MARSHALL DAY Acoustics

CHRISTCHURCH AIRPORT RECONTOURING
ASSESSMENT OF NOISE EFFECTS
ANNUAL AVERAGE UPDATED CONTOURS

Report No.003 | 21 July 2022

Project:	**CHRISTCHURCH AIRPORT RECONTOURING**
	Assessment of Noise Effects – Annual Average Updated Contours
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1.0 INTRODUCTION

The Canterbury Regional Policy Statement (CRPS) and the three District Plans [1]contain the Christchurch International Airport Noise Contours (the Operative Noise Contours). The purpose of these contours is twofold – to use land-use planning around the airport to avoid the effects of aircraft noise on future noise sensitive users and to set a 'noise envelope' for the airport to remain within. This process is explained in detail in the New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*" (**NZS6805**) and summarised in Appendix A of this report.

The Operative Noise Contours were finalised in 2008 following extensive interaction within an 'Expert Panel'. The Expert Panel was made up of experts in aviation forecasting, operational procedures (including flight tracks) and noise modelling. The basic premise behind the contours was that they were to be based on Christchurch International Airport (CIA / the Airport) operating at its 'long-term future capacity' and with future operational procedures.

The Expert Panel Report recommended that the 2008 noise contours (and the aviation assumptions they were based on) be updated in 10 years' time, which aligns with the general philosophy of updating District Plans every 10 years.

In 2018 Christchurch International Airport Limited (CIAL) began the process to update the Operative Noise Contours. Airbiz and Marshall Day Acoustics (MDA) were engaged to prepare updated noise contours, with input from Airways New Zealand (Airways) and CIAL, for inclusion in the CRPS and District Plans. The new noise contours are referred to throughout this report as the "Updated Noise Contours". The details of this process are contained in a combined report by Airbiz, MDA, CIAL and Chapman Trip titled "*2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours*" (the Update Report).

The outcome of the Update Report is that several input parameters for the Updated Noise Contours are different to those used in the Operative Noise Contours. The resultant Updated Noise Contours are a different shape - being larger in some areas and smaller in others.

The purpose of this report is to provide an assessment of noise effects associated with:

1. The change in the future anticipated aircraft noise environment
2. The potential future change to the receiving environment

Four different methodologies have been used to assess the effects (see section 3.1). We've assessed the change to the future anticipated aircraft noise environment by comparing the Operative Noise Contours with the Updated Noise Contours. We have also examined the change to future receiving environment by comparing the existing housing stock in the noise contours with the potential future housing stock assuming maximum potential growth under the planning framework.

To summarise our findings, the Updated Noise Contours generally represent a moderate increase in aircraft noise effects compared with the Operative Noise Contours. This is primarily due to the updated long term future operational capacity of the Airport.

As well as considering the impact of the change in aircraft noise environment, we assessed the impact of the potential change in receiving environment. Our analysis shows that the potential increase in aircraft noise effects resulting from' worst case' growth in residential activity **currently** permitted inside the Airport Noise Contours, is far greater than the increase in effects due to the change in aircraft noise. If the land use controls applying inside the Airport Noise Contours (as of March 2022) were relaxed, the scale of airport noise effects on the surrounding population would increase even more significantly.

[1] Christchurch District Plan, Waimakariri District Plan, Selwyn District Plan

2.0 UPDATED NOISE CONTOURS – ANNUAL AVERAGE

Details of the process and inputs to developing the Updated Noise Contours are contained in a combined report by Airbiz, MDA, CIAL and Chapman Trip titled "*2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours*" (the Update Report). The Updated Noise Contours presented in this report are the Annual Average version which is explained further below. A brief summary of the modelling assumptions and a figure showing the Operative and Updated Noise Contours is provided in Appendix C.

Christchurch International Airport effectively has four operational runways, two on the main runway and two on the shorter crosswind runway as follows:

- Runway 02 where aircraft land and take-off into a northly wind.
- Runway 20 where aircraft land and take-off into a southerly wind.
- Runway 29 where aircraft land and take-off into a north-westerly wind.
- Runway 11 where aircraft land and take-off into a south-easterly wind.

Generally, each of these runways is used during the given wind direction. The runway usage in any given three-month period will vary significantly. For example, during the summer there are often periods when the north-westerly wind is dominant for several days (necessitating higher than normal usage of the north-west Runway 29). The extent of this effect varies from year to year.

Aircraft need to be allocated to each runway in the noise modelling and there are two options for how runway usage is modelled in the Updated Noise Contours:

- The Outer Envelope future noise contour (composite of 3-month worst case runway usage for four wind directions)
- The Annual Average future noise contour (annual average runway usage)

NZS6805 recommends that noise contours are based on noise over a three-month period (or such other period as agreed)[2]. If the three-month period is used for the noise contouring, then compliance would be based on three monthly monitoring, and it is important that Christchurch Airport can comply in any given three-month period – including any unusual runway usage due to unusual wind conditions.

The Operative Noise Contours were based on a highest 3-month usage of runways 29 and 11 and an annual average usage of runways 02 and 20.

The Annual Average Updated Contours are similar to the Operative Contours as they are both based on annual average usage of the main runway (02-20). However, the Updated Annual Average Contours do not include a 3-month seasonal factor for the cross-runway (11-29) as they use the annual average. A summary of the runway usage applied in the Annual Average Updated Noise Contours is included as Appendix E.

If the annual average is adopted, it is recommended that compliance would then be based on the annual data. If a 3 month compliance period was adopted there is a potential compliance problem when assessed over 3-months. To address this, we recommend a compliance tolerance is provided to allow for worst case 3-month weather patterns.

[2] Clause 1.4.1.2 - New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning"

3.0 ASSESSMENT OF NOISE EFFECTS - METHODOLOGY

Appropriate management of airport noise effects is a two-pronged approach involving aircraft noise management and land use management. The scale of future noise effects is influenced by changes in both.

The Updated Noise Contours represents a change in the **aircraft noise planning environment** which we have assessed in this report by comparing with the Operative Noise Contours.

We have also considered the impact of future changes to the **receiving environment** which is determined by land use planning controls. For this assessment, we have quantified the potential change in effects due to future growth of residential activity inside the Airport Noise Contours. This analysis is based on a hypothetical Future Housing Stock calculated to be the maximum residential development permitted under the operative District Plan land use controls.

The existing aircraft noise planning environment is the level of aircraft noise permitted and anticipated in the various Operative District Plans and is defined by the Operative Noise Contours. Replacing these with the Updated Noise Contours would result in changes to the permitted and anticipated aircraft noise levels in many areas. The purpose of our assessment is to quantify and describe these changes and their associated noise effects.

To quantify the change, we have used noise contours and Geographic Information System (GIS) software to calculate the change in noise at each existing residential property within the Airport Noise Contours. Then we have used this data to quantify and describe the change for the existing population overall.

The methods we have used to quantify and assess the change in noise environment by comparing the Operative and Updated Noise Contours are:

1. Difference in number of houses within the contours;
2. Difference in number of people potentially highly annoyed;
3. Difference in future L_{dn} noise level – houses affected by a noticeable change;
4. Difference in number of people experiencing aircraft noise events above 70 dB L_{Amax}.

As well as considering what changes the Updated Contours mean for the existing population, we have also quantified the potential change in effects due to future growth of residential activity inside the noise contours. The purpose of the Future Housing Stock analysis is to demonstrate the impact that changes to the receiving environment (i.e. land use planning) have on future outcomes.

3.1 Methodology - Existing and future housing stock assumptions

As described above, we have considered two different housing layers in our assessment. These are:

1. **Existing Housing Stock** - derived from Canterbury Maps Rating Units database;
2. **Future Housing Stock** - based on an estimate of the maximum residential development permitted under the existing planning framework.

The Existing Housing Stock layer was derived using the 'Rating units' database from Canterbury Maps. The rating units layer contains information on land use and we simply removed rating units that are not residential related land use.

The Future Housing Stock layer was derived by calculating a theoretical maximum number of residential units permitted on land where residential activity is enabled in the various district plans. This is essentially the residential capacity around Christchurch Airport that may develop over time as properties are subdivided and the density of noise sensitive activities increases. Details of how the potential Future Housing Stock was calculated and the limitation of the analysis is provided in Appendix D.

For the Future Housing Stock analysis, we have assumed that the operative land use controls that applied inside the Operative Noise Contours as of March 2022, would also apply inside the Updated Noise Contours. We have not made any assumptions about potential changes to the density controls occurring after March 2022.

Throughout this report the Existing and Future Housing Stock data has been used in our analysis. For the number of people highly annoyed analysis, the 'sample area' of properties was the outer extent of the 50 dB L_{dn} contours from the Operative and Updated Noise Contours. We have assumed 2.5 persons per household when calculating the number of people affected. This number is from Statistics New Zealand Census data which provides an average number of people per household in Christchurch.

3.2 Method 1 - Difference in houses inside the contours

Replacing the Operative Noise Contours with the Updated Noise Contours would mean a change in the number of existing houses included in the contours. This is a simple method to describe the change in planning environment for the Existing Housing Stock due to the Updated Noise Contours.

We have also calculated the number of houses inside the Airport Noise Contours using the Future Housing Stock to quantify the future impact resulting from changes to the receiving environment.

3.3 Method 2 - Difference in community annoyance

Over the last 40 years, a number of studies have been carried out in an attempt to determine the general relationship between aircraft noise and community annoyance. Most of these studies examine the relationship between annoyance and the Day/Night Level (L_{dn}), as this metric is shown to correlate best with annoyance.

L_{dn} is the metric recommended in NZS6805:1992 to be used for defining aircraft noise contours and hence is the metric that defines Christchurch Airport's noise contours. L_{dn} represents the cumulative noise energy (or noise exposure) over 24 hours with a 10-decibel penalty added to any night flights between 10pm and 7am. It is generally calculated over a 3 month or annual period which represents the long-term noise exposure. It takes into account both the number of aircraft noise events and the loudness of each event and is a measure of noise exposure.

The results of these studies are normally plotted as a dose response curve – i.e. a graph of the number of people who report being 'Highly Annoyed' versus the noise level they experience (see Figure 1 below).

An early study carried out by Schultz in 1978 included various forms of transportation noise. In 2001 a comprehensive amalgamation of various airport noise studies was carried out by Miedema and Oudshoorn[3]. This study produced a dose-response curve that has been used widely for many years (Figure 1).

Marshall Day Acoustics has recently carried out a literature review of the more recent studies into community annoyance due to aircraft noise. Our detailed literature review is presented in a separate report "*Christchurch Airport – Community Response to Aircraft Noise Literature Review*" dated 16 May 2022. In summary, the two most significant studies were by the World Health Organisation (WHO)[4] in 2018 which included 12 airports from around the world and the Federal Aviation Administration (FAA)[5] in 2021 which included 20 airports in the USA.

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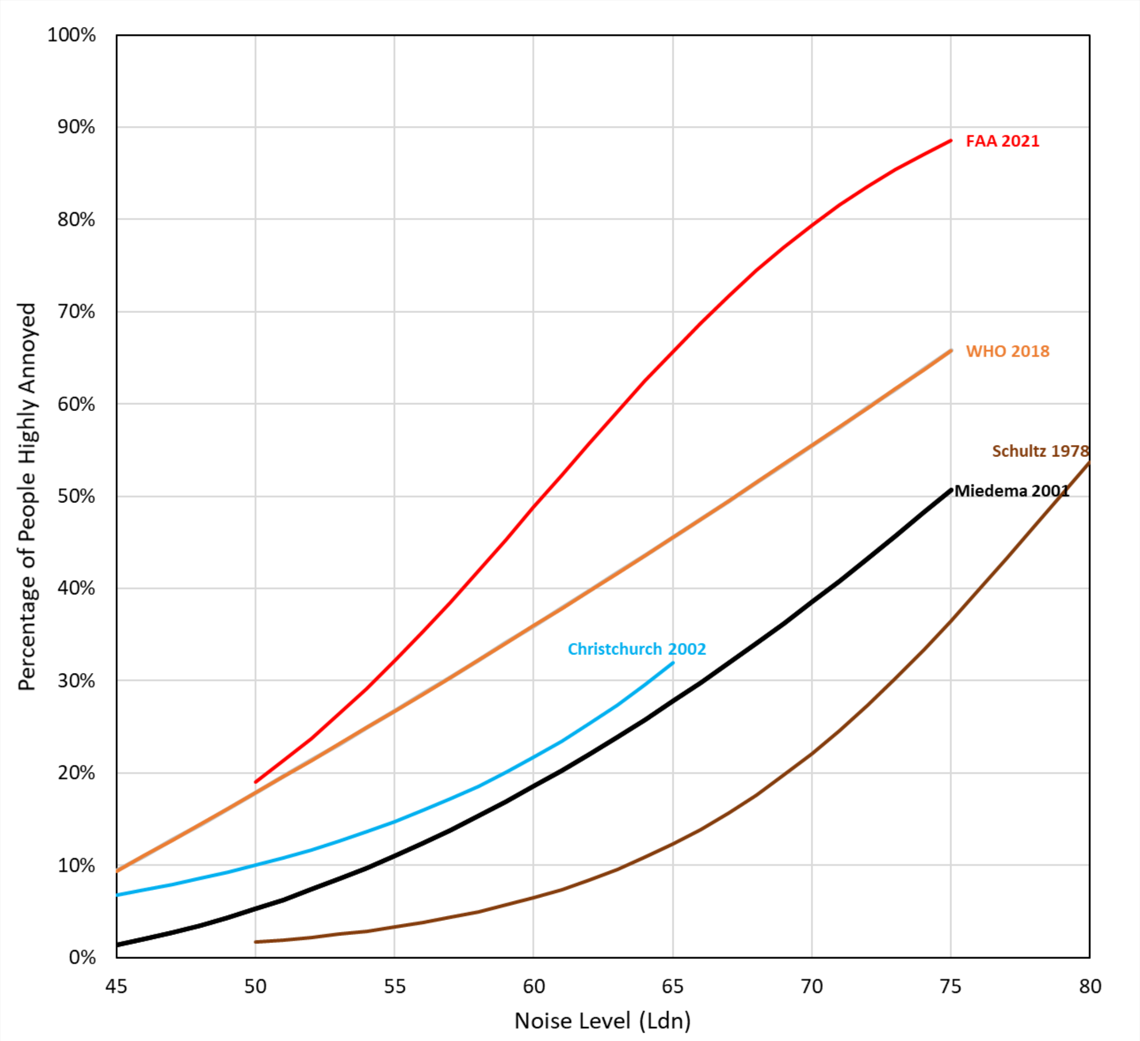
[3] Miedema and Oudshoorn (2001); "Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals"

[4] World Health Organisation (2018). Environmental noise guidelines for the European Region.

[5] U.S Department of Transportation (FAA). (2021). *Analysis of the Neighbourhood Environmental Survey.*

Figure 1: Community response to aircraft noise



The comparison in Figure 1 shows there is an appreciable variation between the curves making it difficult to predict the actual annoyance outcome with certainty. The general conclusion from Figure 1 is that community annoyance due to aircraft noise increases with noise level exposure (as expected), and overall has increased over time.

The dose-response relationships discussed above can be used to estimate the number of people likely to be highly annoyed at various levels of aircraft noise. For example, at 55 dB L_{dn}, 27% of the population are likely to be highly annoyed using the WHO curve.

Our assessment of effects, calculates the number of people in Christchurch predicted to be highly annoyed using the 2018 WHO curve for both the Operative and Updated Noise Contours. We have calculated this for both the Existing and Future Housing Stock.

To determine these numbers, the Integrated Noise Model (INM) was used to calculate L_{dn} contours in 1 dB increments and then GIS software was used to count the number of houses within each 1 dB noise band (L_{dn}). The number of people in each band was then multiplied by the annoyance level from the WHO curve to give an overall number of people annoyed under each noise contour scenario. The sample area analysed is the outer extent of the 50 dB L_{dn} contour for the Operative and Updated Noise Contours.

3.4 Method 3 - Difference in L_{dn} noise level

Replacing the Operative Noise Contours with the Updated Noise Contours will mean a change in future aircraft noise at many properties. For some houses the future noise level would increase compared to the existing planning environment, and for others it would decrease.

The subjective response to a change in noise level is widely variable from individual to individual, and also varies for a change that occurs immediately compared with a change that occurs slowly over many years.

However, 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.

Our assessment concentrates on existing houses impacted by a noticeable change of +/-5 dB L_{dn} or more between the Operative and Updated Noise Contours.

The change in L_{dn} level is most relevant to the Existing Housing Stock and has little relevance to the Future Housing Stock. Therefore, we have not completed this analysis for the Future Housing Stock.

3.5 Method 4 - Difference in houses exposed to aircraft noise events above 70 dB

In Australia, a noise effects assessment concept known as 'Number Above'[6] is used to describe the impacts that residents living near aircraft flight paths will experience in practice. The concept is simply based on the number of aircraft noise events that people experience. The Australian study states that the 'Number Above' concept is not meant to replace the noise exposure analysis, but rather to be used in conjunction with that analysis to assist with the communication of noise effects to the public. It is proposed that residents can more easily relate to a number of noise events experienced than a noise level expressed in dB L_{dn}.

The authors of the concept[7] submit that an aircraft is 'registered as a noise event' by receivers when it exceeds an external noise level of 70 dB L_{Amax}. Thus, for any one receiver, a noise event of 90 dB L_{Amax} is counted the same as an event of 71 dB L_{Amax}. Events below 70 dB L_{Amax} are not considered to be disruptive or particularly noticeable and therefore are not counted.

Using aircraft noise modelling software, it is possible to calculate the 'number of events above' 70 dB L_{Amax} at any given location for a given airport operations scenario. It is also possible to produce N70 contours to indicate where, for example, 20 aircraft events per day are experienced. This is referred to as an N70,20 contour.

We have calculated the N70 contours for the aircraft operations scenarios used in Operative and Updated Noise Contours and used this data to calculate:

- The difference in number of events at representative locations surrounding the Airport;
- The number of people predicted to experience more than 10 events above 70 dB;
- The Person Event Index for Operative and Updated Noise Contours.

We have completed this analysis for both the Existing and Future Housing Stock.

[6] "Expanding Ways to Describe and Assess Aircraft Noise" Transport and Regional Services, Australia

[7] David Southgate, Rob Aked, Nick Fisher and Greg Rhynehart

We note the operating scenarios used for the N70 contours are an average day of aircraft operations. This means on average residents would experience 10 or more events over 70 dB L_{Amax} but on any given day this number could be greater or smaller.

4.0 ASSESSMENT OF NOISE EFFECTS - RESULTS

4.1 Results 1 – Difference in number of houses inside the contours

Replacing the Operative Noise Contours with the Updated Noise Contours would mean a change in the number of houses inside the contours. We have quantified the number of houses in noise level bands (i.e. 50 – 55 dB Ldn and so on) for the Operative Contours and the Updated Contours.

Table 1 lists the results for the Existing Housing Stock and Table 2 lists the results for the Future Housing Stock.

Table 1: Number of houses in Operative and Updated Noise Contours – Existing Housing Stock

L_{dn} Band	Operative Contours	Updated Contours
50 – 54	7,847	8,876
55 – 59	1,473	1,694
60 – 64	101	133
>65	36	60
Total	9,457	10,763

Table 2: Number of houses in Operative and Updated Noise Contours – Future Housing Stock

L_{dn} Band	Operative Contours	Updated Contours
50 – 54	15,260	13,599
55 – 59	1,904	2,559
60 – 64	417	410
>65	36	60
Total	17,617	16,628

Table 1 shows a moderate increase in existing houses inside the Updated Noise Contours compared with the Operative Contours. CIAL currently has an acoustic mitigation programme in place for existing houses affected by levels greater than 65 dB L_{dn} as recommended in NZS6805:1992. We recommend this programme is reviewed and updated to provide for the Updated Noise Contours.

Comparing Table 1 and Table 2 we can see that the impact of the potential change in receiving environment (i.e. additional housing) would have a greater impact on the number of houses affected by aircraft noise than the change in aircraft noise planning environment would (i.e. the Updated Noise Contours).

The analysis also shows that under the Future Housing Stock scenario, the Operative Contours would include slightly more houses than the Updated Contours. This difference is most apparent in the 50 – 54 dB L_{dn} band.

The change in receiving environment is based on the assumption that the permitted density and subdivision controls that applied within the Operative Noise Contours in March 2022 would also apply within the Updated Noise Contours. Any loosening of the current land use controls inside the airport noise contours would result in an even greater increase in affected residents.

4.2 Results 2 – Difference in number of people highly annoyed

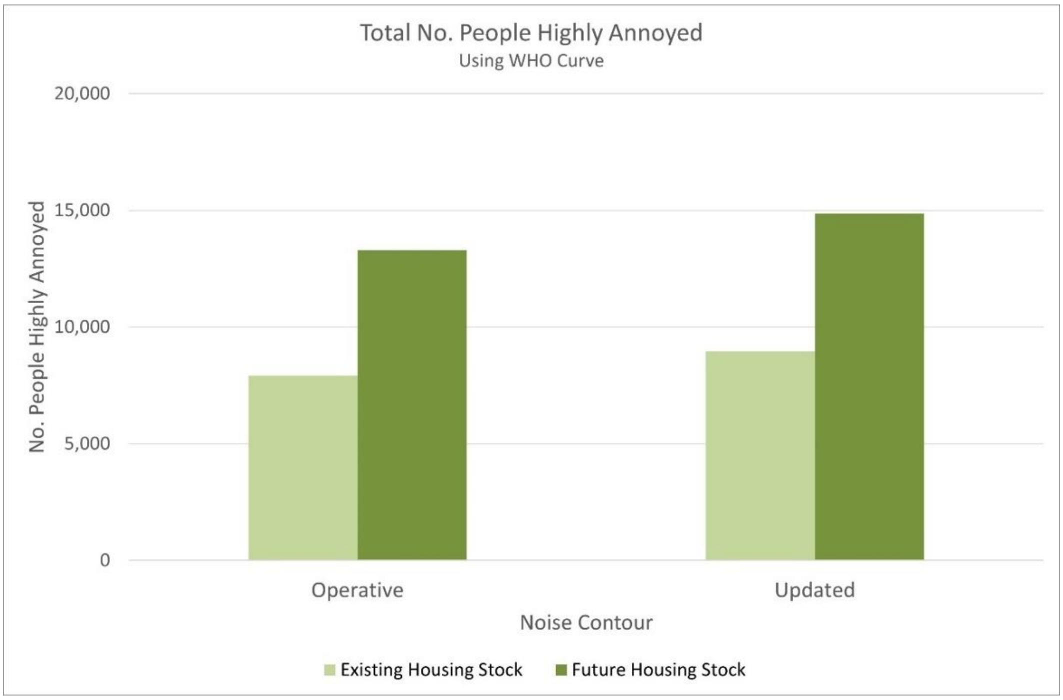
The results above show the number of houses under the different scenarios without taking into account the difference in annoyance at the different noise levels. This section uses those house counts and the noise levels to calculate the number of people potentially highly annoyed for the Operative and Updated Contours using the WHO 2018 dose-response curve[8]. The methodology is described in Section 3.3. Table 3 shows the results for both the Existing Housing Stock and the Future Housing Stock.

Table 3: Number of people highly annoyed under the WHO curve

	Operative Contours	Updated Contours
Existing housing stock	7,919	8,964
Future housing stock	13,291	14,869

For the Existing Housing Stock there is a moderate increase in people potentially highly annoyed resulting from the Updated Contours. However, the potential growth in residential development inside the Airport Noise Contours presents a far greater increase in people potentially highly annoyed. The number of people highly annoyed under the Future Housing Stock scenario is considerably greater than the Existing Housing Stock scenario (66% greater). This data is also represented graphically in Figure 2.

Figure 2: Number of people highly annoyed Operative and Updated Noise Contours using WHO Curve



[8] The predictions relate to the whole sample area covered by both the Operative and Updated Contours combined, including residents located outside 50 dB L_{dn} for one scenario but inside 50 dB L_{dn} for the other. This way we compare the annoyance outcome in the population within the same sample area for both scenarios.

Using an annoyance dose response relationship is useful for comparison purposes to evaluate the relative impacts of various scenarios. However as discussed in Section 3.3, there are various different annoyance curves available to use and it is difficult to predict the actual outcome with certainty. We have used the WHO 2018 curve which predicts approximately three times as many people being highly annoyed as the Miedema 2001 curve, which has historically been used in New Zealand.

4.3 Results 3 – Difference in L_{dn} noise level

Replacing the Operative Noise Contours with the Updated Noise Contours would mean a change in the future anticipated L_{dn} noise level at properties surrounding the Airport. For some properties the difference is an increase in aircraft noise and for others it is a decrease.

An indicative map of the difference in noise level at properties within the Airport Noise Contours is shown in Figure 3. The map shows that larger increases occur in areas such as West Melton and Ohoka between 50 and 55 dB L_{dn} for the Updated Contours. These areas are not inside the Operative Contours but are in the Updated Contours due to changes in airspace management that have occurred since the Operative Contours were developed in 2008.

To further understand the scale of the change across the population, we have counted the number of existing houses impacted by a noticeable change of +/-5 decibels or more. In our view, the significance of a change also depends on the absolute noise level, for example a 5 decibel increase from 45 to 50 dB L_{dn} is not as serious as an increase from 65 to 70 dB L_{dn}. Therefore, we've presented the results in L_{dn} contour bands.

Table 4 below shows the number of houses in each contour band where the anticipated increase is 5 dB L_{dn} or more. Table 4 shows that the majority of houses affected by a noticeable increase is in the lower noise contour bands. The last row in Table 4 lists the number of houses with a 5 dB or greater decrease in L_{dn} compared with the Operative Noise Contours.

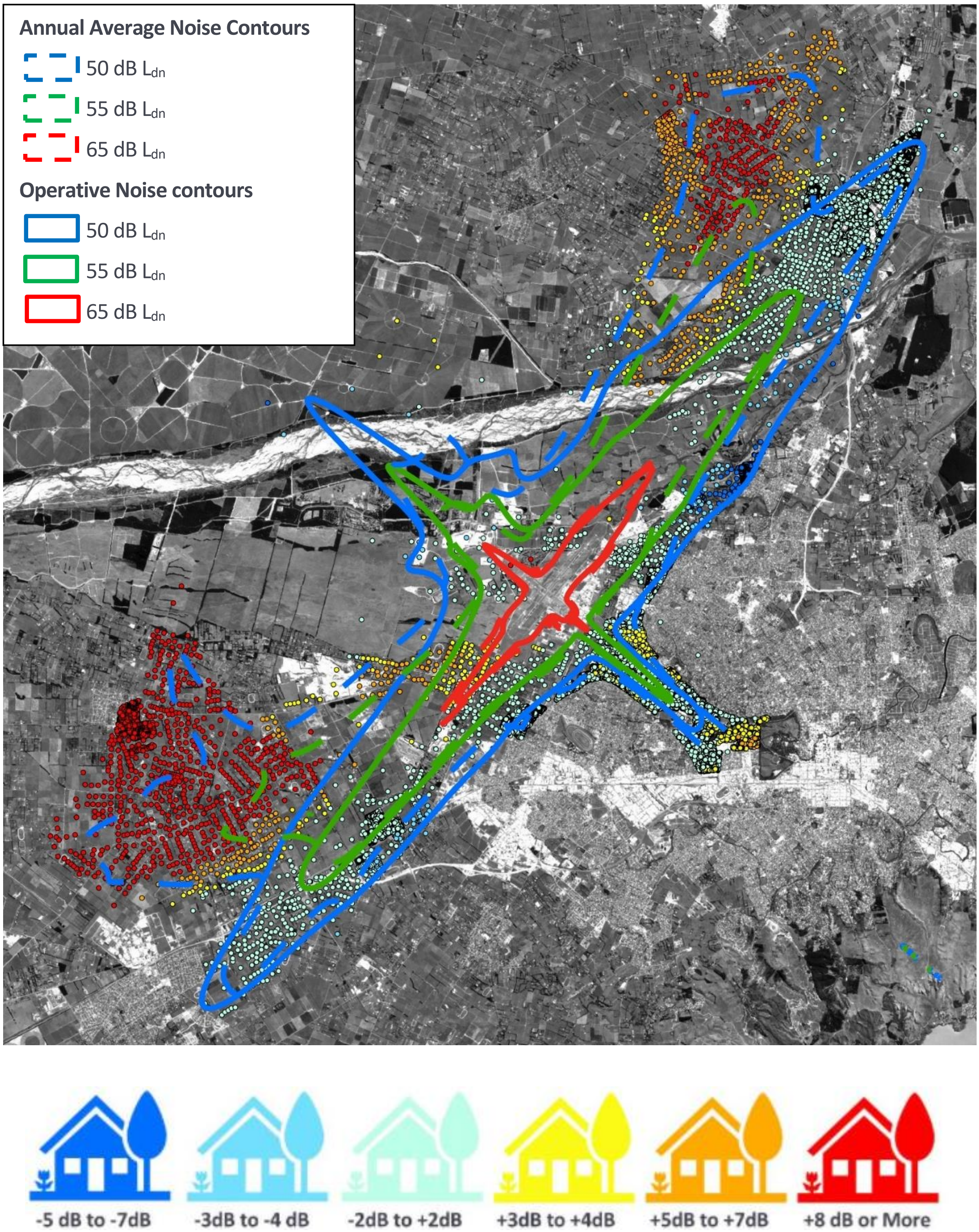
Table 4: Number of existing houses with L_{dn} increase of 5 dB or greater

L_{dn} Band	Updated Contours
50 – 54	635
55 – 59	203
60 – 64	11
>65	1
Houses with a 5 dB or greater increase in L_{dn}	850
Houses with a 5 dB or greater decrease in L_{dn}	378

Most houses with a noticeable increase are in the lower noise bands and result from the different shape of the Updated Noise Contours. This is also demonstrated on the map in Figure 3.

Figure 3: Difference in modelled airport noise level at each dwelling (relative to the Operative Contours)

Note: This diagram is indicative only. The points are based on existing titles in zones where residential activity may occur. Not all existing titles contain existing houses. The titles data used in this diagram has not been adjusted to exclude vacant land or non-residential buildings.



4.4 Results 4 - Number of noise events above 70 dB

As discussed earlier, the N70 or 'Number Above' concept is aimed at identifying potential noise effects based on the number of aircraft noise events that people experience. The concept looks at the number of events above a specified noise level – L_{Amax} 70 dB, which is termed N70. Aircraft events above this level are considered to be noticeable whereas events below this level are treated as not particularly noticeable or disruptive and are not counted.

We have used N70 in three ways – Methods 4a, 4b and 4c.

4.1.1 Results 4a - Number of noise events above 70 dB experienced at representative locations

This method examines 11 representative locations and calculates the number of noise events experienced under the Operative Contours and under the Updated Contours. Figure 4 below shows the 11 locations (in orange) along with N70 contours for the Operative and Updated Contours.

Figure 4: N70 contours and receiver locations for 'number above' analysis

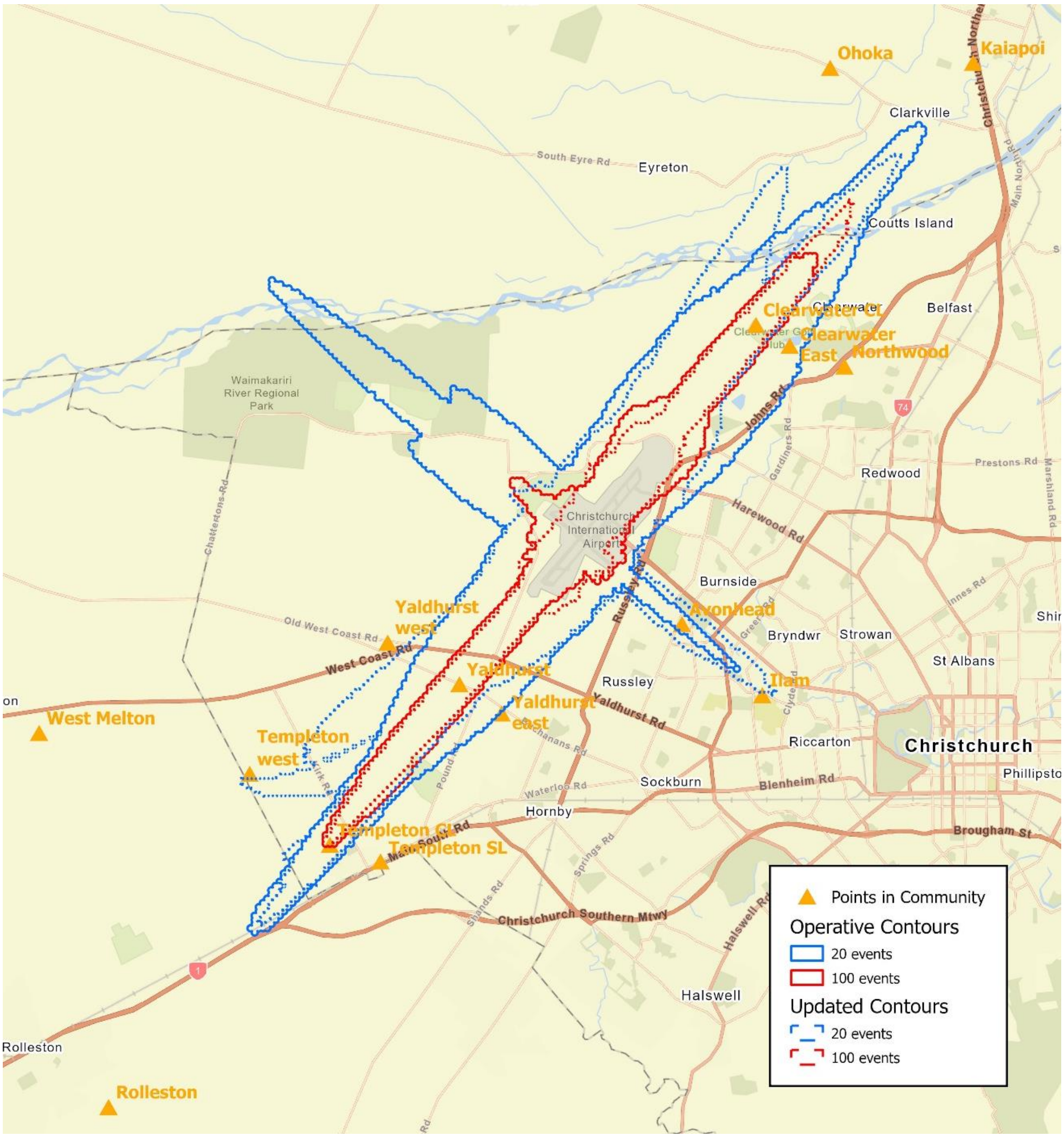


Table 5 lists the number of noise events above 70 dB L_{Amax} at the 11 representative receiver locations.

Table 5: Number of noise events above 70 dB L_{Amax} per average day in each receiver location

Location	Operative Contours	Updated Contours	Change
Templeton East	4	< 1	Decrease
Clearwater East	37	<1	
Northwood	13	<1	
Yaldhurst East	13	8	
Clearwater Centreline	138	122	
West Melton	<1	<1	Small increase, low to moderate number of events
Kaiapoi	< 1	4	
Yaldhurst West	3	4	
Rolleston	< 1	9	
Ohoka	< 1	8	
Templeton West	2	9	
Ilam	15	20	
Avonhead	24	28	
Templeton Centreline	102	130	Moderate increase, substantial number of events
Yaldhurst	152	234	

Templeton East, Clearwater East, Northwood and Yaldhurst East and Clearwater Centreline all have fewer noticeable aircraft noise events under the Updated Noise Contours compared with the Operative Contours.

West Melton, Kaiapoi, Yaldhurst West, Rolleston, Ohoka and Templeton West all have more noticeable aircraft noise events under the Updated Noise Contours compared with the Operative Contours, but the numbers remain relatively small (9 events or less per day on average).

Ilam and Avonhead have a moderate number of noticeable aircraft noise events per day on average, and a small increase under the Updated Contours compared with the Operative Contours. On a day with north westerly winds, the number would be greater than the average day predictions in Table 5.

Templeton and Yaldhurst are rural areas located on the extended runway centreline of the main runway. These areas experience the greatest number of noticeable aircraft noise events. For Yaldhurst and Templeton on centreline, the Updated Contours include more noticeable aircraft noise events than the Operative Contours.

4.1.2 Results 4b – Overall number of people experiencing aircraft noise events above 70 dB

The number of events analysis in Section 4.1.1 is helpful for residents at a particular location to assess how many events they will experience in the future, but it does not show how many people are exposed to this number of events, or how the overall community is affected.

The N70 contours can also be analysed to determine the number of people that will experience a given number of aircraft events. We have used the N70 contours to calculate the number of houses and number of people[9] that will experience events over 70 dB L_{Amax} for the Operative Contours and the Updated Contours. Table 6 shows the results of this analysis for the Existing Housing Stock and Table 7 shows the results for the Future Housing Stock.

An indicative map in Figure 5 provides a geographical overview with dots for existing properties coloured to represent the number of aircraft events above 70 dB L_{Amax}.

Table 6: Number of people experiencing aircraft noise events above 70 dB L_{Amax} (Existing Housing Stock)

	Operative Contours	Updated Contours
10-20 Events	7,290	7,545
20-50 Events	2,413	5,605
50-100 Events	553	410
100+ Events	350	288
Total	**10,605**	**13,848**

Table 7: Number of people experiencing aircraft noise events above 70 dB L_{Amax} (Future Housing Stock)

	Operative contours	Updated Contours
10-20 Events	16,750	12,645
20-50 Events	3,315	6,998
50-100 Events	968	785
100+ Events	530	465
Total	**21,563**	**20,893**

Looking at the data in Table 6 we see that the Updated Contours have approximately 30% more people overall, experiencing 10 or more noticeable aircraft noise events per average day. Most of this increase occurs in the 20 – 50 events bracket (row 3 of Table 6) whereas the Updated Contours have slightly fewer people in the higher events brackets of 50 or more events per day. The large increase in people affected by 20 – 50 events per day is visible in Figure 5 where we see the Updated Contours has a larger area of green dots over urban Christchurch than the Operative Contours. The greater population density in this area of Christchurch influences this result.

Comparing Table 6 and Table 7, the scale of impact on the Future Housing Stock compared with the Existing Housing Stock is considerable. The data shows the increase in effects due to the change in aircraft noise environment is less significant than the increase resulting from the change in the receiving environment.

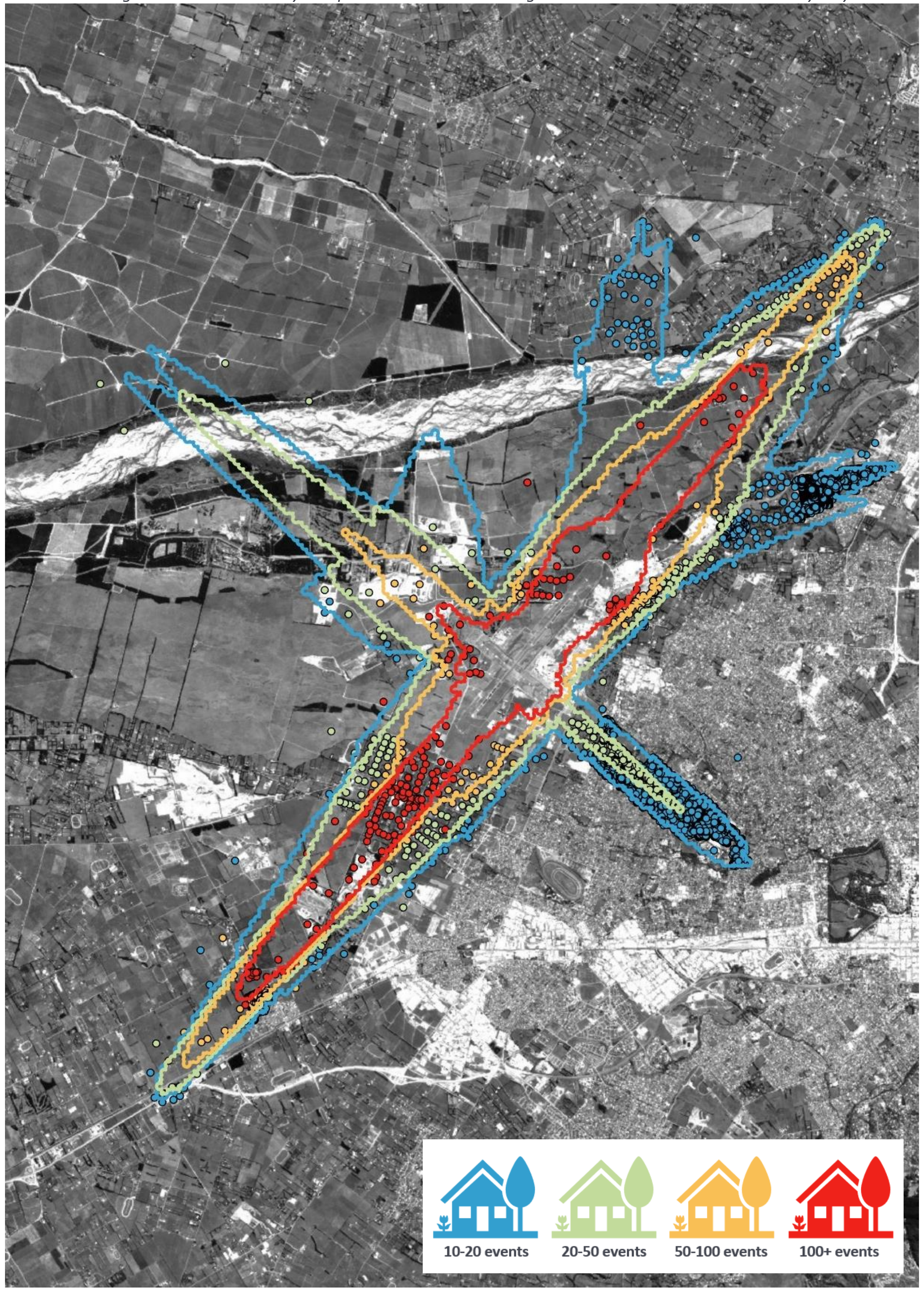
[9] The number of people per house is based on data from Statistics NZ of 2.5 persons per household

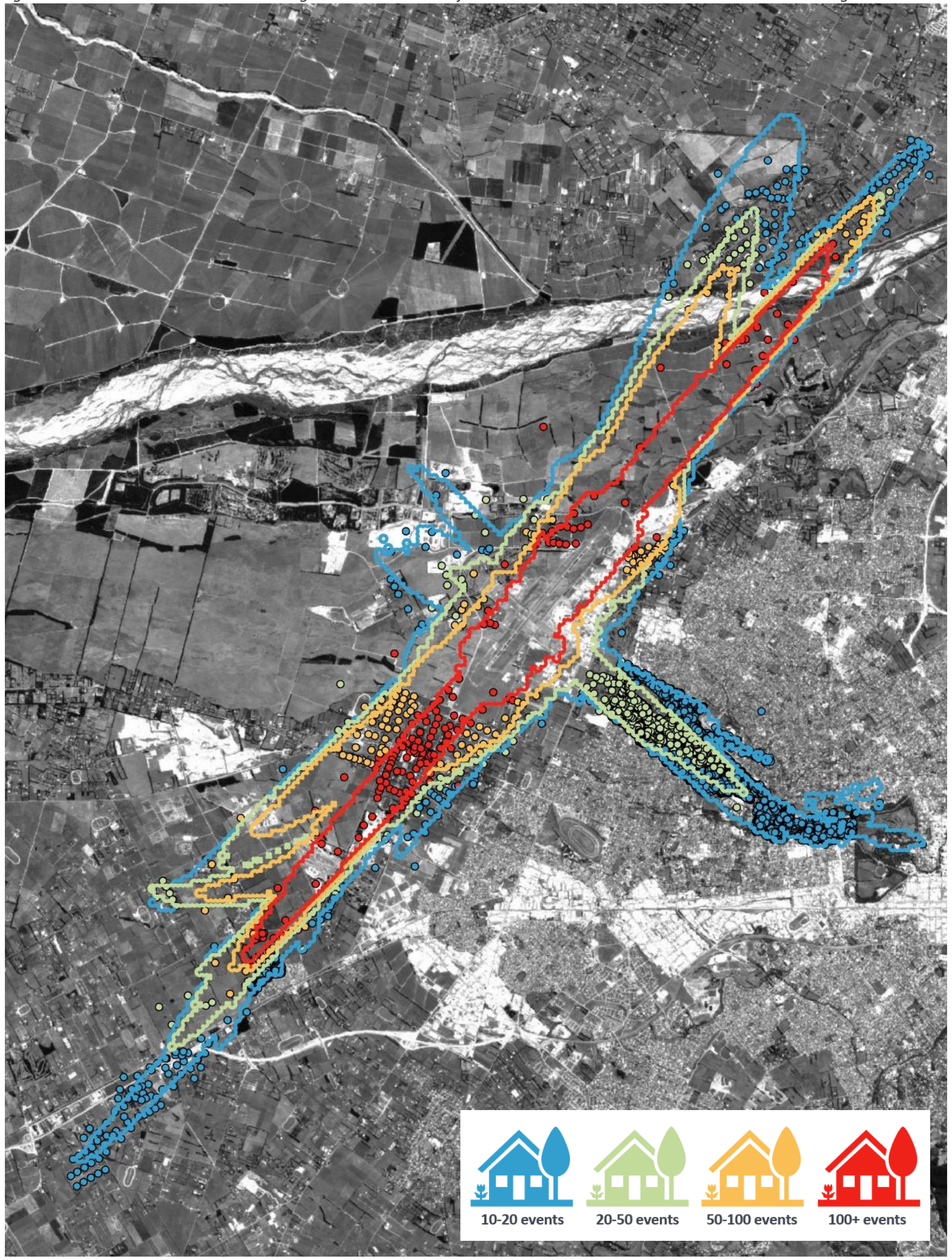
Figure 5: Number of modelled aircraft noise events above 70 dB L_{Amax} experienced at existing properties

Operative Contours

Updated Contours

Note: These diagrams are indicative only. The points are based on existing titles in zones where residential activity may occur. Not all existing titles contain existing houses. The titles data used in these diagrams has not been adjusted to exclude vacant land or non- residential buildings.





4.1.3 Results 4c – Person event index

The above analysis provides a useful comparison of the number of people that will experience various numbers of events. However, it does not differentiate between the people that experience 10 events per day (a small effect) and those that experience 100 events per day (a greater effect).

The Australian N70 study also developed a 'Person Event Index' ("PEI") which is a single value metric used to evaluate and compare the effects on a population as a whole. From the N70 contours the Person Event Index (PEI) can be calculated by multiplying the number of people in each N70 band by the number of events. For instance, if 50 people were exposed to 10 events per day or 5 people were exposed to 100 events per day, the PEI would be 500 in both cases (i.e., 50x10 and 5x100). The PEI gives a general indication of the magnitude of the noise impact for the overall population sample.

Only dwellings exposed to 10 events or more per day have been considered. The results from the PEI analysis for the Existing Housing Stock are shown in Table 8 and for the Future Housing Stock in Table 9.

Table 8: Person event index analysis for Existing Housing Stock (numbers reported in millions)

	Operative Contours	Updated Contours
10-20 Events	0.10	0.10
20-50 Events	0.06	0.14
50-100 Events	0.04	0.03
100+ Events	0.05	0.05
PEI ($x10^{-6}$)	**0.25**	**0.31**

Table 9: Person event index analysis for Future Housing Stock (numbers reported in millions)

	Operative Contours	Updated Contours
10-20 Events	0.22	0.15
20-50 Events	0.09	0.17
50-100 Events	0.07	0.05
100+ Events	0.07	0.08
PEI ($x10^{-6}$)	**0.45**	**0.46**

We see the same trend in the PEI as we saw in method 4b in the previous section. The overall PEI for the Updated Contours is 24% greater than the Operative Contours and the greatest change occurs in the 20 – 50 event per day bracket.

The results for the Future Housing Stock in Table 9 show the potential change to the receiving environment (i.e. increase in residential activity) would result in the PEI increasing substantially.

5.0 RELATIONSHIP BETWEEN COMPLAINTS AND EFFECTS

As discussed in our literature review ("*Christchurch Airport – Community Response to Aircraft Noise Literature Review*" dated 16 May 2022), annoyance is determined by the noise level experienced and also a number of non-acoustic factors such as personal and attitudinal factors that can make certain individuals more sensitive to noise. Complaints are considered one of many mechanisms that can be used to cope with the annoyance being experienced. However, complaining is only one way of coping with noise annoyance. Therefore, analysis of complaint data only gives us access to a small slither of the population being annoyed by noise. Studies at Schipol and Brisbane airports showed that not all people annoyed by noise complain. Only 19% and 34% of highly annoyed respondents complained about the noise at Schipol and Brisbane airports respectively.

Complaints data has been analysed in past studies to try and determine a relationship between noise levels, annoyance and complaints. However, no reliable correlation has been found to date. A paper by FICON in 1992 commented that "annoyance can exist without complaints, and conversely complaints may exist without annoyance" and it has long been thought that we therefore cannot use complaints data to accurately predict annoyance levels. This continues to be the finding of the latest research in this area. However, recent studies have shown that analysis of complaints data can show us other trends which may be helpful to understand.

A major reason for people not complaining about noise is when they perceive nothing can be done about the noise source. This explains why often most complaints received at airports are well outside the noise contours where there is scope to shift flight paths rather than close into the airport where flight paths are essentially fixed on extended runway centreline and cannot be shifted.

This occurred at Auckland Airport throughout the SMART trials, which were trials of new arrival paths into the airport. The trial proceeded unnoticed for the first 6 months and no complaints were received. It was then picked up by a local newspaper and complaints increased as the media coverage grew and was eventually reported on the 6 o'clock news.

A large number of complaints were received during the yearlong trial that were well above historical complaint levels. These complaints were mainly from Mt Eden and Epsom (areas exposed to noise levels below 45 dB L_{dn}) whereas noise complaints from people living inside the noise contours were limited. In reality, the noise levels of the SMART flight paths in the Mt Eden and Epsom areas were not much different to the conventional flights paths that had flown over these areas for years.

The trial ceased after a year but interestingly the largest number of complaints received was in the week after the trial had stopped. There was also a very low correlation between people's complaints and the new flight tracks, with most people inadvertently complaining about conventional arrival and departure flight tracks thinking they were the new SMART flights tracks.

After the trial, a public consultation and review was completed, and the tracks were tweaked slightly and approved for permanent use. Complaints remained low during this period despite the tracks being used on a daily basis.

A similar scenario played out at Sydney airport and complaints from outside the noise contours resulted in a curfew being put on the airport. Similar trends are seen for complaints from Christchurch Airport, with most complainants coming from people located outside the noise contours. Analysis of complaints data from 2017 to March 2022 shows that 75% of complainants were located outside the noise contours.

Another reason people may be more likely to complain is if there is a large upcoming change proposed at an airport, such as a new runway, which people feel they can have a say in. Manchester Airport unveiled plans to construct a new runway in 1996 which caused public outcry and increased community complaint. Complaints in the years following decreased after this initial period to levels lower than those seen prior to 1996, even though the number of flights kept increasing over this time. The runway was eventually built in 2001 which again triggered another spike in complaints which were unrelated to the overall number of flight movements at the airport.

A study by Maziul in 2005 summarises that the following factors can lead people to/to not complain. As discussed above a large factor increasing people's likelihood to complaint is if they feel they can have some influence over an outcome. There are also things such as a person socio-economic status or the ease in which someone can make a complaint which influences people's likelihood of complaining.

Factors that enhance to lodge a complaint	Factors that rather keep from complaining
Knowledge of noise complaint service	Not knowing where to complain
Believe in the effectiveness of the complaint	Low expectancy of success or belief in having to 'put-up-with' the disturbance)
Confidence in one's ability, good socio - economic status (education, house ownership)	Low socio-economic status
Past complaint experience	Past complaint experience
Noises which people believe authorities can influence	Noises which people believe authorities cannot influence
Time of day that noise occurred	Time of day that noise occurred
Individual characteristics (e.g. susceptibility, individual threshold, coping mechanisms, willing to express criticisms, tendency to complain)	
Way different airports deal with noise complaints	
Concern about health, and fear of aircraft crashes.	Neither concern about health (in relation to noise) nor fear of crashes

In addition to the factors listed above, the noise level and time of an aircraft noise event can influence someone's likelihood of complaining. Hume 2003 did an analysis of complaints at Manchester Airport which showed that the louder the aircraft noise event, the more complaints that were generated. Also, night flights caused on average nearly five times more complaints than daytime flights. This study also found that more complaints were received in the busy season and that complaints tended to be lowest on Monday and highest on Sunday, increasing throughout the week.

Overall, we do not consider that complaints can be used as a reliable indicator of annoyance as they only represent a small proportion of people that are highly annoyed and are more likely to be from people living in lower noise environments. Complaints are also highly impacted by airport changes such a new runways or tracks being developed or public action against noise, which make them an unreliable source.

Analysis of complaints data over the years has not shown any reliable correlation to annoyance or overall noise levels. However, there are some trends that can be ascertained from looking at the data that can be helpful to understand the root cause of complaints and how an airport can best manage itself to avoid these.

This discussion confirms that it is important to use appropriate land use planning to avoid both complaints (and reverse sensitivity consequences) and to avoid annoyance (and adverse effects on the community).

6.0 ASSESSMENT OF NOISE EFFECTS - SUMMARY

NZS6805:1992 is intended to "*ensure communities living close to the airport are properly protected from the effects of aircraft noise whilst recognising the need to be able to operate an airport efficiently*". The Standard recommends doing this by applying a two-pronged approach that:

a. Manages aircraft noise emissions; and

b. Manages noise sensitive land use.

The current aircraft noise and land use controls for Christchurch International Airport are generally based on the NZS6805 approach.

CIA's Airport Noise Contours are intended to be reviewed every 10 years as recommended by the Expert Panel in 2008. Accordingly, CIAL has commissioned the preparation of Updated Noise Contours to replace the Operative Noise Contours.

This report considers the impact of changes to the two factors influencing the scale of aircraft noise effects on the surrounding population:

- **Change in aircraft noise planning environment** (Updated Noise Contours)
- **Change in the receiving environment** (i.e. growth in residential activity enabled by operative land use controls)

We have assessed the change in the aircraft noise planning environment by comparing the scale of aircraft noise effects for the Updated Noise Contours with the Operative Noise Contours in the context of the Existing Housing Stock.

We have assessed the change in the receiving environment by comparing the scale of aircraft noise effects for the Existing Housing Stock with that for a potential Future Housing Stock. The Future Housing Stock is based on the maximum development enabled by the existing planning framework. For this analysis, we have assumed that the operative land use controls applying inside the Operative Noise Contours as of March 2022, would also apply inside the Updated Noise Contours.

6.1 Annual Average Updated Noise Contours

The Annual Average Updated Noise Contours are based on the historical annual average use of CIA's four runways. Appendix E lists the runway usage splits applied in the Annual Average noise modelling.

For reference, the Operative Noise Contours are based on an annual average usage of runways 02 and 20 and a highest 3 month usage of runways 29 and 11.

A brief comparison of the inputs and resulting noise contours is provided in Appendix C.

6.2 Change in aircraft noise planning environment

The Updated Noise Contours represents a change in the aircraft noise planning environment which we have assessed in this report by comparing with the Operative Noise Contours. We have used four different methods to quantify the aircraft noise effects for the Existing Housing Stock:

1. Number of houses within the Airport Noise Contours (# Houses);
2. Number of people potentially highly annoyed (People HA);
3. Number of houses affected by a noticeable change in L_{dn} (# Houses >5dB Increase);
4. Number of people experiencing aircraft noise events above 70 dB L_{Amax} (PEI).

Table 10 summarises the difference between the Updated Contours compared with Operative Contours for each of the metrics above.

Table 10: Updated Noise Contours change in aircraft noise effects for Existing Housing Stock

	# Houses	People HA	# Houses 5dB+ Increase in L_{dn}	PEI (10^{-6})
Change compared with Operative Contours	+14%	+13%	850	+24%

Our assessment shows a moderate increase in the scale of effects predicted under all four assessment methods. This change reflects the revised airspace management and operational capacity of the airport used for modelling the Updated Noise Contours.

6.3 Change in receiving environment

We have considered the impact of future changes to the receiving environment which is determined by land use planning controls. For this assessment, we have quantified the potential change in effects due to future growth of residential activity inside the Airport Noise Contours. This analysis is based on a hypothetical Future Housing Stock calculated to be the maximum residential development permitted under the operative District Plan land use controls.

We have compared the scale of aircraft noise effects for the Future Housing Stock with that for the Existing Housing Stock using three methods:

1. Number of houses within the Airport Noise Contours (# Houses);
2. Number of people potentially highly annoyed (People HA);
3. Number of people experiencing aircraft noise events above 70 dB L_{Amax} (PEI).

Table 11 summarises the increase in the scale of noise effects for the Future Housing Stock compared with the Existing Housing Stock for each of the metrics above.

Table 11: Increase in aircraft noise effects due to change in receiving environment

Noise Contour Scenario	# Houses	People HA[10]	PEI (10^{-6})
Operative	+86%	+68%	+76%
Updated	+54%	+66%	+46%

Table 11 shows that under the operative land use controls (March 2022), the potential increase in residential activity within the Airport Noise Contours would result in a substantial increase in the scale of aircraft noise effects in the community.

For the change in receiving environment analysis, we have assumed that the permitted density and subdivision controls that apply within the Operative Noise Contours (as of March 2022) would also apply within the Updated Noise Contours. Any loosening of the current land use controls inside the airport noise contours would result in an even greater increase in affected residents.

[10] This change relates to the whole sample area covered by both the Operative and Updated Contours combined including residents located outside 50 dB L_{dn} for one scenario but inside 50 dB L_{dn} for the other. This way we compare the annoyance outcome in the population within the same sample area for both scenarios.

6.4 Conclusions

In summary, the Updated Noise Contours generally represent a moderate increase in aircraft noise effects compared with the Operative Noise Contours. This is a result of the updated long term future operational capacity of the Airport.

As well as considering the impact of the change in aircraft noise environment, we assessed the impact of the potential change in receiving environment. Our analysis shows that the potential increase in aircraft noise effects resulting from worst case growth in residential activity currently permitted inside the Airport Noise Contours, is far greater than the increase in effects due to the change in aircraft noise. If the land use controls applying inside the Airport Noise Contours (as of March 2022) were relaxed, the scale of airport noise effects on the surrounding population would increase even more significantly.

APPENDIX A NEW ZEALAND STANDARD NZS6805

In 1992, the Standards Association of New Zealand published New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*" (the Standard) with a view to providing a consistent approach to noise around New Zealand airports. The Standard was finalised after several years of preparation and consultation and forms the consensus of opinion in 1991 of many different groups including the Ministry of Transport, the Department of Health, Airline representatives, Local Authorities, residents action groups, acoustic consultants and others including CIAL.

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

- "Establish compatible land use planning" around an airport; and
- "Set noise limits for the management of aircraft noise at airports"

The Noise Boundary concept involves fixing an Outer Control Boundary and a smaller, much closer Airnoise Boundary around the airport. Inside the Airnoise Boundary, new noise sensitive uses (including residential) are prohibited. Between the Airnoise Boundary and the Outer Control Boundary new noise sensitive uses should also ideally be prohibited (and of those that are required, all should be provided with sound insulation). The Airnoise Boundary is also the location for future compliance monitoring with a 65 dB Ldn limit.

The Standard is based on the Day/Night Sound Level (Ldn) which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10-decibel penalty applied to night flights. Ldn is used extensively overseas for airport noise assessment, and it has been found to correlate reasonably well with community response to aircraft noise.

The location of the Airnoise Boundary is based upon the projected 65 dB Ldn contour, and the location of the Outer Control Boundary is generally based on the projected 55 dB Ldn contour. The Standard does however state in paragraph 1.4.3.8 that the local authority may show "the contours in a position further from or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case". The Canterbury Regional Council, and therefore Christchurch, Waimakariri and Selwyn Councils use the 50 dB L_{dn} contour for the location of the Outer Control Boundary.

The Standard recommends that the Airnoise Boundary and Outer Control Boundary are generally based on noise over a three-month period (or such other period as agreed). Airports in New Zealand mostly use a three-month average with Auckland Airport using an Annual Average. The Standard also recommends planning and management procedures be based on predicted noise contours (Ldn) for a future level of airport activity. The Standard (clause 1.4.3.1) recommends that a "minimum of a 10-year period be used as the basis of the projected contours."

It is important for a major international airport to plan for a period significantly longer than 10 years. At Auckland International Airport the original 1995 contours were based on a projection for the year 2030 (35 years ahead at the time). At Wellington International Airport the projections were based on the ultimate runway capacity. At Christchurch Airport they are based on ultimate runway capacity.

Clause 1.1.5(c) of the Standard recommends consideration of the noise from individual maximum noise events for night-time operations, and this is normally achieved by plotting the arrival and departure SEL 95 contours from the noisiest and most frequent night-time aircraft. If the SEL 95 contour extends beyond the 65 dB L_{dn} contour then a composite of both contours forms the Airnoise Boundary. For Christchurch Airport the Airnoise Boundary used for land use planning is a composite of the 65 dB Ldn contour and the single event 95 dB SEL contour from an individual aircraft event.

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

Planning rules

The efficient use and development of Christchurch International Airport (CIA / the Airport) as a significant regional infrastructure resource is provided for in the Canterbury Regional Policy Statement (CRPS), in both Chapter 5 (Land use and Infrastructure) and Chapter 6 (Recovery and Rebuilding of Greater Christchurch).

The Airport is defined as "Regionally Significant Infrastructure" in the CRPS and is recognised across a number of policies and objectives. Policy 6.3.5 relevantly:

- provides for the continued safe, efficient and effective use of regionally significant infrastructure;
- provides for the provision for efficient and effectively functioning infrastructure;
- seeks to ensure that land use activities and new development are managed including avoiding activities that have the potential to limit the efficient and effective, "provision, operation, maintenance or upgrade of strategic infrastructure and freight hubs";
- expressly states that this includes "avoiding noise sensitive activities within the 50 dBA L_{dn} airport noise contour for Christchurch International Airport."

Policy 6.3.9(5) requires that the location and design of rural residential development avoid noise sensitive activities occurring within the 50 dB L_{dn} Air Noise Contour.

The Canterbury Regional Council and territorial authorities (Christchurch, Selwyn and Waimakariri District Councils) must give effect to the CRPS through their regional and district plans. This includes those provisions which direct the protection of strategic / regionally significant infrastructure.

The 50 dB L_{dn} Air Noise Contour has consistently been used as a basis for land use planning throughout Greater Christchurch. For example, in rural zones, noise sensitive land uses (including residential activities) are typically non-complying to give effect to Policy 6.3.9(5) of the CRPS. Sound insulation is also required for noise sensitive activities within 55 dB L_{dn}, which is reflected in relevant rules across all three district plans.

APPENDIX B GLOSSARY OF TERMINOLOGY

Name	Description
AANC	Annual Aircraft Noise Contour. Prepared annually to determine compliance with the Air Noise Boundaries.
AEDT	Aviation Environmental Design Tool. A proprietary noise model created by the FAA used to calculate noise contours around an airport (replacement of the INM).
Airways New Zealand	The sole Air Traffic Service provider in New Zealand.
Ambient Noise	The totally encompassing sound in a given situation at a given time, from all sources near and far including the specific sound.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
CIAL	Christchurch International Airport Limited
Cross-runway	Refers collectively to Runway 11 and Runway 29.
CRPS	Canterbury Regional Policy Statement.
Current Fleet	Refers to the fleet mix provided by Airbiz that currently exists.
Current Runway Configuration	Refers to the currently existing main and cross-runway. Doesn't include any proposed extensions.
Daytime	Assumed to be from 7 am to 10 pm.
dB	Decibel. The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 mPa i.e. dB = 20 x log(P/Pr)
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear.
DMAPS	Divergent Missed Approach Protection System. Departure tracks that turn at an angle soon after take-off, instead of flying straight and then turning when instructed by Air Traffic Control.
DMAPS Tracks	Refers to the flight tracks currently in use, with RNP procedures in place and DMAPS departures.
Existing Aircraft Noise Planning Environment	The permitted and anticipated future aircraft noise environment defined by airport noise contours on the district planning maps.
Existing Housing Stock	Existing houses located inside the airport noise contours.
Expert Panel Report	Prepared in 2008 and outlines the assumptions and methodologies used to prepare the Operative Plan Noise Contours

FAA	The Federal Aviation Administration in the United States. The developer of the INM and the AEDT noise models.
Future Fleet	Refers to the fleet mix provided by Airbiz in the future. Includes new generation aircraft.
Future Housing Stock	The capacity of potential houses inside the airport noise contours based on the maximum density and subdivision permitted under the operative district plans as of March 2022.
Future Runway Configuration	Refers to the envisaged future main and cross-runway. Includes proposed extensions to runway 11 and 20.
ILS Approach	Instrument Landing System Approach. A type of approach that uses a precision runway approach aid based on two radio beams that provide vertical and horizontal guidance.
INM	The FAA's Integrated Noise Model. A proprietary noise model used to calculate noise contours around an airport.
L_{Amax}	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}.
Main Runway	Refers collectively to Runway 02 and Runway 20.
MDA	Marshall Day Acoustics.
Night-time	Assumed to be from 10 pm to 7 am.
Noise	A sound that is unwanted by or distracting to the receiver.
Noise Model	A programme used to model aircraft noise to produce the noise contours. The INM and the AEDT are types of noise model.
NZS 6805:1992	New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"*
Operative Plan Noise Contours	The Noise Contours Currently in the Canterbury Regional Policy Statement and Christchurch, Selwyn and Waimakariri District Plans.
Outer Envelope	The outer extent of multiple overlaid noise contours. The Updated Noise Contours are the Outer Envelope of four runway bias scenario contours.
RNP	Performance-Based Navigation. Encompasses a shift from ground-based navigation aids emitting signals to aircraft receivers, to 'in-aircraft' systems that receive satellite signals from sources such as the Global Positioning System (GPS).

RNP Approach	Required Navigation Performance Approach. Is a type of RNP approach that allows an aircraft to fly a specific track between two 3-dimensionally defined points in space.
Receiving Environment	The environment affected by an external impact. In this case, the land within the airport noise contours.
Runway 02	Runway 02 is the main runway with aircraft landing and taking off in a northerly direction (heading 020 degrees magnetic)
Runway 11	Runway 11 is the cross-runway with aircraft landing and taking off in an easterly direction (heading 110 degrees magnetic)
Runway 20	Runway 20 is the main runway with aircraft landing and taking off in a southerly direction (heading 200 degrees magnetic)
Runway 29	Runway 29 is the cross-runway with aircraft landing and taking off in a westerly direction (heading 290 degrees magnetic)
Runway bias scenario	Four airport operating scenarios used for modelling the Outer Envelope Updated Noise Contours. Each runway bias scenario represents the highest historical 3-month usage for the runway vector (02, 20, 29 or 11).
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
Updated Noise Contours	The updated noise contours to replace the Operative Plan Noise Contours, modelled by CIAL's experts and to be peer reviewed by a panel of experts before confirmation.
Visual Approach	An approach when either part or all an instrument approach procedure is not completed, and the approach is executed with visual reference to the terrain.

APPENDIX C CALCULATED NOISE CONTOURS

A detailed explanation of the re-modelling process and outcomes is contained in the combined report by Airbiz, MDA, CIAL and Chapman Trip titled "*2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours*".

In summary, the inputs to the Updated Noise Contours differ from the Operative Noise Contours in a number of aspects. The Operative Contours were based on a different flight schedule, fleet mix, airspace management, runway configuration, runway usage and version of the noise model. These changes reflect progress in all these areas since 2008 when the Operative Contours were developed. Table C1 below summarises the main differences in inputs between the Operative and Updated Noise Contours.

C1 Differences in noise model inputs

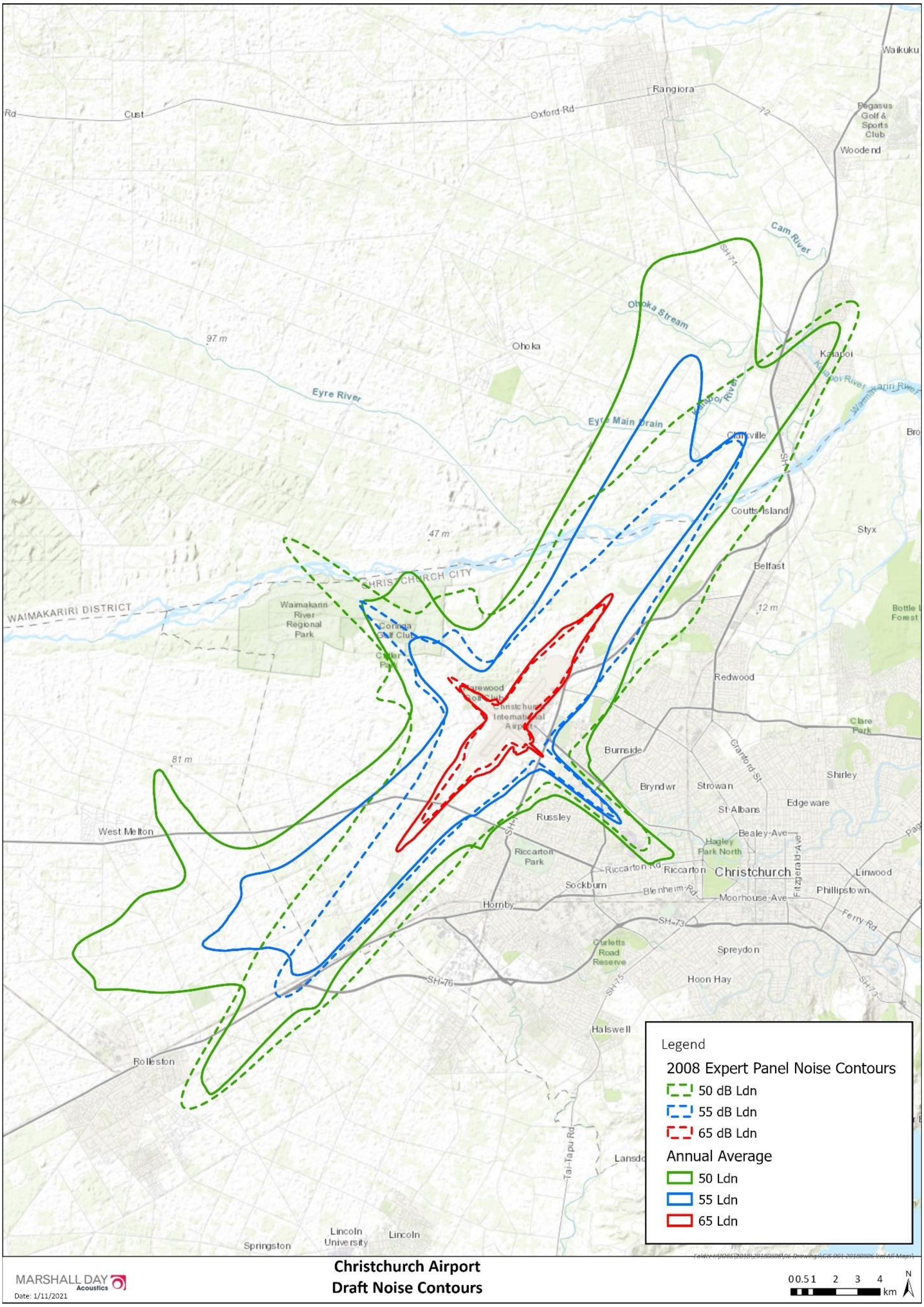
INM Inputs	Operative Plan Noise Contours	Updated Noise Contours
Movement Numbers	175k scheduled passenger 5 freight flights per week	200k scheduled passenger aircraft 11k freight aircraft 15k FBO/small commercial, airline/MRO) (Antarctic/military/govt excluded) 29k Helicopters/drones
Fleet mix	Older aircraft	Newer aircraft (A320 Neos etc) but more wide bodies
Runway Configuration	Current RWY 02/20 length. Extension on RW11/29	Runway extensions on 02/20 and 11/29
Flight Tracks	Conventional straight tracks	Updated airspace management including DMAPS for departures and RNP arrivals
Taxiing	Doesn't include	Does include
Runway Usage	Annual average with 3 month seasonal factor applied RW11/29	Annual average on all runways
Model version	INM v7.0	INM v7d & AEDT v3d

The resulting Updated Noise Contours are generally larger in most areas but smaller in some areas as shown in Figure C2. The Operative Noise Contours are shown as dashed lines and labelled "2008 Expert Panel Noise Contours".

The updated flight tracks result in a change to shape of the outer noise contours. The tracks used for the Operative Contours did not include RNP or DMAPS flight tracks and were predominantly straight (aligned with the runways) within the extent of the noise contours.

The Annual Average Updated Noise Contours do not include a 3 month seasonal factor for the cross-runway like the Operative Contours. The runway use factors applied in the model are detailed further in Appendix E.

C2 Operative and Updated Noise Contours



APPENDIX D DERIVATION OF POTENTIAL GROWTH IN RESIDENTIAL UNITS IN THE RECEIVING ENVIRONMENT

The analysis of the potential future growth of residential units within the airport noise contours was carried out jointly by CIAL, MDA and Chapman Tripp.

The Future Housing Stock was derived using parcel information from LINZ and the operative land use controls (as of March 2022) to estimate the development potential under the current planning framework.

The Operative District Plan land use controls from Selwyn, Waimakiriri and Christchurch City Councils were used to identify zones where residential activities could occur and at what density. Non-sensitive land uses such as industrial or commercial were excluded from our analysis.

The land area of each parcel was analysed to determine the development potential under the current planning rules taking into consideration the density controls applying to land within the 50 dB L_{dn} Airport Noise Contour. We have assumed that the same controls would continue to apply inside the Updated Noise Contours. No account was made for any change to density controls operative in March 2022.

The Future Housing Stock calculation **does not** account for how the following factors affect the potential number of residential units permitted on a given parcel:

- Shape of the parcel;
- Existing residential development on the land;
- Potential for combined development of adjoining parcels;
- Changes to the existing density controls and land use zones operative as of March 2022.

The calculation is simply based on parcel area and the permitted density.

In summary, we have used available GIS information to prepare an estimate of the Existing and Future Housing Stock. The data contains inherent uncertainties and therefore the housing stock numbers presented in the report are an estimate only.

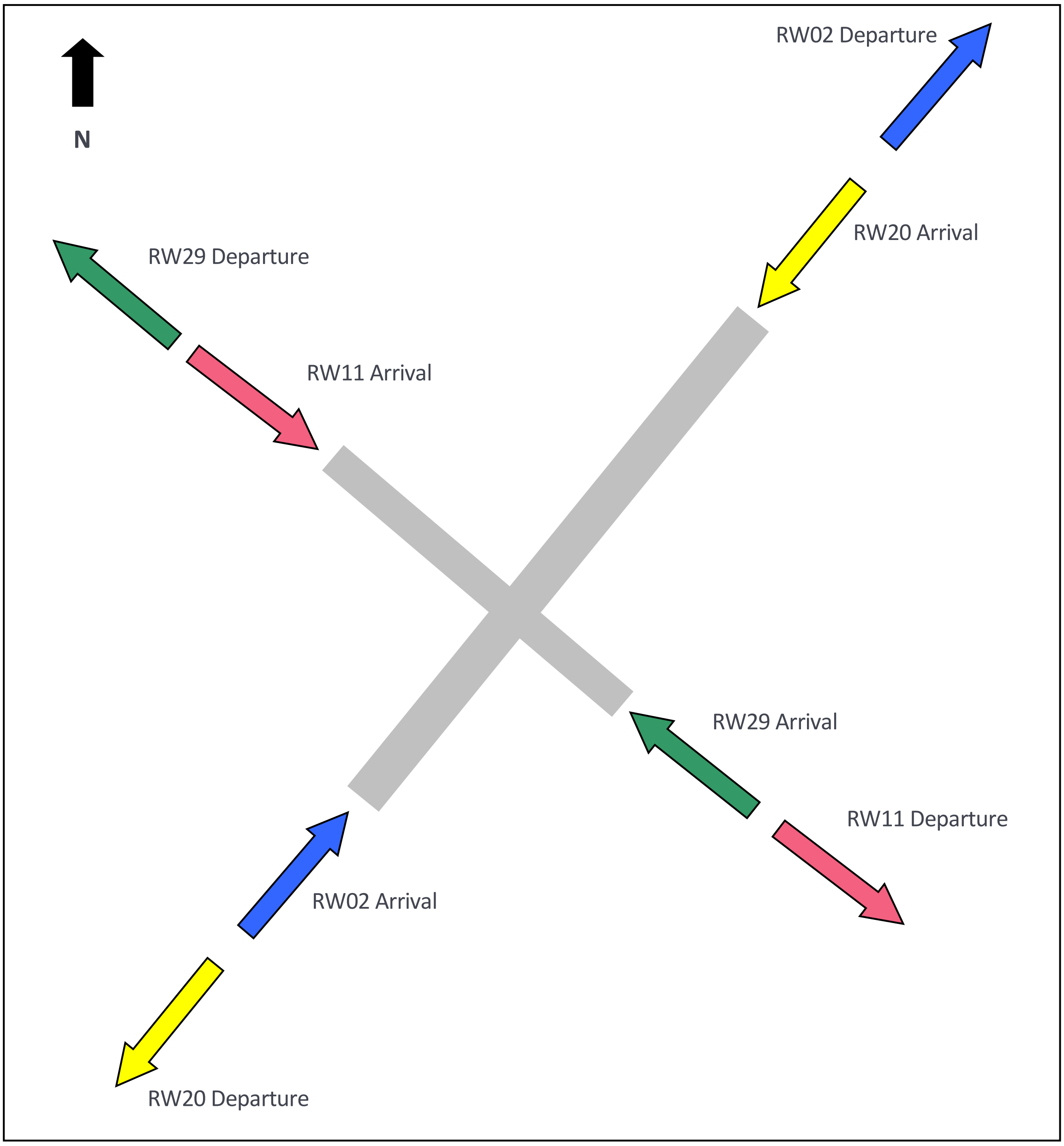
APPENDIX E RUNWAY USAGE

Runway 02 refers to operations using the main runway with a heading of 20 degrees from true north i.e. arrivals from the south west landing in a north easterly direction and departures towards the north east.

Runway 20 refers to operations using the main runway with a heading of 200 degrees from true north i.e. arrivals from the north-east landing in a south westerly direction and departures towards the south west.

Runway 11 refers to operations using the crosswind runway with a heading of 110 degrees from true north i.e. arrivals from the north-west landing in a south easterly direction and departures towards the south east.

Runway 29 refers to operations using the crosswind runway with a heading of 290 degrees from true north i.e. arrivals from the south-east landing in a north westerly direction and departures towards the north west.



Our aircraft noise contour modelling is based on an average day of aircraft movements which means we apply average runway usage percentages to assign aircraft movements to each runway. For Christchurch Airport the runway usage in any given three-month period will vary significantly due to seasonal wind conditions. For the Updated Noise Contours, we considered two options for modelling runway usage:

- The Outer Envelope future noise contour (composite of 3-month worst case runway usage for four wind directions)
- The Annual Average future noise contour (annual average runway usage)

Therefore, five different runway splits were initially used in developing the Updated Noise Contours. Four for the Outer Envelope and one for the Annual Average noise contour. This report presents the Annual Average option, and the associated runway splits are detailed below.

Annual Average

The Annual Average runway splits were determined by calculating the runway splits for each calendar year from 1999-2019 and then finding the average of these. These are shown in Table E1.

RW29/11 is factored up by 10% to account for potential climate change effects on increasing the prevalence of north-westerly wind patterns. This explains why the total is 101% rather than 100%.

The runway splits given in Table E1 below are the overall runway splits that are not broken down for different aircraft types or operations. The more detailed runway splits given in Tables E2 below, reflect the fact that departures have not been allocated to runway 11 and slightly different runway splits apply for wide bodied jets which cannot use the cross-runway at all.

E1 Annual Average Runway Splits

Runway 02	Runway 20	Runway 11	Runway 29	Total
58.5%	36.7%	0.3%	5%	101%

E2 Runway Splits– Detailed Annual Average

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	58.5%	36.7%	0.3%	5%	100.5%
Narrow bodied jet & Turboprop Departures	58.5%	36.7%	-	5.3%	100.5%
Wide bodied Jet Arrivals & Departures *(that can't use the cross-runway)*	61%	39%			