, the location of which is based on the predicted day/night sound level of L_{dn} 55 dBA from future airport operations.

Annual Airport Noise Contours (AANC) – means the Annual Airport Noise Contours calculated using the Integrated Noise Model (INM) developed by the US Federal Aviation Authority and a record of the actual aircraft movements recorded over the

past year. The same version of the INM and the same methodology as used for the District Plan contours shall be used for the AANC. The version used for the District Plan noise control boundaries is INM v7a.

Activity Sensitive to Aircraft Noise (ASAN) – means habitable rooms within household units, minor household units, pre-schools/education facilities, schools, other education facilities, childcare centres, and other care centres, residential centres, hospitals, other healthcare facilities, rest homes and other homes for the aged.

Aircraft Operations – includes the operation of aircraft during landing, take-off and taxiing but excludes:

- aircraft operating in an emergency;
- aircraft using the Airport as a planned alternative to landing at a scheduled airport;
- military aircraft movements;
- engine testing (controlled by separate rule).

APPENDIX G: FIGURES

Figure 1: Current District Plan Noise Contours

Figure 2: 2008 Compliance Noise Contours

Figure 3: Flight Tracks Runway 05

Figure 4: Flight Tracks Runway 23

Figure 5: Flight Tracks Runway 14

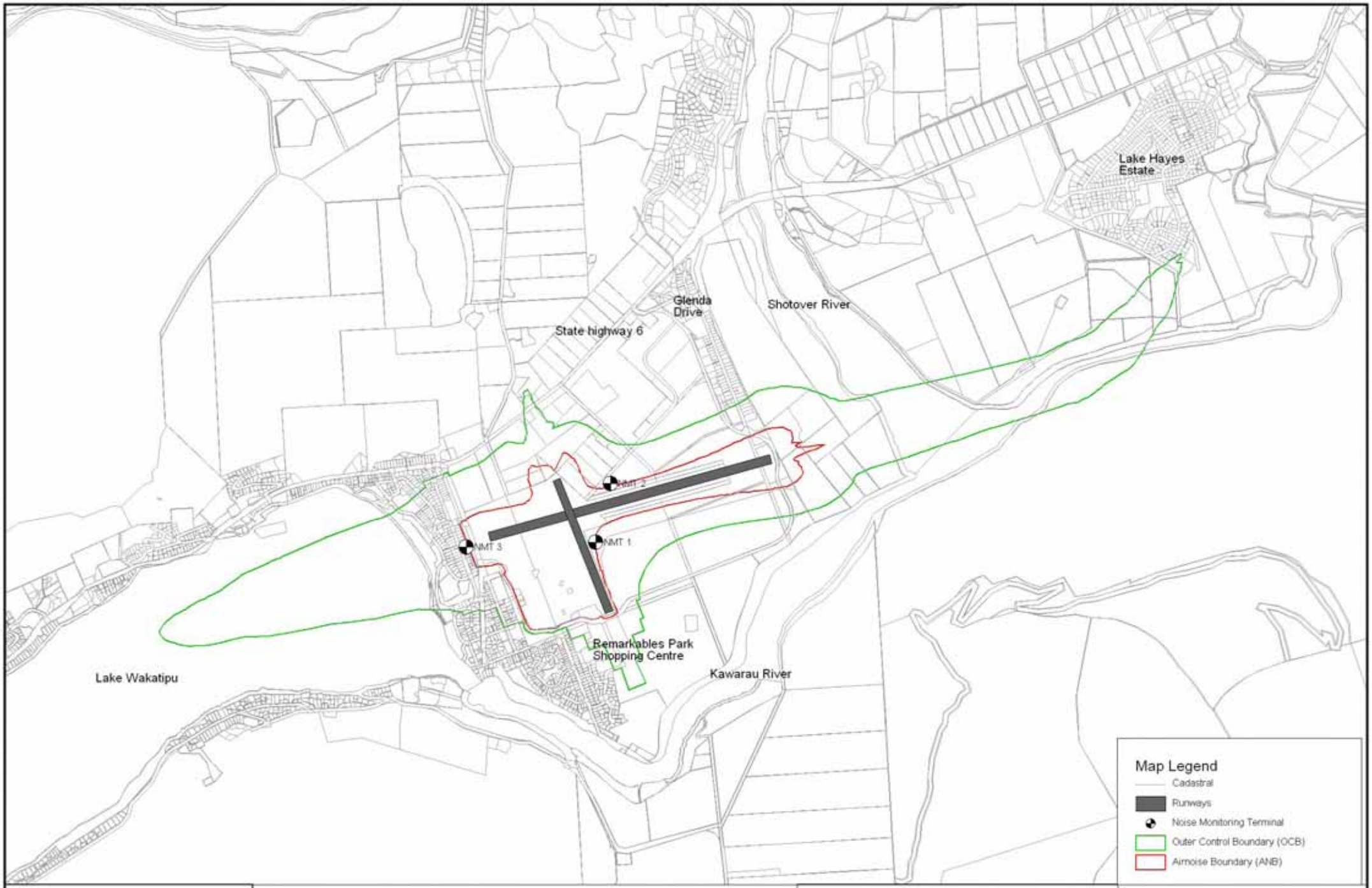
Figure 6: Flight Tracks Runway 32

Figure 7: Flight Tracks Fixed Wing Circuits and Helicopters

Figure 8: 2037 Noise Contours

Figure 9: Proposed Noise Control Boundaries

Figure 10: Indicative Airport Noise Emissions

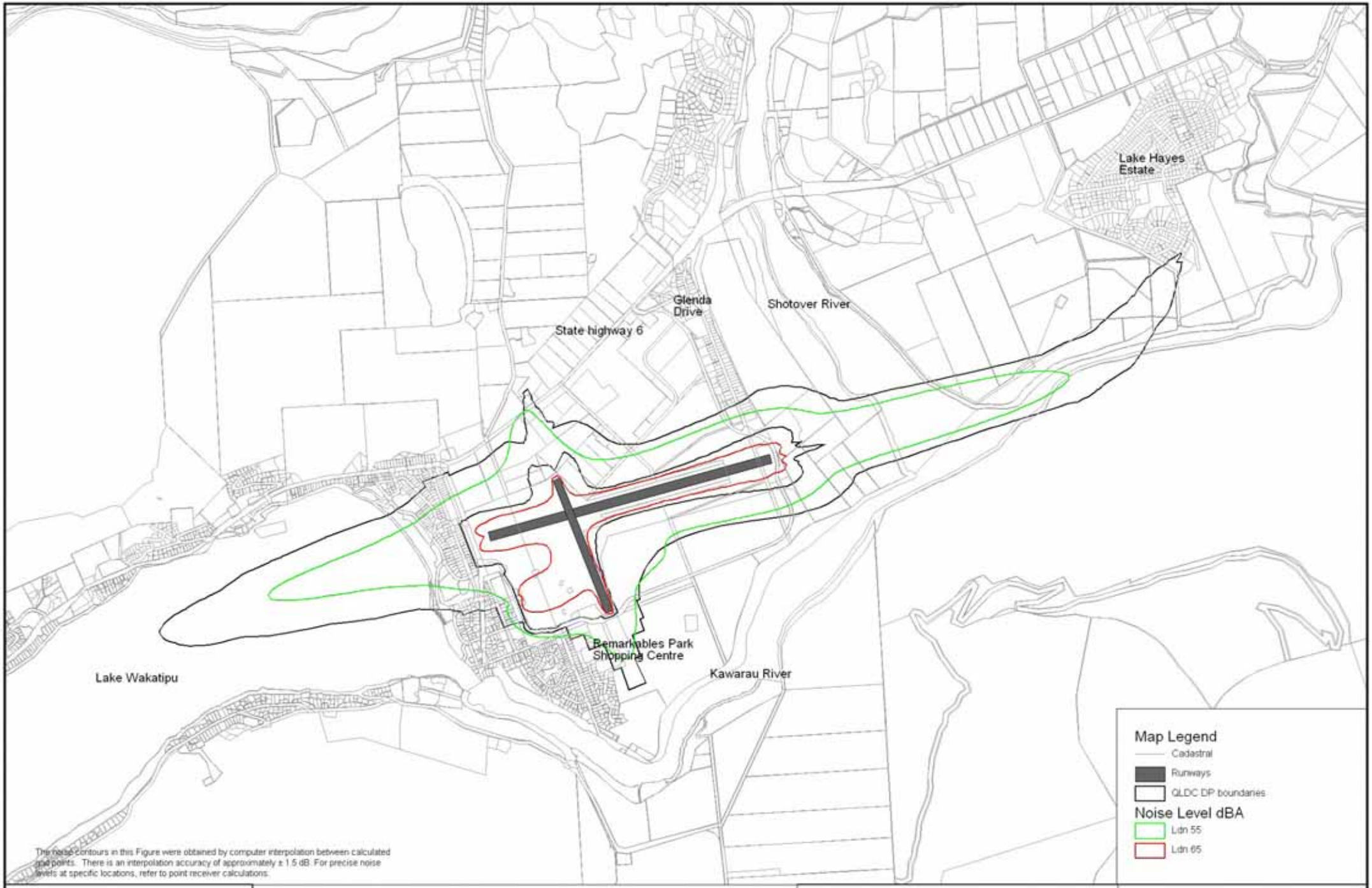


MARSHALL DAY Acoustics

Figure 1 - Current District Plan Noise Contours

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_93\92166B Ctrl\2037 Forecast Info\Figures\Report Figures
Filename: 0908 Figure 1.SGS
Prepared by: SJP Date: 11/09/09

Scale 1:22500



MARSHALL DAY Acoustics

Figure 2 - 2008 Compliance Noise Contours

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_93\92166B Ctrl\2037 Forecast Info\Figures
Filename: 0906 Figure 2.SGS INM case: 2008 R0
Prepared by: SJP Date: 11/06/09

Scale 1:22500

0 500 200 400 600 800 m

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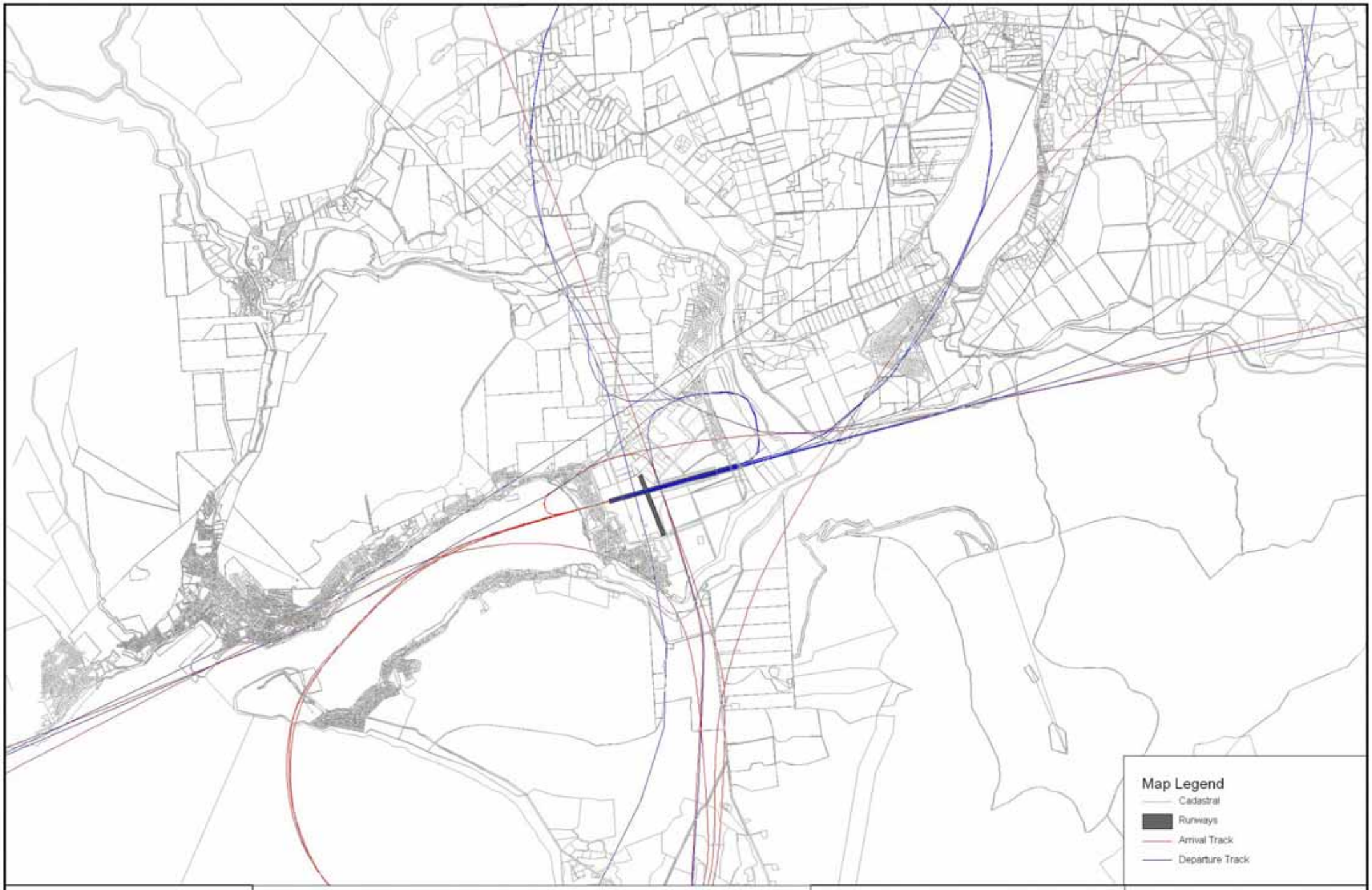

MARSHALL DAY Acoustics

Figure 3 - Flight Tracks Runway 05

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_83\92166B Ctrl\2037 Forecast Info\Figures\Report Figures
Filename: 0908 Figure 3.5GS INM case: 2037 Forecasts R17 series
Prepared by: SJP Date: 11/08/09

Scale 1:50000

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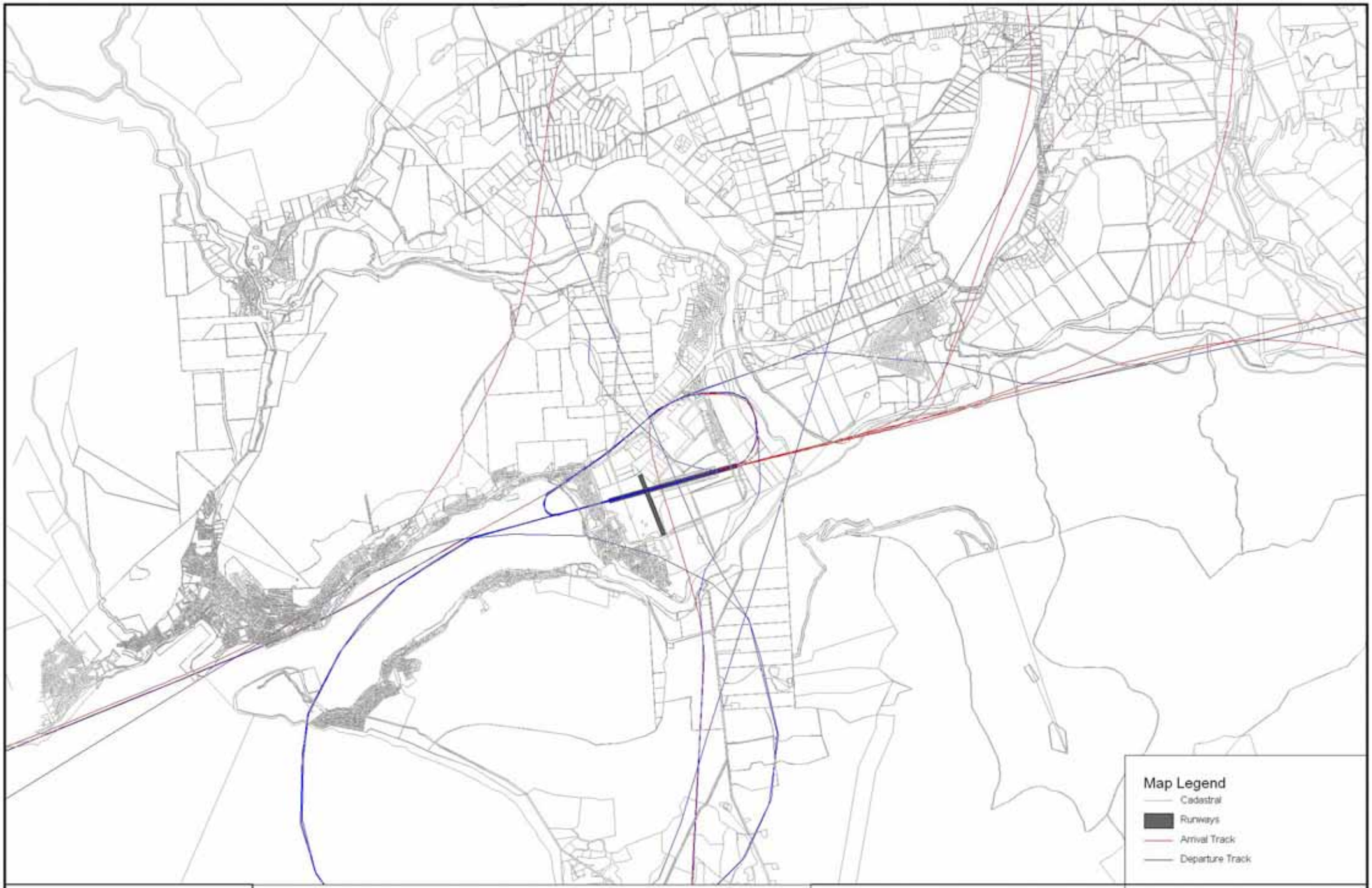

MARSHALL DAY Acoustics

Figure 4 - Flight Tracks Runway 23

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_93\92166B Ctrl\2037 Forecast Info\Figures\Report Figures
Filename: 0908 Figure 4.5GS INM case: 2037 Forecasts R17 series
Prepared by: SJP Date: 11/08/09

Scale 1:50000

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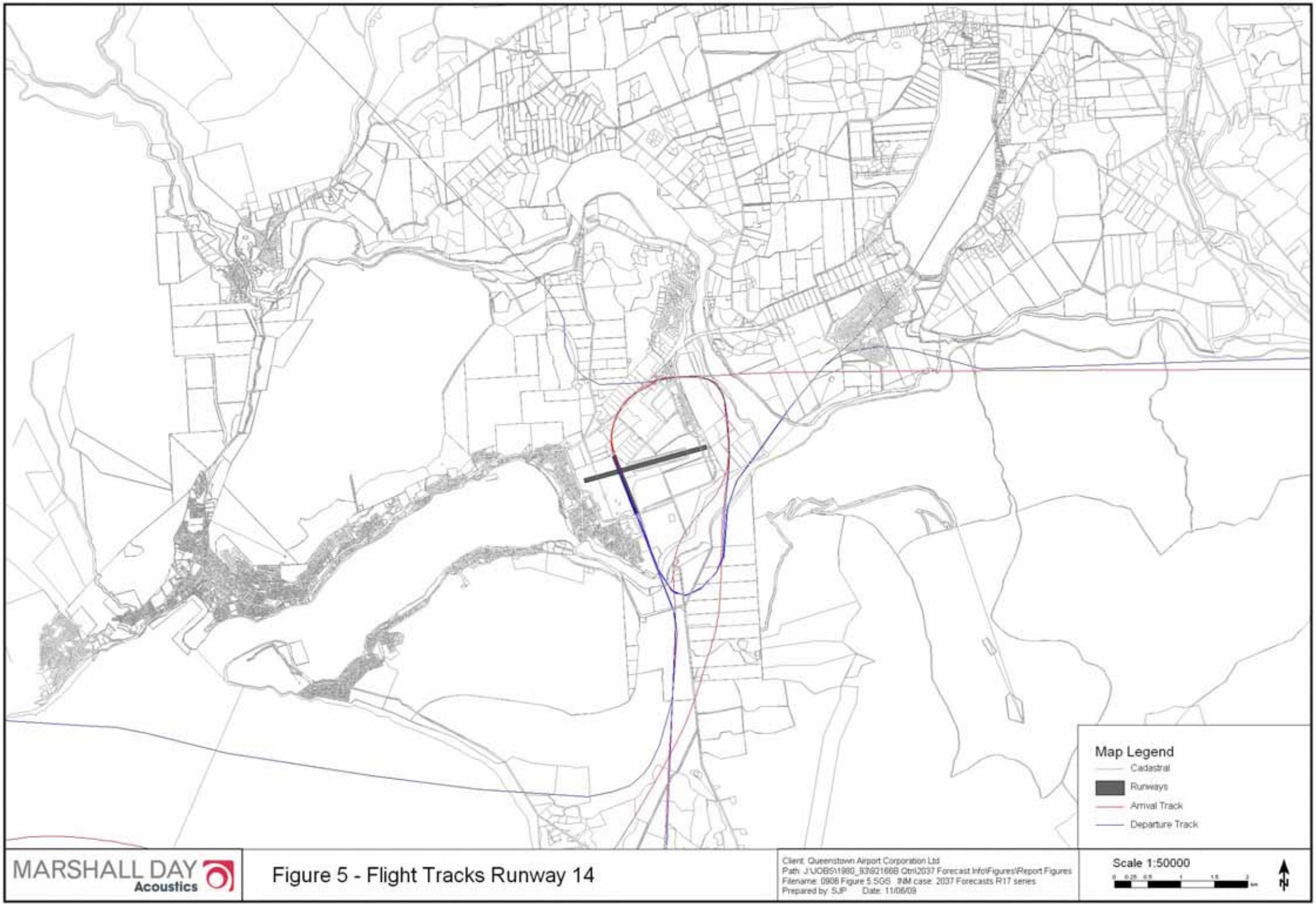

MARSHALL DAY Acoustics

Figure 5 - Flight Tracks Runway 14

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_83\92166B Ctrl\2037 Forecast Info\Figures\Report Figures
Filename: 0908 Figure 5.5GS INM case: 2037 Forecasts R17 series
Prepared by: SJP Date: 11/08/09

Scale 1:50000

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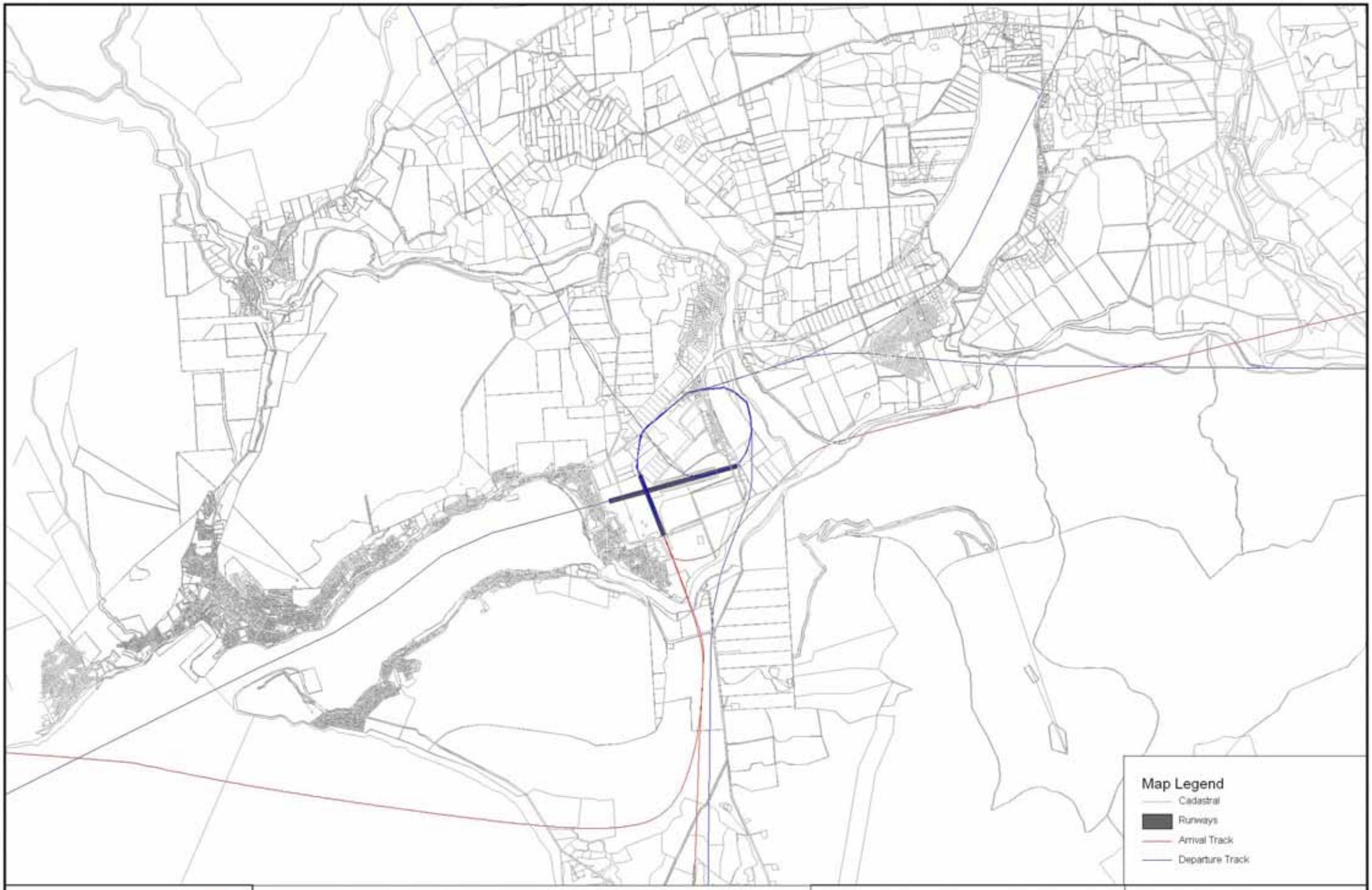


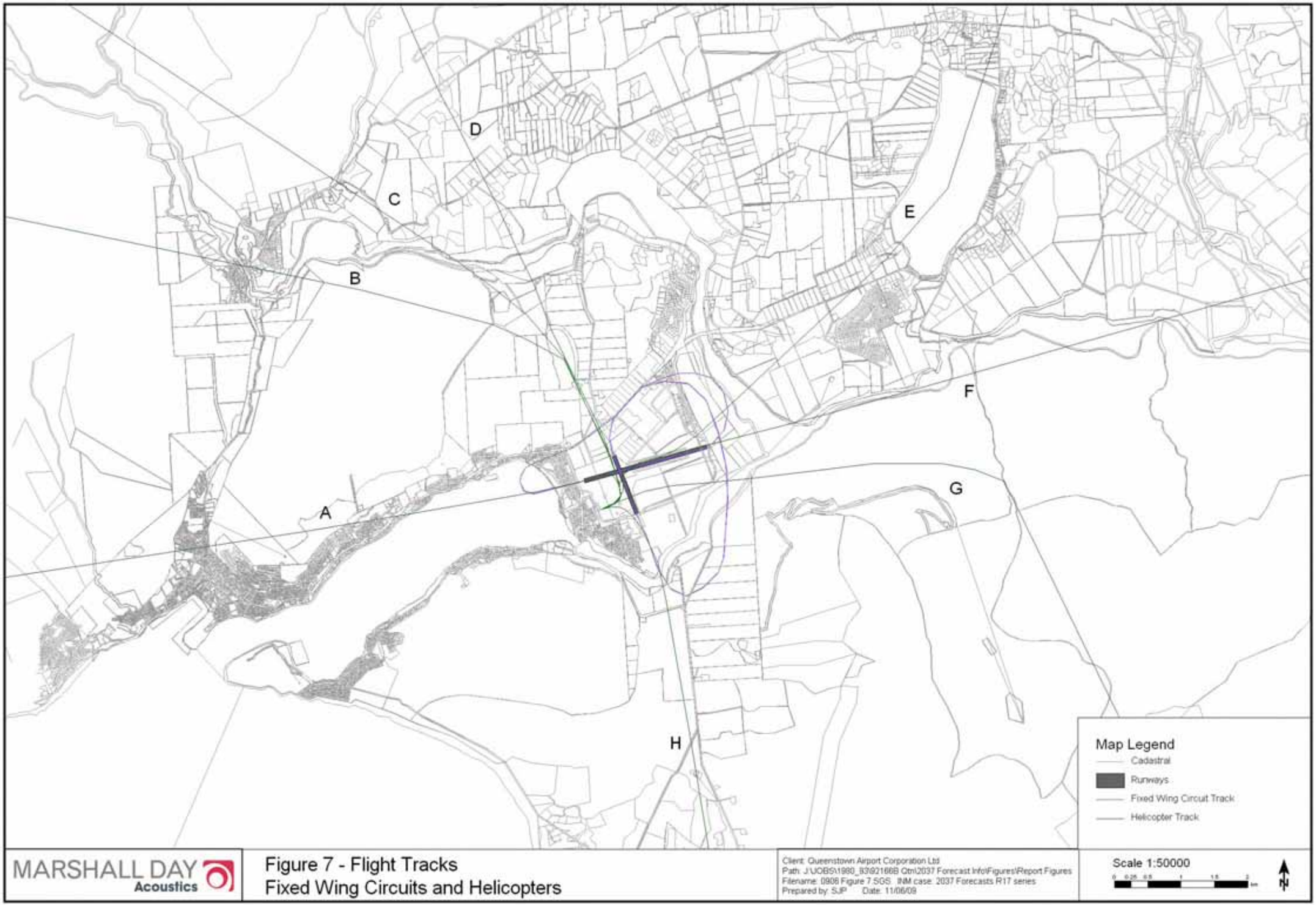
MARSHALL DAY Acoustics

Figure 6 - Flight Tracks Runway 32

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_93\92166B Otn\2037 Forecast Info\Figures\Report Figures
Filename: 0906 Figure 6.5GS INM case: 2037 Forecasts R17 series
Prepared by: SJP Date: 11/06/09

Scale 1:50000

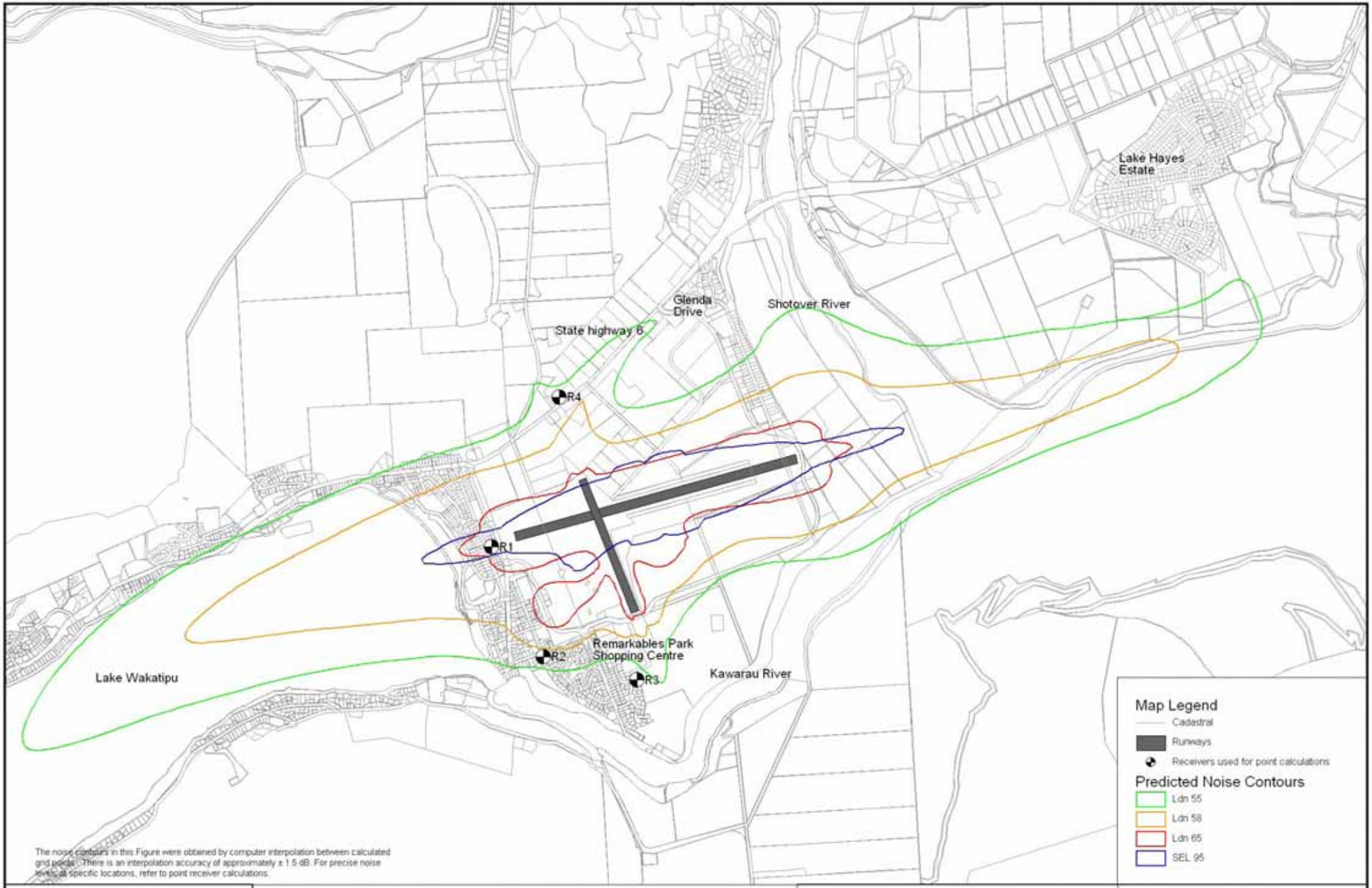
N



MARSHALL DAY Acoustics

Figure 7 - Flight Tracks
Fixed Wing Circuits and Helicopters

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_83\92166B Ctrl\2037 Forecast Info\Figures\Report Figures
Filename: 0906 Figure 7.5GS INM case: 2037 Forecasts R17 series
Prepared by: SJP Date: 11/06/09

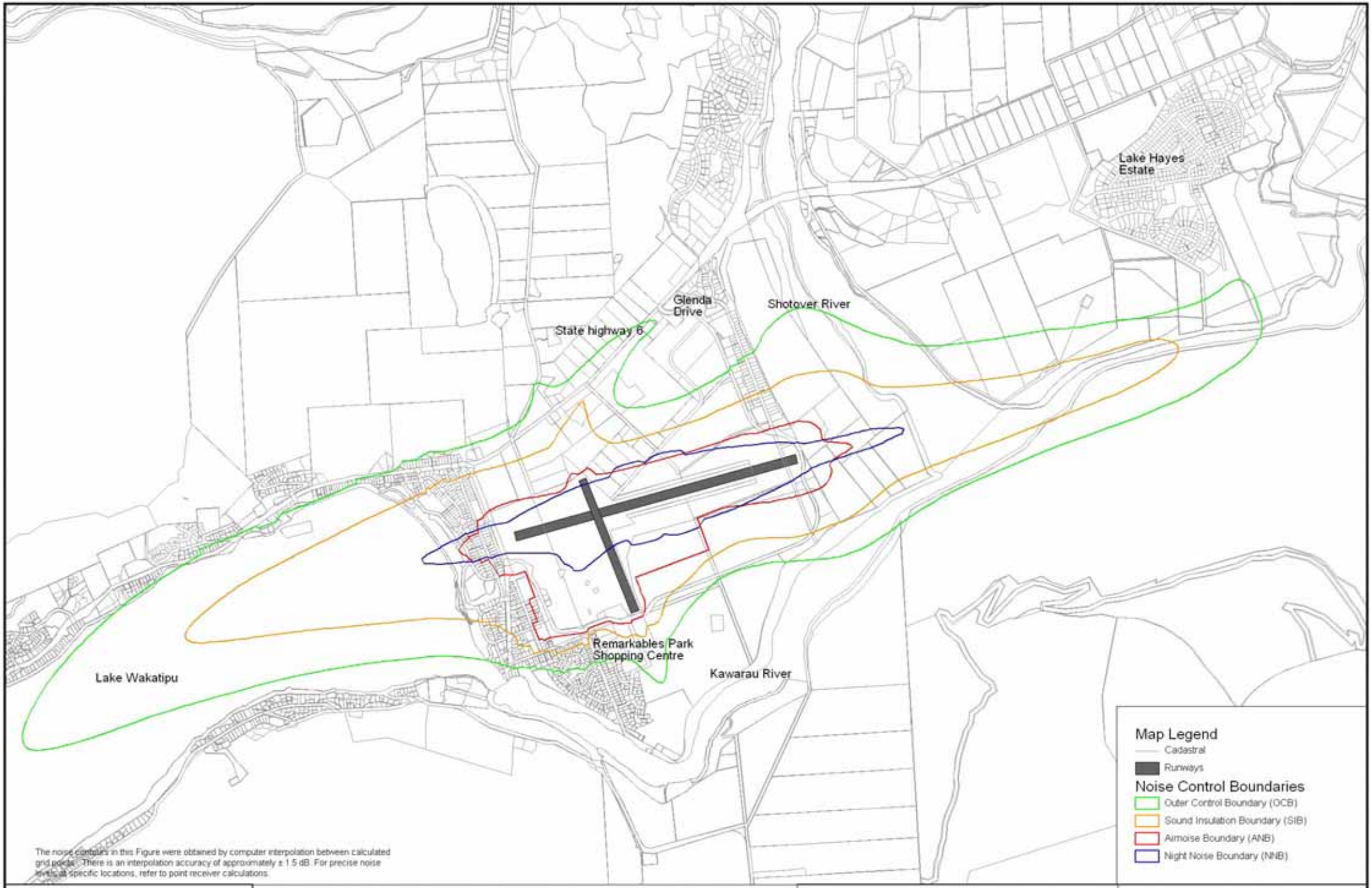


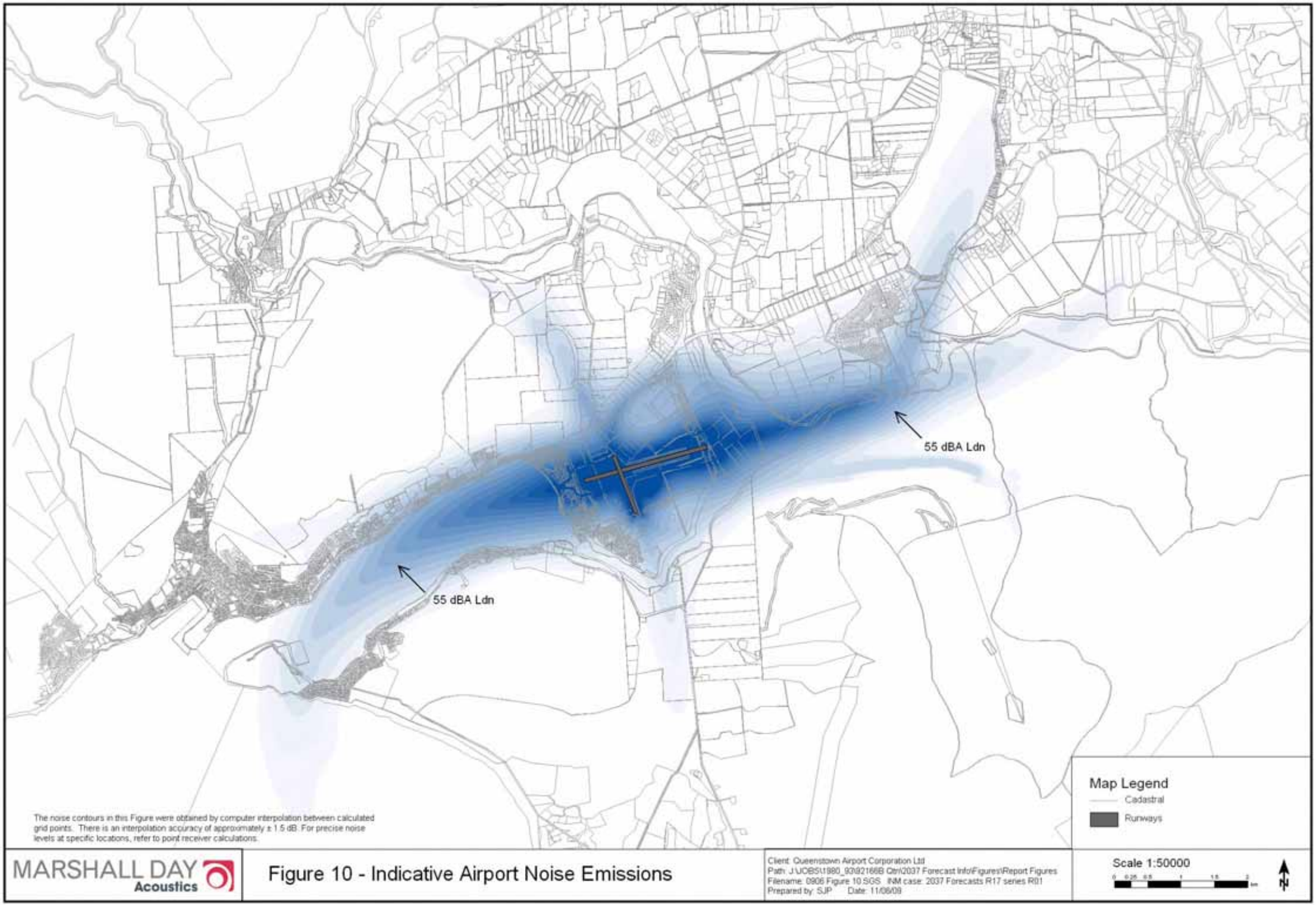
MARSHALL DAY Acoustics

Figure 8 - 2037 Noise Contours

Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_93\92166B Qtn\2037 Forecast Info\Figures\Report Figures
Filename: 0908 Figure 8.SGS INM case: 2037 Forecasts R17 series R01
Prepared by: SJP Date: 11/09/09

Scale 1:22500


Lake Hayes Estate
Glenda Drive
Shotover River
State highway 6
Remarkables Park Shopping Centre
Kawarau River
Lake Wakatipu
Map Legend
Cadastral
Runways
Noise Control Boundaries
Outer Control Boundary (OCB)
Sound Insulation Boundary (SIB)
Airnoise Boundary (ANB)
Night Noise Boundary (NNB)
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 9 - Proposed Noise Control Boundaries
Client: Queenstown Airport Corporation Ltd
Path: J:\JOBS\1980_93\92166B Qtn\2037 Forecast Info\Figures\Report Figures
Filename: 0908 Figure 9.SGS INM case: 2037 Forecasts R17 series
Prepared by: SJP Date: 11/06/09
Scale 1:22500
0 100 200 400 600 800 m
N


55 dBA Ldn
55 dBA Ldn
Map Legend
Cadastral
Runways
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 10 - Indicative Airport Noise Emissions
Client: Queenstown Airport Corporation Ltd
Path: J:\QOBS\1980_93\92166B Qtn\2037 Forecast Info\Figures\Report Figures
Filename: 0906 Figure 10.SGS INM case: 2037 Forecasts R17 series R01
Prepared by: SJP Date: 11/09/09
Scale 1:50000
N

APPENDIX H: GLOSSARY OF TERMINOLOGY

dBA	A measurement 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.
L_{eq}	The time averaged sound level (on a log/energy basis) over the measurement period (normally A-weighted).
L_{dn}	The day-night sound level which is calculated from the 24 hour L_{eq} with a 10 dBA penalty applied to the night-time (2200-0700 hours) L_{eq} (normally A-weighted).
L_{95}	The sound level which is equalled or exceeded for 95% of the measurement period. L_{95} is an indicator of the mean minimum noise level and is used in New Zealand as the descriptor for background noise (normally A-weighted).
L_{10}	The sound level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level and is used in New Zealand as the descriptor for intrusive noise (normally A-weighted).
L_{max}	The maximum sound level recorded during the measurement period (normally A-weighted).
SEL	The sound level of one second duration which has the same amount of energy as the actual noise event measured.
Noise	A sound that is unwanted by, or distracting to, the receiver.
Ambient Noise	Ambient Noise is the all-encompassing noise associated with any given environment and is usually a composite of sounds from many sources near and far.
NZS 6801	New Zealand Standard NZS 6801:1991 *"Measurement of Sound"*
NZS 6802	New Zealand Standard NZS 6802:1991 *"Assessment of Environmental Sound".*
NZS 6805	New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"*
NZS 6807	New Zealand Standard NZS 6807:1994 *"Noise Management and Land Use Planning for Helicopter Landing Areas*"

Appendix 2

Dwellings/sites within the LDRZ overlaid by the ANB

	1	2	3	4	5	6	7	8	9
	Address	**Site Area (m²)**	**No of Existing Dwellings**	**Vacant (7.4.11)**	**Additional Dwellings enabled by 450m²**	**Additional Dwellings enabled by 300m²**	**New lots under 600m² allotment size**	**NOTES**	
1	Northern Strip	734	0	1	1	2		Designation 155	Recreation Reserve
2	Southern Strip	4859	0	1	10	16	7	Designation 164	Local Purpose (Beautification)
	Sub total		**0**	**2**	**11**	**18**	**7**		
	McBride Street								
3	50	1849	1		3	5	2	Church	
4	58	1012	1		1	2			
5	62	1012	1		1	2			
6	64	1012	1		1	2			
7	68	1012	1		1	2		Owned by QAC	
8	72	1012	0	1	2	3			
9	76	430	1		0	0			
10	76A? (Behind 76)	582	1		0	0			
11	80	1012	1		1	2		Owned by QAC	
12	84	1012	1		1	2		Owned by QAC	
13	88	1012	0	1	2	3		Owned by QAC	
14	90A and 90B	521	2		0	0			
15	92	490	1		0	0			
16	96	511	1		0	0			
17	96A (behind 96)	450	1		0	0			
18	98	450	1		0	0			
19	98A(behind 98)	461	1		0	0			
20	100a	460	0	1	1	1			
21	100b	450	1		0	0			
22	102	911	1		1	2			
23	104	890	1		0	1			
24	87	1012	1		1	2			
25	83	1012	0	1	2	3			
26	79	1012	1		1	2			
27	75	470	1		0	1			
28	77	581	1		0	0			
29	71	1014	1		1	2			
30	67	1091	2		0	1			
31	63	1200	1		1	3	1		
32	57	525	1		0	0			
33	59	783	1		0	1			
	McBride St Sub Total		**29**	**4**	**21**	**42**	**3**		
	Lake Avenue								
34	30	561	1		0	0			
35	30A	450	1		0	0			
36	32A and 32B	1012	2		0	1			
37	34	614	1		0	1			
38	34A (behind 34)	600	0	1	1	2			
39	36	1012	1		1	2			
40	38	483	1		0	0			
41	38A	529	1		0	0			
42	40	501	1		0	0			
43	40B	510	1		0	0			
		405	0	1	1	1		QLDC Designation	
	Lake Ave Sub total		**10**	**2**	**3**	**7**	**0**		
	Douglas Street								
44	56-58	6753	20		0	2	11		
45	54	1077	1		1	2		Fire Station	
46	50	1523	2		1	3	1		
47	46A and 46B	815	2		0	0			
48	42A and 42B	782	2		0	0			
49	44A and 44B	903	2		0	1			
50	34	**857**	1		0	1			
51	32	**1111**	1		1	2			
52	26	1110	1		1	2			
53	24A and 24B	1111	2		0	1			
54	Hospital	3143	0	1	6	10	4		
	Douglas St Sub total		**34**	**1**	**10**	**24**	**16**		
	TOTAL EXISTING DWELLINGS		**73**						
				Scenario Outcomes					
1A	Additional with 7.4.11			9					
1B	Additional with 7.4.11 less constrained sites			**4**					
2A	Additional enabled by 450m²				45				
2B	Additional less constraints				**18**				
3A	Additional enabled by 300m²					91			
3B	Additional less constraints					**46**			
4A	New allotments						26		
4B	New allotments less constraints						13		
4C	New allotments less 56-58 Douglas St						**2**		

Notes:

55 Scenarios 1A/2A/3A/4A represent the gross dwellings development yeild on an unconstrained basis.

56 Scenarios 1B/2B/3B/4B represent the number of dwellings enabled less constrained sites.

57 Scenario 4C. 56 - 58 Douglas St a multi dwelling site requiring clearance to achieve scenario site numbers

58 Constrained sites are identified as Designations / QAC and QLDC owned sites / Fire Station / Hospital / Church.

59 Source: Council's GIS maps, District Plan maps, Google Earth and ground truthing.