APPENDIX 6 - Wanganui Airport Plan Review, Noise Control Boundaries Assessment of Noise Effects Report, Marshal Day Acoustics, Nov 2013

MARSHALL DAY
Acoustics

WANGANUI AIRPORT PLAN REVIEW

Noise Control Boundaries - Assessment of Noise Effects

Rp 001 r01 2012055A

13 November 2013

MARSHALL DAY Acoustics

84 Symonds Street
PO Box 5811 Wellesley Street
Auckland 1141 New Zealand
T: +64 9 379 7822 F: +64 9 309 3540
www.marshallday.com

Project: **WANGANUI AIRPORT PLAN REVIEW**

Prepared for: **Wanganui District Council**
PO Box 637
Wanganui 4500

Attention: **James Witham**

Report No.: **Rp 001 r01 2012055A**

Document control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Draft	00		4 October 2013	Laura McNeill	Steve Peakall
Revised	01	J Witham Comments	13 November 2013	Laura McNeill	Steve Peakall

TABLE OF CONTENTS

1.0 INTRODUCTION

Marshall Day Acoustics (MDA) has been engaged by Wanganui District Council (WDC) to prepare airport noise contours for Wanganui Airport. Airport noise contours would provide the basis for the implementation of New Zealand Standard NZS 6805 in the Wanganui District Plan (District Plan). Wanganui Airport currently has no noise boundaries in the District Plan.

The purpose of this report is to prepare airport noise contours and to assess any noise effects as a result. Consideration of NZS 6805 and recommendations for appropriate noise control boundaries and land use controls are provided, that will assist in the Plan Review process.

A glossary of technical terms is provided in Appendix A.

2.0 NOISE PERFORMANCE STANDARDS

The New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"* (NZS 6805) provides a recommended approach for territorial authorities dealing with airports and land affected by airport noise. The process aims to manage the adverse effects of airport noise by controlling the use of land around airports, and by ensuring the airport does not exceed the future noise contours used for the planning process.

A summary of NZS 6805 is provided in Appendix B.

The Standard recommends two boundaries, the Airnoise Boundary (ANB) set at 65 dB L_{dn} and the Outer Control Boundary (OCB) set at 55 dB L_{dn}. Wanganui Airport does not currently have any noise boundaries in the District Plan. Therefore there are currently no specific airport noise controls or land use planning controls in the District Plan.

When establishing the location of noise boundaries, an allowance for the expected growth of the airport is made and NZS 6805 recommends a minimum 10 year projection of future aircraft operations. Some New Zealand Airports have used capacity as the future growth scenario. In this case the future year on which the noise contours are based is 2043, as advised by WDC, which MDA understands provides an appropriate level of potential airport growth.

The recommendations of New Zealand Standard NZS 6807:1994 *"Noise Management and Land Use Planning for Helicopter Landing Areas"* have also been considered as helicopter operations occur at Wanganui Airport.

3.0 INTEGRATED NOISE MODEL

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 referenced 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 dB 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 most recent version of the INM is Version 7d. This version has been used to calculate the noise contours.

3.1 Runways & Helipads

Wanganui Airport has one sealed and four grass runways in operation currently. The airport also has a helicopter takeoff and landing area. It is understood that this area is located on the north eastern side of runway end 11L.

The runway and vector splits are shown in Table 3.1; the runway layout is depicted graphically in Figure 3.1

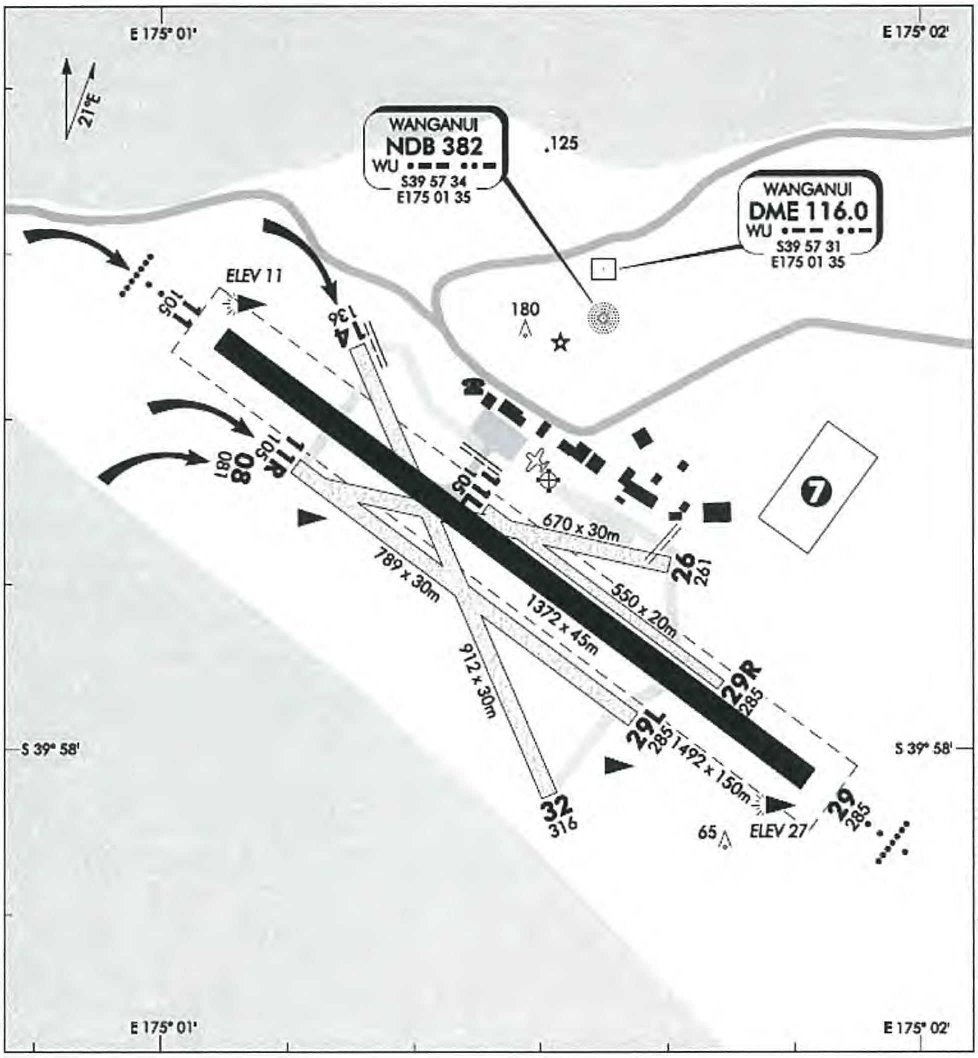
It is understood that most aircraft are able to use all five runways and do so based on the wind direction at the time of arrival or departure and other air traffic in the area. However, we have been advised that larger aircraft including all scheduled aircraft mostly use the sealed runway 11/29. This assumption has been included in the noise modelling and 100% of their movements have been assigned to the sealed runway (11/29).

Table 3.1: Runway Splits

Runway	% of Movements*	Vector Splits
11/29 Sealed	76%	RW29 (65%)
		RW11 (35%)
11L/29R Grass	15%	RW29 (65%)
		RW11 (35%)
11R/29L Grass	3%	RW29 (65%)
		RW11 (35%)
08/26 Grass	3%	RW08 (5%)
		RW26 (95%)
14/32 Grass	4%	RW14 (50%)
		RW23 (50%)

** Aircraft able to use only the sealed runway will have 100% of their movements on RW11/29*

Figure 3.1: Wanganui Airport Runways



Source: AIP New Zealand

3.2 Flight Tracks

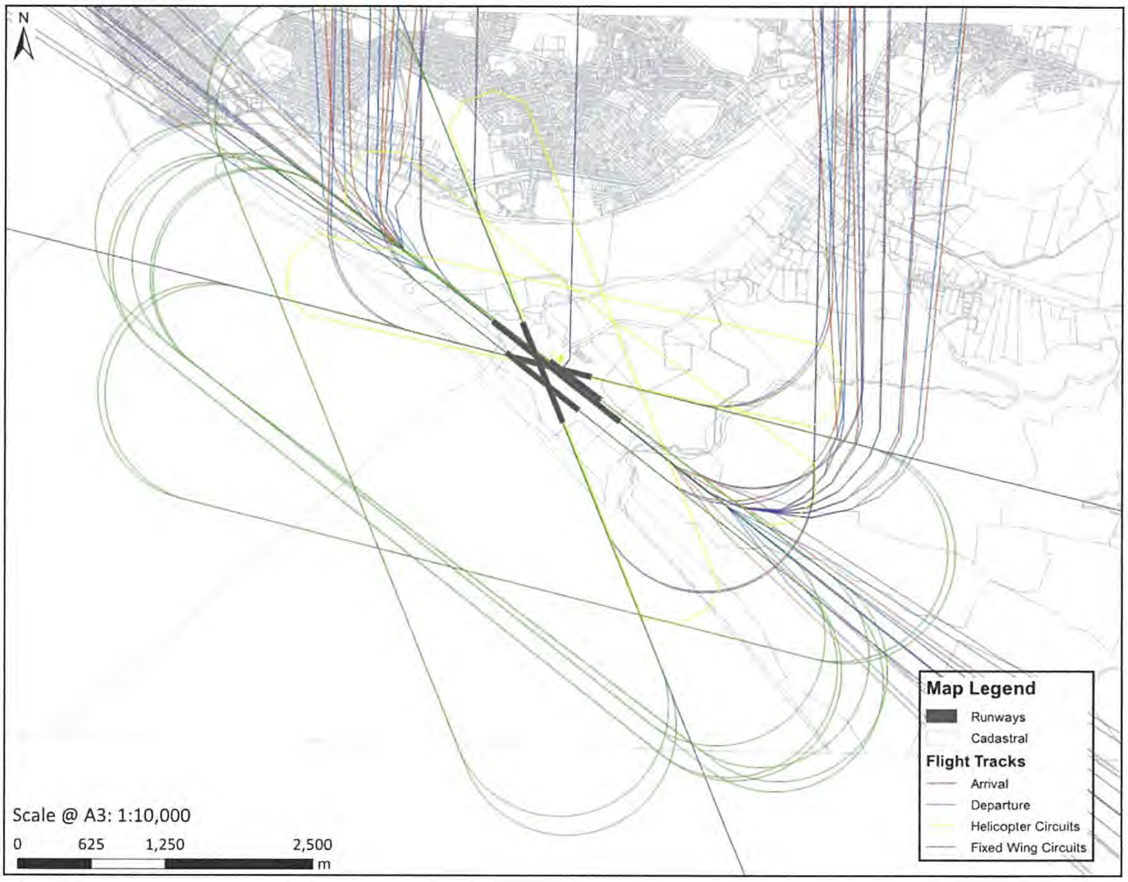
It is understood that aircraft arriving and departing from the airport generally fly straight tracks when close to the airport. However, the ATR-72, Beechcraft 1900, Bombardier Q300 and Pacific Aerospace Cresco generally fly tracks to/from the north.

The circuit tracks for fixed wing aircraft fly a right or left hand pattern seaward of the runway that they are using. The pattern extends approximately 1.5 nautical miles from the threshold of the runway with the downwind leg approximately 1 nautical miles parallel to the runway itself.

Helicopters fly a mix of tracks to/from the north and also the east/west. Helicopter circuits fly a right or left hand pattern landward of the runways. The pattern extends approximately 1 nautical mile from the threshold of the runway with the downwind leg approximately 0.4 nautical miles parallel to the runway itself.

The flight tracks in the model have been based on the assumptions described above and are shown in the figure below.

Figure 3.2: Modelled Flight Tracks



3.3 Aircraft Taxiing

The INM does not specifically include calculations for aircraft taxi operations. However, there is provision to estimate noise from taxiing in the model. In situations where airport noise boundaries are located close to an airport, aircraft taxiing may contribute to the size and shape of the boundaries. Therefore in these cases it is considered appropriate to include taxiing operations when calculating the airport noise contours. For Wanganui Airport it is considered appropriate to include the noise from all aircraft taxiing to and from the Apron.

Taxiing has been included in the noise modelling for all fixed wing aircraft. Taxiing tracks have been assumed to originate from the apron area located to the north east of the runways.

3.4 Helicopters

The noise contours include approximately 35 helicopter movements per day. 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 50 dB L_{dn} which is 5dB more stringent than the 55 dB L_{dn} contour used for the fixed wing OCB, recommended in NZS 6805. A night-time 70 dB L_{AFmax} limit is also defined in NZS 6807 for the management of sleep disturbance effects in residential and rural areas.

The land use planning measures recommended inside the helinoise boundary are similar to those recommended in NZS 6805 for areas within the OCB, i.e. 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.

Therefore for completeness, the 50 dB L_{dn} contour for helicopter movements has been calculated in accordance with NZS 6807. This is shown for comparison with the total fixed wing *and* helicopter movement contours calculated in accordance with NZS 6805.

3.5 Projected Aircraft activity

Future aircraft activity has been projected for the year 2043 by Wanganui Airport. Incorporated into the growth projection from WDC is the establishment of a sizeable flight school and an increase in flights based on a business model of zero landing fees. Movement data has been provided for each different aircraft type for different periods of the day. This movement data has been assigned to the differing flight tracks as a percentage of the overall movements.

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

- Aircraft or helicopter type
- Time of day (day 0700-2200 or night 2200-0700)
- Runway usage
- Departure, arrival or training circuits

Appendix C presents a summary of the projected aircraft movement data provided by Wanganui Airport for the year 2043.

A seasonal loading 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 has been derived from data provided by Wanganui Airport which gives a range of aircraft movements for each aircraft type. The upper end of this range representing the busiest period of annual airport activity has been used to represent the busiest three months. We understand that this upper end correlates well with observations of current airport activity trends.

The future forecasts allow for growth in the number of passengers using the airport by way of a change to a larger scheduled aircraft type. This could be either a Bombardier Q300 or an ATR-72. To allow either to be accommodated, the ATR-72 has been assumed for all future scheduled air traffic as it is slightly louder.

The data presented in Appendix C reflects these assumptions.

3.6 Standard INM Aircraft Data

MDA has undertaken extensive noise measurements at many New Zealand airports and for some aircraft operations, these measurements show significant discrepancies between the INM predicted noise levels and measured noise levels.

Where this occurs, modifications to the INM are applied to more closely align with the measured noise levels. In MDA's opinion, this is best engineering practice, particularly considering the airport is likely to be required to carry out noise monitoring in the future to confirm compliance with the predicted noise contours.

MDA note that overseas users of the INM are generally against this type of procedure from an aeronautical engineering point of view. This is likely to be based on the fact that when the INM is used in the United States for statutory purposes - no adjustments to the noise model are allowed. However, we believe the essence of this noise assessment is to provide the most accurate prediction of noise levels as possible.

On this basis, an adjustment to the NPD data of the Bombardier Q300 has been implemented to more accurately predict the noise levels.

4.0 CALCULATED NOISE CONTOURS

4.1 2013 Current Noise Contours

Noise contours for the current situation (2013) have been calculated to allow an assessment of current noise exposure in the community to occur and also to enable a comparison to be made between that current noise exposure and that which would be allowed under the proposed revised noise boundaries.

The predicted current noise contours are shown on Figure 1, Appendix E. As can be seen current airport noise exposure extends over the Wanganui River to the northwest and southeast over rural land. Where flights tracks turn north/south increased exposure occurs, largely due to the type and frequency of the aircraft using these tracks. It is noted that no existing residential areas are within the 55 dB L_{dn} existing noise contour.

4.2 2043 Future Noise Contours

The predicted future noise contours are shown on Figure 2, Appendix E.

The noise contours normally used for the ANB and OCB under NZS 6805 are the 65 dB L_{dn} and 55 dB L_{dn} contours respectively. The 95 dB SEL contour, and the 50 dB L_{dn} (for helicopter movements only) are also shown.

The combined 50 dB L_{dn} helicopter contour and 55 dB L_{dn} contour for all activity is also shown as it is used as the population sample area considered for the effects assessment in Section 6.

As can be seen from Figure 2, the predicted 65 dB L_{dn} noise contour extends to the northwest to the edge of the Whanganui River and to the southwest for a similar length. The predicted SEL 95 contour extends further northwest and southeast of the 65 dB L_{dn} contour but is thinner on sideline. It also lies entirely within the 55 dB L_{dn} contour.

As expected, because of anticipated future growth the future contours are larger in extent than the 2013 noise exposure.

The SEL 95 contour has been predicted using the worst case combination of arrival and departure noise from and ATR-72. The SEL 95 contour has been included to allow assessment of potential for sleep disturbance effects from night-time aircraft movements (refer Section 6.4).

5.0 RECOMMENDED NOISE BOUNDARIES

5.1 NZS 6805 Recommended Boundaries

NZS 6805 normally recommends two noise boundaries 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 the District Plan permits such use is subject to a request to provide sound insulation. The ANB is also generally nominated as the location for future noise monitoring of compliance with a 65 dB L_{dn} limit.

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

5.2 Recommended Noise Boundaries

The recommended noise control boundaries are presented in Figure 3, Appendix E. In summary, these are:

- The Outer Control Boundary (OCB)
- The Airnoise Boundary (ANB)

Recommended land use planning and airport noise controls associated with the proposed boundaries are detailed in Section 7 and 8.

5.2.1 Outer Control Boundary

In order to strictly ensure consistency between the application of NZS 6805 and NZS 6807, the OCB should encompass the largest area defined by the fixed wing aircraft 55 dB L_{dn} contour and the helicopter 50 dB L_{dn} contour.

In many cases MDA has recommended the total fixed wing and helicopter 55 dB L_{dn} be used as the OCB. This has mainly been due to the very small differences in extent between this and the helicopter 50 dB L_{dn} contour.

Figure 2 Appendix E shows that the helicopter 50 dB L_{dn} contour is moderately more extensive than the total fixed wing *and* helicopter movements 55 dB L_{dn} contour at some points. As such, MDA recommends that the largest extent of both contours be adopted as the OCB; this is shown on Figure 3, Appendix E.

This would present some practical difficulties with noise compliance measurements. However, because we recommend compliance measurements should be undertaken on the 65 dB L_{dn} contour this would not occur in practise. The additional compliance assessment using prediction software would enable determination of compliance or otherwise with 55 dB L_{dn} at the OCB.

5.2.2 Air Noise Boundary

NZS 6805 recommends the 65 dB L_{dn} contour be used for the ANB. This approach is proposed for Wanganui Airport. The proposed ANB is shown on Figure 3, Appendix E.

6.0 ASSESSMENT OF NOISE EFFECTS

NZS 6805 inherently envisages some level of growth in noise emissions from the airport by adopting a minimum 10 year planning period and by recognizing the need to be able to operate an airport efficiently. In this instance a 30 year horizon is used. Further, the Standard advocates the implementation of practical land use and airport management techniques to promote and conserve the health of people living near airports.

As a result there is a requirement to determine what level of airport growth is reasonable, when considered in conjunction with the requirement to ensure a satisfactory living environment for existing and future residents. To facilitate this, and in terms of the RMA, an effects assessment is necessary, as detailed below.

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

There are currently no Activities Sensitive to Airport Noise (ASANs) located inside the proposed OCB and ANB.

6.1 Existing Noise Environment

Noise level measurements of the existing noise environment were carried out between 26 March and 6 April 2013. The monitor experienced technical difficulties from 28 to 30 March and also on the 1, 3 & 5 April meaning that 6 ½ days of data in total were collected.

The measurements involved automated noise data logging on the airfield at Receiver R8, on Figure 6.1 below.

In terms of the noise environment in the vicinity of the airport, at times when no aircraft are operating, measured noise levels show that the area is typical of a rural environment, with background noise levels of approximately 41 dB L_{A90} in the daytime and 34 dB L_{A90} at night-time.

These show that the area is quiet with minimal local noise sources, mainly comprising of natural sounds in the vicinity (wind in trees, birds etc.), but with some barely audible contributions from the nearby roading network.

The measured noise level from aircraft operations during the noise survey was approximately 67 dB L_{dn}.

6.2 Change in Noise Level

The proposed airport noise boundaries would represent a change in aircraft noise levels compared with the current noise exposure. The effect of this change on the surrounding areas has been assessed.

Two airport operating scenarios have been examined:

- **'Current'** - The level of actual activity in 2013,
- **'Proposed'** - The proposed future noise contours (Figure 2, Appendix E)

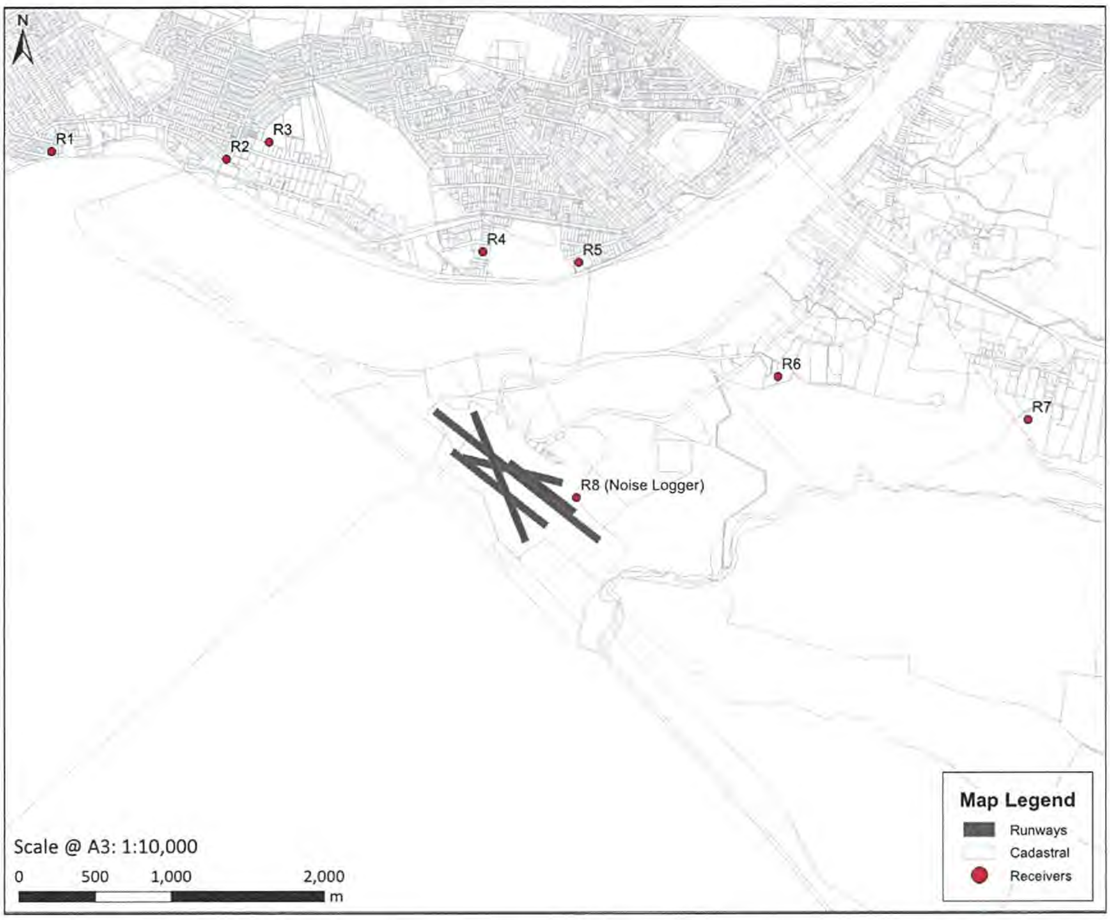
The future growth of air traffic would result in a change in average noise exposure as described by the L_{dn} noise metric. The change in aircraft that are expected to operate between the current and future scenarios would also result in a change in the noise level from an individual event (SEL) at a particular receiver. These are both considered below.

In both cases, the change in noise level varies depending on the location around the airport, so representative receivers have been used as assessment positions, as described in Table 6.1. The locations of these dwellings are also shown in Figure 6.1. Noise sensitive receivers are described in this assessment as Activities Sensitive to Aircraft Noise (ASANs), and are defined in Appendix A.

Table 6.1: Assessment Positions

Assessment ID	Assessment Location
R1	1 Short Street, Castlecliff
R2	446 Heads Road, Castlecliff
R3	Kokohuia School, 36 Matipo Street, Castlecliff
R4	16 Beach Road, Castlecliff
R5	51 Balgownie Avenue, Gonville
R6	91 Wikitoria Road, Putiki
R7	5 Marybank Road, Marybank
(R8)	(Noise Logger)

Figure 6.1: Map of Assessment Positions



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.

However, to give an indication of the meaning of the changes in noise level presented below, 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.

6.2.1 Daily Noise Level (L_{dn})

The change in average noise exposure level, described by the L_{dn} noise metric, has been predicted using the INM at the assessment locations surrounding the airport for two operational scenarios listed above. The results are listed in Table 6.2.

Table 6.2: Predicted Change in Noise Level at Assessment Positions

Assessment Location	2013 Noise Level (dB L_{dn})	2043 Noise Level (dB L_{dn})	Change (2043 –2013)
R1	47	53	+6
R2	50	54	+4
R3	50	54	+4
R4	48	50	+2
R5	46	47	+1
R6	44	45	+1
R7	45	47	+2

The predicted change in noise level of one to six decibels from 2013 to 2043 would be perceived as not discernible to noticeable for these dwellings if it occurred overnight. However, as this increase is predicted to occur slowly over 30 years, it is likely to be less noticeable. In all cases the noise level remains below 55 dB L_{dn}.

6.2.2 Single Event Level

In terms of current airport activity, the loudest passenger aircraft type operating at the airport is the Beechcraft 1900D. It is anticipated that, in the future, this aircraft would be phased out and replaced with the ATR 72. This would result in a change in noise from individual aircraft events.

The change in sound exposure level resulting from the change in the scheduled aircraft type has been calculated at the 7 receiver locations. For the noisiest operations the predicted noise levels range from 67-93 dB. The ATR-72 is generally noisier that the Beechcraft 1900D by 2-5 decibels depending on the operation.

This increase in noise level exposure on arrivals would likely be a just detectable change between what occurs now and what is proposed.

Noise Levels of 90 – 100 dB L_{AE} (SEL) are not uncommon for dwellings surrounding airports. Nevertheless, MDA considers that although this single event noise level would be acceptable during the day, during night-time hours however, levels in excess of 95 dB SEL are not. This matter is addressed further in section 6.4.

6.3 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 the overall relationship of response to noise of a residential community as a whole. Much of this was taken into account when NZS 6805 was developed.

A dose response relationship specific to aircraft noise has been developed by Miedema and Oudshoorn[1], as shown in Figure 6.2 below. This relationship is similar to other relationships developed by Bradley[2] and another study by Miedema and Vos[3]. The Miedema and

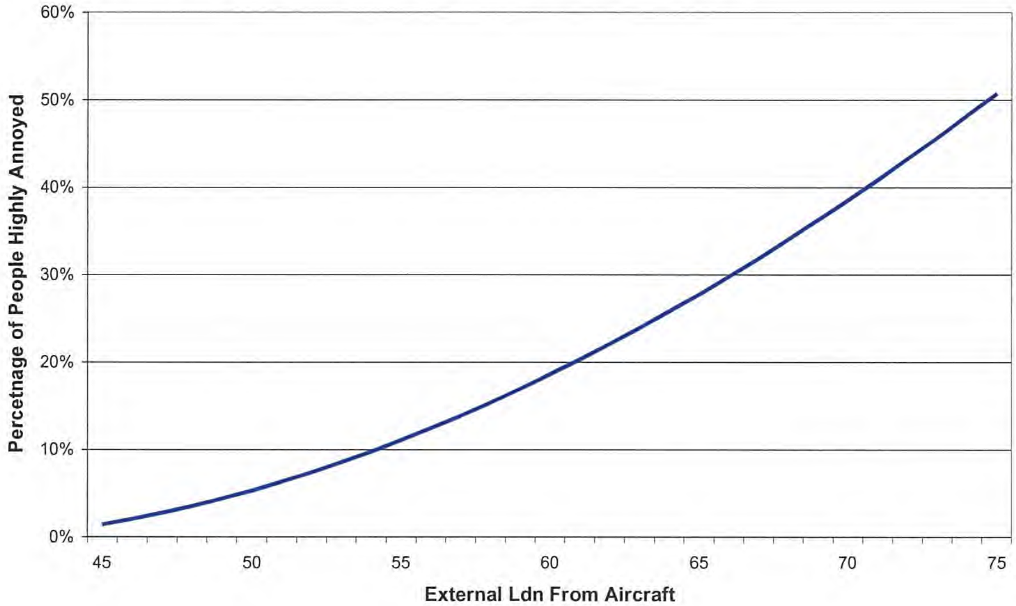
[1] Miedema, H M E and Oudshoorn, G M (2001) *"Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals."* Environmental Health Perspectives 109 (4) 409 – 416.

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

Oudshoorn relationship has been adopted by the European Commission position paper in 2002[4] and is generally regarded as the latest research in this area.

The above dose response relationship indicates that for aircraft noise environments of 65 dB L_{dn} 28% of the population are likely to be highly annoyed. This is one of the reasons that NZS 6805 recommends prohibition of noise sensitive activity inside the ANB. For aircraft noise environments of 55 dB L_{dn} 11% of the population are likely to be highly annoyed by the noise.

Figure 6.2 Miedema & Ouldshoorn Dose-Response Relationship



Taking the above into consideration, an analysis has been carried out to predict the change in the number of people likely to be highly annoyed by aircraft noise in the two scenarios detailed in section 6.2. To maintain a common population sample for this study, all dwellings located within the predicted 50 dB L_{dn} contour for the proposed future scenario (refer Figure 2, Appendix E) have been considered[5].

Results for each of the two scenarios are summarised in Table 6.3 below. Further details of the analysis are provided in Appendix D.

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

[4] European Commission Working Group on Dose-Effect Relations, 2002, "*Position Paper on dose response relationships between transportation noise and annoyance*" Luxembourg: Office for Official Publications of European Communities.

[5] The 50 dB L_{dn} contour relating to the future contours is used as this results in the largest potential coverage of the two scenarios.

Table 6.3: People Highly Annoyed (Miedema & Ouldshoorn)

Activity Scenario	Number of houses per 5 dB L_{dn} band for each scenario[1,2]					Number of People Highly Annoyed (% of population sample)
	45-50	50–55	55–60	60–65	> 65	
Existing	538	89	0	0	0	60 (3.8%)
Proposed	0	626	0	0	0	126 (7.9%)

[1] The 5 dB band used in this assessment are based on all the houses contained within the 50 dB L_{dn} contour for the future scenario as shown on Figure 2, Appendix E.
[2] Total sample size is 629 houses with a total of 1584 people (refer Appendix D).
NB: this assessment excludes schools and childcare centers as this relationship is only accurate for dwellings).

The proposed noise boundaries represent an increase in the number of people likely to be highly annoyed compared with the current situation. However it is also noted that all of these people likely to be highly annoyed live *outside* the proposed noise control boundaries.

The reasons for this level of annoyance is because there is some residential land use reasonably close to the airport and that a significant number of people live in these areas and are exposed to moderate aircraft noise. This is the case at present and is also the cause of why the number of people highly annoyed would increase as the airport expands.

The above analysis supports the rationale for recommending prohibiting noise sensitive development inside the OCB, to reduce future noise exposure and hence annoyance. It also shows that despite the presence of noise control boundaries, which delineate the onset of moderate to significant noise effects, there are still lesser effects outside these boundaries.

Nevertheless, considering the small change in noise exposure between that proposed and that currently allowed, it is considered that overall annoyance effects would not alter significantly.

6.4 Sleep Disturbance Effects

6.4.1 Introduction

For airports with a small number of movements the 65 dB L_{dn} contour (and thus the ANB) could be located very close to the airport. If residential development is allowed to establish just outside the ANB, then residents may be exposed to relatively high single event noise levels. During the day this may not create annoyance, however night time flights may result in sleep disturbance effects for 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 awakening to affecting the depth of sleep in various stages and creating difficulty with falling asleep.

Many of the studies acknowledge that continuous noise and intermittent noise events have differing effects on sleep. The effects from intermittent noise events are the most relevant to aircraft noise.

The findings of relevant studies relate sleep disturbance effects to either the SEL or L_{AFmax} noise level in the bedroom. L_{AFmax} is the maximum noise level occurring during the aircraft noise event. The Sound Exposure Level, SEL, is the noise level of one second duration that has the same total sound energy as the aircraft noise event.

Generally for multi-use airports, MDA uses the SEL metric and recommends an upper limit of acceptability of 95 dB SEL for night time events in residential areas. 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.

Note that receiver 3 - Kokohuia School has been excluded from the following assessment as it is unoccupied at night-time and thus no sleep disturbance effects would occur.

6.4.2 FICAN Dose Response Relationship

The effects can be quantified in general terms by applying a dose-response relationship. The relationship developed in 1997 by FICAN[6] (shown in Figure 6.2) predicts the maximum percentage of an exposed population[7] expected to be behaviourally awakened for a given indoor SEL.

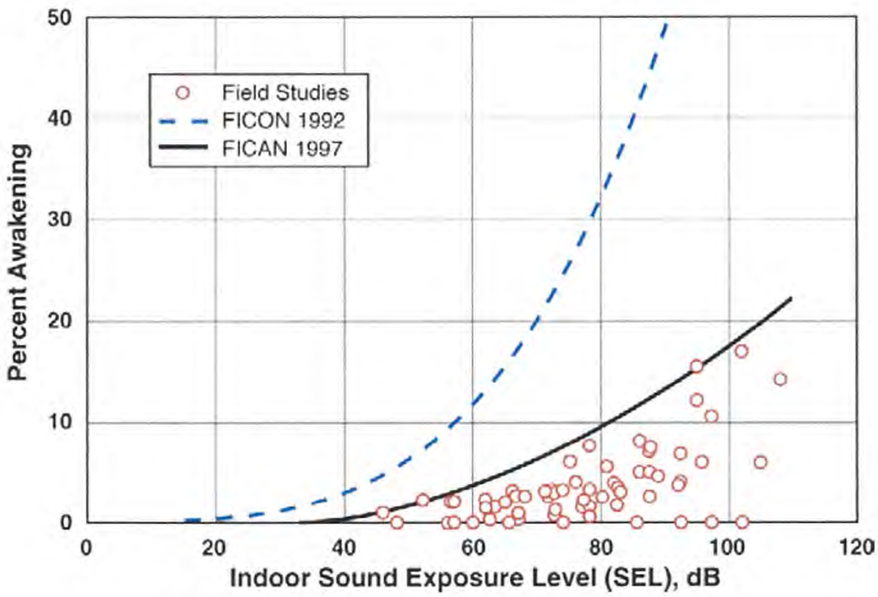


Figure 6.2: FICAN Sleep Disturbance Dose-Response Relationship

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

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

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

The current loudest movement (Beechcraft 1900D), which occurs at night is 89 dB SEL at the assessment locations. This level is considered to be reasonably low.

For the proposed scenario the predicted noise level are similar but slightly higher at 93 dB SEL for the loudest aircraft movement (ATR-72). This change in noise level would be a small increase for residents but such a small change would generally not be readily discernible.

6.4.3 Health Effects - World Health Organisation L_{night}

L_{night} is a 'health' noise indicator developed by the World Health Organisation (WHO) as part of the Night Noise Guidelines for Europe. It is the A-weighted long-term average sound level outside at the most exposed façade, determined over all the night periods in a year in which the night period is eight hours.

Based on exposure-effects relationships presented in the Night Noise Guidelines for Europe, the WHO recommends 40 dB L_{night} is desirable for the protection of public health from night noise with an interim target of 55 dB L_{night}.

In the opinion of MDA, it is considered that a one year average (as used for L_{night}) is an inappropriate criterion and that the NNG of 40 dB L_{night} is not a realistic criterion in relation to noise effects from night-time aircraft activity where such activity may vary in frequency on different nights.

6.4.4 Conclusion

Based on above analysis, the number of night-time movements, the predicted noise levels, the small percentage of the exposed population likely to be awakened and the similar noise exposure that is allowed from an individual event at present, it is considered that the potential for sleep disturbance effects is limited and therefore acceptable.

Based on this assessment, and the fact that the predicted future SEL 95 contour falls within the predicted future 55 dB L_{dn} contours it is our opinion that a Night-time Noise Boundary is not required.

6.5 Noise Effects Outside the Noise Boundaries

It is noted that annoyance effects are not confined to noise levels in excess of 55 dB L_{dn} as demonstrated in Section 6.3. Although the 55 L_{dn} 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.

It is noted that there is an allowance for some circuit training activity in the noise contours. Whilst this occurs on seaward tracks for fixed wing aircraft, such circuit training may be readily perceived in the community. Nevertheless it is at a noise level that is considered acceptable overall. This is why the 50 dB L_{dn} contour is used for the annoyance effects calculations and is shown on Figure 2, Appendix E.

There is a school (Kokohuia School) located just outside the proposed OCB. Although considered acceptable from an overall noise exposure point of view, it is exposed to relatively high levels of noise from individual aircraft flyovers. This may give rise to speech intelligibility issues. This can cause problems in educational facilities because although these are not sensitive land uses at night, during the day such speech intelligibility issues may cause cognitive impairment problems with comprehension and disruption to learning.

Research by Bradley considered the time variation of aircraft noise and the temporary degradation or loss of speech intelligibility during aircraft flyover events. He found that using the standard L_{eq} metric would over estimate the negative effect of aircraft noise interference and that an SEL criterion would account for both noise level and duration.

Bradley concluded that an indoor noise level of 64 dB SEL could be used to delineate acceptable conditions for speech communication for normal vocal effort. For a slightly greater vocal effort (just greater than a normal voice level) the same degree of communication can be achieved with an indoor noise level of 70 dB SEL.

The predicted SELs at the school from scheduled aircraft that occur at present is 89 dB SEL, in the future, this may increase to 93 dB SEL. The typical noise level reduction from outdoor to indoor with windows slightly ajar is less for schools than houses, and would be approximately 10 – 15 dB. This would mean internal noise levels of 78 – 83 dB SEL. This would occur a number of times a day.

It is concluded that indoor communication at the school may be adversely affected. For most airports around New Zealand where this occurs, mitigation has not been installed.

6.6 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;

This is the approach adopted elsewhere in New Zealand and it is considered appropriate for Wanganui Airport. Sections 7 and 8 outline recommended provisions where appropriate.

7.0 LAND USE PLANNING RECOMMENDATIONS

7.1 Inside the OCB

NZS 6805 recommends that noise sensitive activity is prohibited between the OCB and the ANB unless a District Plan permits it subject to appropriate sound insulation requirements. This approach recognises that not all of the effects of aircraft noise can be mitigated by insulating buildings, particularly for residential activity.

People generally have a desire for exposure to the outdoors and an expectation to be able to spend time in the garden, entertain guests outdoors and leave doors and windows open. In these situations, the level of aircraft noise exposure cannot be practicably mitigated. If new residential activity is to be permitted between the OCB and the ANB it can be expected that some residents would be annoyed by aircraft noise outdoors.

MDA supports the NZS 6805 approach to prohibit new noise sensitive activity inside the OCB as a desirable starting point but acknowledges that other factors such as historical land use development, landowners' expectations of property rights and regional pressures on developable land can modify land use restrictions that would otherwise be imposed by a territorial authority as a result of moderate noise effects.

In this case, there is no existing expectation of residential activity being able to establish. It is for this reason that MDA recommend new noise sensitive activity not be allowed in the OCB. In our opinion this is consistent with the provisions of NZS 6805.

There are no *existing* ASANs inside the OCB and therefore sound insulation controls for alterations or additions to existing ASANS would not be required.

7.2 Inside the ANB

Noise environments greater than 65 dB L_{dn} are not suitable for residential activity. Sound insulation measures can improve internal noise environments but do not fully mitigate the effects for residential activity, particularly in outdoor living areas or where residents wish to open windows and doors.

NZS 6805 recommends that land use controls to prohibit new noise sensitive activities should be imposed within the ANB. This approach is recommended for Wanganui Airport.

In keeping with the provisions of NZS 6805, MDA recommends that new ASANs inside the ANB be prohibited.

There are no *existing* ASANs inside the ANB and therefore sound insulation controls for alterations or additions to existing ASANS would not be required.

7.3 Summary of Recommendations

MDA recommends that:

- *New* Activities Sensitive to Aircraft Noise (ASAN) located within the Outer Control Boundary (OCB), should be prohibited.
- *New* Activities Sensitive to Aircraft Noise (ASAN) located within the Air Noise Boundary (ANB), should be prohibited.

8.0 AIRPORT NOISE CONTROL RECOMMENDATIONS

8.1 Airport Noise Management

MDA recommends that:

- The Airport should be managed so that the noise from aircraft operations does not exceed a Day/Night Level of 65 dB L_{dn} outside the proposed Air Noise Boundary (ANB) and 55 dB L_{dn} outside the proposed Outer Control Boundary (OCB).
- To ensure compliance with the above, calculation of Aircraft Noise Contours using the Integrated Noise Model (INM) program and records of actual aircraft activity at the Airport is recommended, initially within 12 months of the proposed plan change becoming adopted, and thereafter every 3 years. Calculations should be undertaken in accordance with the provisions of NZS 6805.
- Noise monitoring should be undertaken to verify that noise levels are not exceeding the requirements set out above. It is recommended that when the calculated noise level exceeds 64 dB at any point on the ANB, then infield monitoring is required for a minimum of one month (at one measurement location) to demonstrate compliance with the noise limit of the 65 dB L_{dn}, as shown on Figure 3, Appendix E.

- It is also recommended that all helicopter operators be made aware of the Helicopter Association International's "Fly Neighbourly" program and should avoid,

8.2 Engine Testing

The aviation industry has strict requirements regarding the need to run an engine after maintenance before it can be used for passengers. Routine or unplanned work on an engine will often require a period of idling or a short full power run of the engine. Therefore, the testing of aircraft engines is another noise generating activity that is vital to the operational viability of a commercial airport with scheduled flights.

Routine engine maintenance on passenger aircraft is not proposed at Wanganui Airport. However, in the event of unexpected equipment failure, unplanned work may be carried out requiring engines to be run up before returning the aircraft to service.

It is noted that at present engine testing is controlled by the standard noise rules for the airport area in the District Plan. Just as aircraft noise cannot be pragmatically controlled by the standard District Plan noise rules for land based activities, MDA consider that engine testing often requires its own specific noise rule.

The recommended method of control for unplanned engine testing is to allow a limited number of events within a 12 month period with a maximum duration and noise limit.

A recommended Engine Testing Rule for Wanganui is presented below:

"Noise levels from Aircraft Engine Testing shall comply with the following:

i. *Between the hours of 7am and 10pm, noise generated by aircraft engine testing and measured at the notional boundary of any site in the zoned for rural or residential land use shall not exceed 55 dB $L_{Aeq(15\ hours)}$; and*

ii. *All aircraft engine testing shall be scheduled to take place between 7am and 10pm and only essential unplanned engine testing shall take place outside those hours.*

iii. *Essential unplanned engine testing shall take place on no more than 12 occasions per year and noise from such engine testing shall not exceed the following noise levels at the notional boundary of any site in the zoned for rural or residential land use :*

Time Period	*Noise Level*
All days 10.00 pm to 7.00 am	*45 dB $L_{Aeq(9\ hours)}$*
All days 10.00 pm to 7.00 am	*80 dB L_{AFmax}*

iv. *On each of these occasions the date, time, noise level reached, duration and reason for the tests shall be reported within 10 days to the Wanganui Council.*

v. *For the purpose of this control aircraft engine testing shall be measured in accordance with New Zealand Standard NZS 6801:2008 "Acoustics – Measurement of environmental sound" "*

9.0 CONCLUSIONS

Marshall Day Acoustics has prepared noise contours from aircraft operations for Wanganui Airport.

In order to provide for the airport's future growth it is recommended that District Plan noise control boundaries are implemented. It is recommended that an Outer Control Boundary and an Airnoise Boundary be implemented.

It is recommended that District Plan noise rules relating to noise associated with the Airport be revised to reflect the change in noise boundaries and to incorporate the recommendations of NZS 6805.

With the implementation of the proposed noise boundaries and associated land use planning controls, the noise effects as a result of the plan change are considered reasonable.

APPENDIX A GLOSSARY OF TERMINOLOGY

dB	Decibel – A measurement of sound level expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)
ASAN	Activity Sensitive to Aircraft Noise Means any residential activity, visitor accommodation, retirement villages, day care facility, buildings used for overnight patient medical care or educational facilities (including all outdoor spaces associated with such an educational facility).
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear. All noise levels are quoted relative to a sound pressure of $2x10^{-5}$Pa
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
L_{dn}	The day night noise level which is calculated from the 24 hour L_{Aeq} with a 10 dB penalty applied to the night-time (2200-0700 hours) L_{Aeq}.
SEL or L_{AE}	Sound Exposure Level The sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover
NZS 6801:2008	New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of environmental sound"*
NZS 6802:2008	New Zealand Standard NZS 6802:2008 *"Acoustics – Environmental Noise"*
NZS 6805:1992	New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"*
NZS 6807:1994	New Zealand Standard NZS 6807:1994 *"Noise Management and Land Use Planning for Helicopter Landing Areas"*

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 major 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 to achieve its aims. This involves fixing an Outer Control Boundary (OCB) and a smaller, much closer Airnoise Boundary (ANB) around the airport.

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 a 65 dB L_{dn} 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 65 dB L_{dn} contour and the OCB on the projected 55 dB L_{dn}. 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 dB L_{dn} at or outside the ANB (or 65 dB L_{dn} contour). A measurement would involve 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 65 and 55 dB L_{dn} 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 MODELLED AIRCRAFT MOVEMENTS

Aircraft	Existing 2013					Future 2043				
	Arr & Dep		Circuits		Total	Arr & Dep		Circuits		Total
	Day	Night	Day	Night		Day	Night	Day	Night	
Scheduled										
Beechcraft 1900D	12.0	4.4	0.0	0.0	16.4	0.0	0.0	0.0	0.0	0.0
ATR-72	0.0	0.0	0.0	0.0	0.0	16.5	6.1	0.0	0.0	22.6
Bombardier Q300	10.3	0.0	0.0	0.0	10.3	0.0	0.0	0.0	0.0	0.0
General Aviation										
Beech B200 Kingair	2.3	0.2	5.8	0.0	8.2	3.0	0.2	7.5	0.0	10.7
Piper PA-31 Mojave	4.0	0.1	0.0	0.0	4.1	29.1	2.1	68.0	4.1	103.3
Fairchild SA227 Metroliner	4.0	0.1	0.0	0.0	4.1	5.2	0.1	0.0	0.0	5.3
Pacific Aerospace Cresco	7.2	0.0	0.0	0.0	7.2	9.4	0.0	0.0	0.0	9.4
Pacific Aerospace CT4E Airtrainer	6.2	0.0	14.4	0.0	20.6	8.0	0.0	18.7	0.0	26.7
North American Harvard	1.0	0.0	0.0	0.0	1.0	1.3	0.0	0.0	0.0	1.3
Diamond DA42/DA40	6.2	0.0	14.4	0.0	20.6	8.0	0.0	18.7	0.0	26.7
Cessna 150	9.3	0.0	21.6	0.0	30.9	12.0	0.0	28.1	0.0	40.1
Cessna 172	9.3	0.0	21.6	0.0	30.9	58.3	4.1	136.0	8.3	206.7
Fletcher BEC58P	0.9	0.0	2.2	0.0	3.1	1.2	0.0	2.8	0.0	4.0
Helicopters										
UH-1H Iroquois	4.0	0.0	2.2	0.0	6.2	5.2	0.0	2.8	0.0	8.0
Aerospatiale AS350 Squirrel heli	4.0	0.0	2.2	0.0	6.2	5.2	0.0	2.8	0.0	8.0
Hughes 369E helicopter	5.3	0.0	2.9	0.0	8.2	7.0	0.0	3.7	0.0	10.7
Augusta A109 helicopter	2.7	0.0	1.4	0.0	4.1	3.5	0.0	1.9	0.0	5.3
Augusta AW139 helicopter	1.3	0.0	0.7	0.0	2.1	1.7	0.0	0.9	0.0	2.7

APPENDIX D COMMUNITY RESPONSE – NUMBER OF PEOPLE HIGHLY ANNOYED

ASSESSMENT TABLE

Scenario		Contour Band (dB Ldn)	Number of Dwellings with Contour Band	Number of People	Number of People Highly Annoyed
			Existing		
		40-45	0	0	0
		45-50	538	1361.1	42.1
		50-55	88	222.6	17.7
		55-60	0	0	0
		60-65	0	0	0
		>65	0	0	0
TOTALS*	**Existing**		**626**	**1584**	**3.8%**
			Proposed		
		40-45	0	0	0
		45-50	0	0	0
		50-55	626	1583.8	125.6
		55-60	0	0	0
		60-65	0	0	0
		>65	0	0	0
TOTALS *	**Proposed**		**626**	**1584**	**7.9%**

* Totals rounded to the nearest whole number

Assumptions:

Number of persons per house = 2.53 (note this assessment excludes schools and childcare centres as this relationship is only accurate for dwellings).

(Source: 2006 *Occupancy Rate for Usually Resident Households* for Manawatu-Wanganui, Occupancy Rate Tables from excel file 'occupancy rate tables.xls' found at: http://www.stats.govt.nz/browse_for_stats/people_and_communities/housing/housing-indicators.aspx)

Average percentage of people highly annoyed (HA) is based on the Miedema & Ouldshoorn relationship:

L_{dn} 40-45dBA 0.2% HA
L_{dn} 45-50dBA 3% HA

L_{dn} 50-55dBA	8% HA
L_{dn} 55-60dBA	15% HA
L_{dn} 60-65dBA	23% HA
L_{dn} >65	30% HA (based on L_{dn} 67)

Sample size is based on the number of houses located within noise contours greater than or equal to 50 dB L_{dn} generated for proposed airport activity (refer Figure 2, Appendix E). Dwelling ID based on geospatial analysis of cadastral data and its associated attributes (exclusion of road and park parcels), downloaded from:

http://data.linz.govt.nz/#/search/category/property-ownership-boundaries/

APPENDIX E NOISE CONTOUR FIGURES

MARSHALL DAY Acoustics

Scale @ A3: 1:10,000

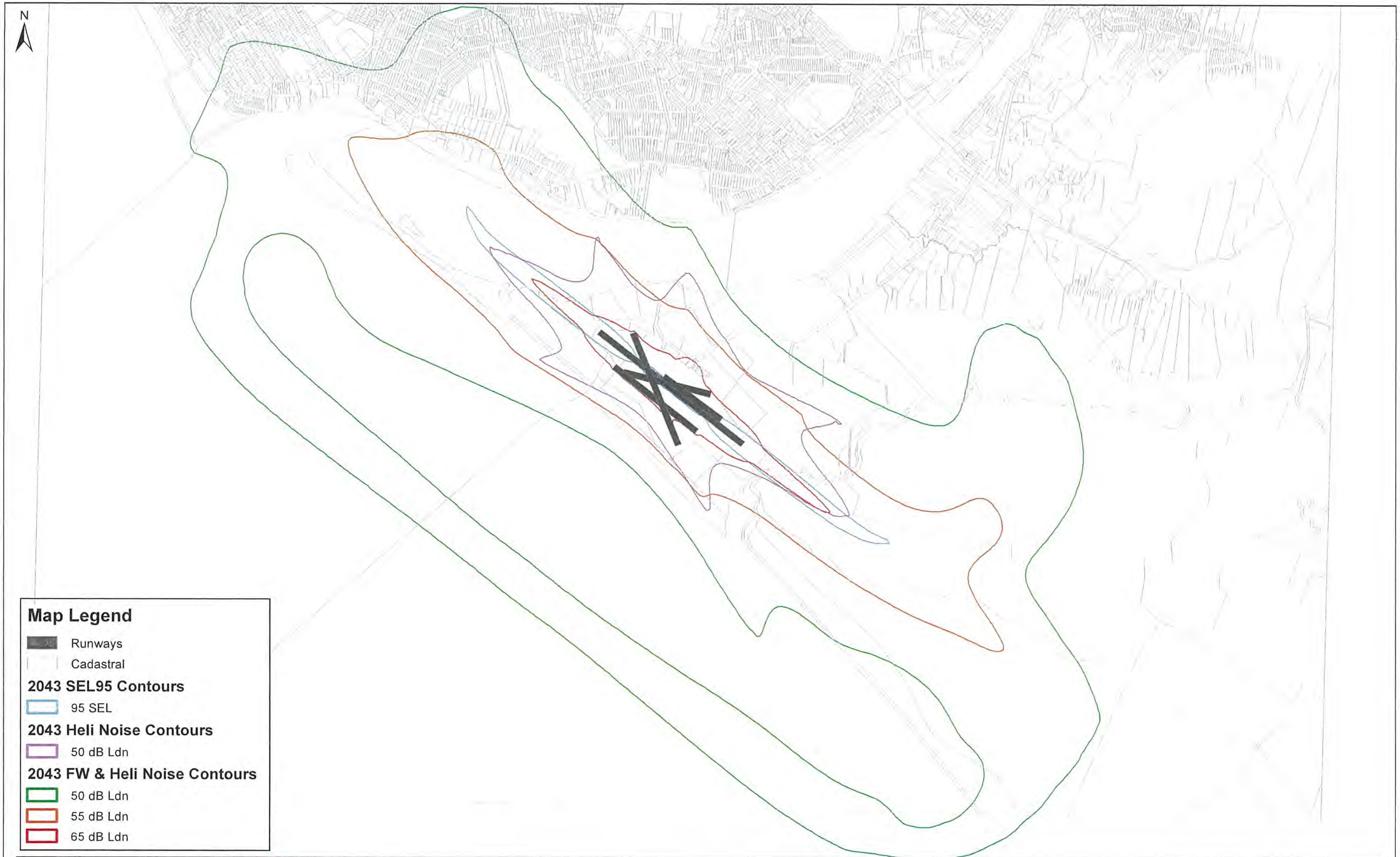
0 385 770 1,540 m

Date: 3/10/2013 Prepared By: lrm Time: 4:39:13 p.m.

Wanganui Airport - Plan Change

Predicted Noise Contours - 2013

Path: J:\JOBS\2012\2012055A\06 Drawings\Out\All GIS Data for Wanganui.mxd



MARSHALL DAY Acoustics

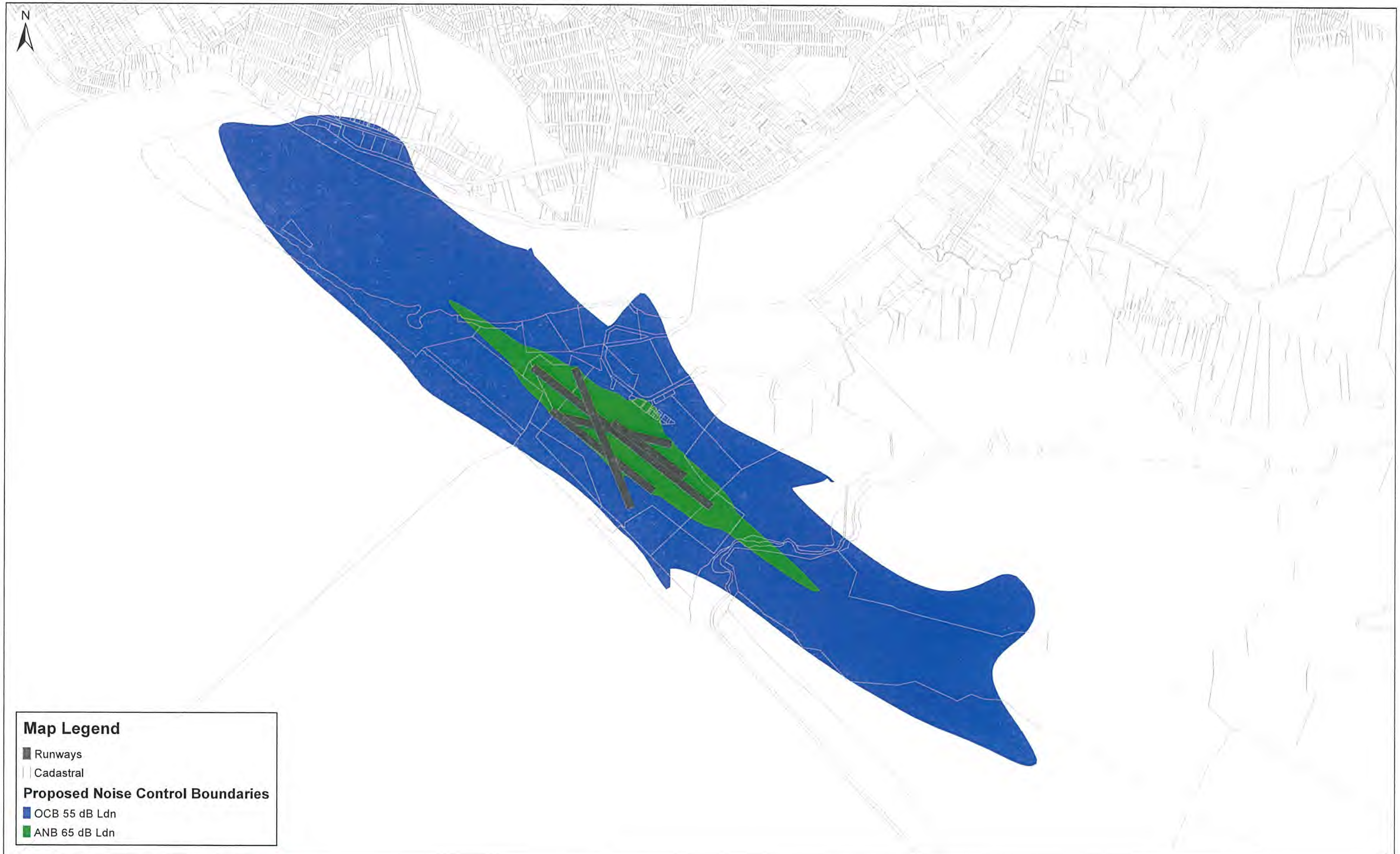
Scale @ A3: 1:10,000

0 385 770 1,540 m

Date: 3/10/2013 Prepared By: lrm Time: 4:18:39 p.m.

Wanganui Airport - Plan Change
Predicted Noise Contours - 2043

Path: J:\JOBS\2012\2012055A\06 Drawings\Out\All GIS Data for Wanganui.mxd



MARSHALL DAY
Acoustics

Scale @ A3: 1:10,000

0 310 620 1,240 m

Date: 3/10/2013 Prepared By: lrm Time: 5:27:23 p.m.

Wanganui Airport - Plan Change
Proposed Noise Control Boundaries

Path: J:\JOBS\2012\2012055A\06 Drawings\Out\All GIS Data for Wanganui.mxd