MARSHALL DAY Acoustics

NELSON AIRPORT - RUNWAY OPTIONS NOISE ASSESSMENT

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Project: **NELSON AIRPORT – Runway Options Noise Assessment**

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1.0 INTRODUCTION

Nelson Airport Limited (NAL) has engaged Marshall Day Acoustics (MDA) to calculate airport noise contours (referred to as airnoise boundaries in NAL's existing Designation DAA2) for two runway extension options to quantify and compare the noise effects. The runway extension options are:

1. Extend the existing runway towards the south
2. Extend the existing runway towards the north

This report describes the noise modelling work for the two runway options and provides a comparison of noise effects for each to inform an options analysis. We have applied a seven-point scale to score each runway option against three acoustic criteria we have selected to describe potential noise effects of the runway extension on the surrounding community. The assessment is based on a future operating scenario forecast for year 2050. This forecast does not include provision for regular scheduled jet services.

The acoustic criteria considered in our assessment are:

1. Community annoyance
2. Single event aircraft noise levels
3. Number of houses inside moderate and high L_{dn} aircraft noise contours

Our analysis has determined that the northern runway extension option would result in slightly greater adverse noise effects on parts of the community than the southern runway extension option. For both options many of the effects can be partially mitigated by acoustically insulating the affected dwellings. Mitigation will be considered in a separate report.

2.0 AIRPORT NOISE MANAGEMENT BACKGROUND

2.1 Nelson Airport Noise Management Framework

Nelson Airport is located in Nelson City and regulated through the Nelson Resource Management Plan (NRMP). The Airport operates under Designations DAA1, DAA2 and DAA3 in the NRMP. DAA2 relates to the Airnoise boundary and managing noise from aircraft operations whereas DAA1 and DAA3 relate to general aerodrome activities and height restrictions respectively. The NRMP provisions also include airport effects overlays and related land use controls and provisions for aircraft engine testing at the airport.

The aircraft operations noise management provisions in the operative NRMP are generally based on New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*" (NZS 6805) described further in Section 2.2.

NAL is seeking to revise the airport provisions in its designations and associated provisions in the NRMP including updating the aircraft noise boundaries. The revised provisions will allow for a future runway extension and this report informs the options analysis to determine the preferred runway extension option. We have calculated future noise contours for each runway extension option that are appropriate to replace the operative noise boundaries and compared the noise effects of each. We will make recommendations on revising the noise management framework separately. For background, the operative airport noise provisions are summarised in Section 2.3.

2.2 New Zealand Standard NZS 6805:1992

NZS 6805 provides guidance to territorial authorities on implementing appropriate land use controls and noise rules to control the level of noise generated by the airport, in order to manage these effects.

The objective of this Standard is to develop a set of noise boundaries around an airport which are designed to protect the surrounding residents by setting a maximum noise limit for the airport and to

protect the airport from reverse sensitivity effects. This is achieved by restricting development of new noise-sensitive activities which also helps to avoid additional people being exposed to the adverse effects of noise.

The Standard uses the noise measurement parameter L_{dn} (the Day/Night Level) which sums the 'noise energy' from each aircraft event with a 10 dB penalty for events that occur at night (10pm to 7am). NZS 6805 recommends that noise boundaries be developed to achieve its objectives using L_{dn} noise contours. This involves fixing an Outer Control Boundary (OCB) based on 55 dB L_{dn} and a smaller, much closer Airnoise Boundary (ANB) based on 65 dB L_{dn}. These boundaries represent noise limits which the airport must not exceed, as well as guidelines for land use planning.

The Standard recommends the location of the noise boundaries is established by calculating noise contours for a future operating scenario at the airport. The future operating scenario allows for the expected growth of the airport and NZS 6805 recommends a minimum 10 year projection period. The Nelson Airport Master plan 2050 sets out a 30-year strategic plan for the operational and functional requirements associated with Nelson Airport. On that basis, the 2050-year growth projection prepared by Airbiz has been used within this assessment to develop the aircraft noise contours.

NZS 6805 recommends that inside the 65 dB L_{dn} contour, new noise sensitive activities such as residential should be prohibited. Between 55 dB and 65 dB L_{dn} new noise sensitive activities should also be prohibited "*unless a district plan permits such uses, subject to a requirement to incorporate appropriate acoustic insulation to ensure a satisfactory internal noise environment".*

The standard also comments on existing noise sensitive uses inside the contours. Between 65 and 70 dB L_{dn} "*steps shall be taken to provide existing residential properties with appropriate acoustic insulation to ensure a satisfactory internal noise environment*". For levels of 70 dB L_{dn} or greater, consideration should be given to purchasing existing dwellings and rezoning the area to non-residential use.

NZS 6805 has been adopted at the major airports in New Zealand and at almost all of the smaller (regional) airports. The implementation of NZS 6805 at each airport has been varied to suit the local conditions but the overriding theme of land use controls and noise controls, as contained in the Standard, remains in each case.

2.3 Overview of Designation DAA2

The full text from Designation DAA2 (Designation) is included in Appendix B. The Designation requires that noise from aircraft operations measured as a rolling three month average does not exceed a limit of 65 dB L_{dn} outside the Airnoise boundary defined on NRMP Map A4.1 (refer Appendix C). In addition, a night-time restriction applies that limits single event noise levels to 95 dB L_{AE} at residential sites outside the Airnoise boundary between 12am and 6am. Exemptions apply to both the L_{dn} and L_{AE} limits for the likes of emergency and medical flights. Other than these exclusions, there is no definition of what aircraft operations or activities are included for the purpose of this rule.

Based on standard industry practice, our interpretation is that the noise boundaries apply to noise from aircraft operations which include fixed wing and rotary aircraft taking off, landing and taxiing before and after a take-off or landing.

Separate noise controls in the NRMP apply to noise from engine testing and airport activities other than aircraft operations (such as noise emitted from land use activities being undertaken within the Airport).

The Designation also sets out requirements for an Airport Noise Monitoring Plan to define monitoring and reporting procedures to demonstrate compliance with the noise limits. There is also a requirement for an independent airnoise compliance audit to be carried out every five years.

The Airnoise boundary encompasses some private properties to the south of the Airport on the Monaco Peninsula and a large area of the adjacent golf course to the north. The Designation extent of DAA2 includes all land within the Airnoise boundary including these private properties. Appendix C includes Map A4.1 from the NRMP which shows the extent of DAA2, the Airnoise boundary and the Airport Effects Overlays (described in further detail below).

2.3.1 Overview of Nelson Resource Management Plan Provisions

The Airport property is zoned Industrial in the NRMP. Chapter 10 of the NRMP includes noise controls that are specific to airport activities as well as general industrial activities as follows. These rules are included in Appendix C.

- Rule Inr.39 sets controls on aircraft operations that reflect the DAA2 controls
- Rule Inr.25 controls noise from aircraft engine testing
- Rule Inr.37 controls noise from general industrial activities including airport activities other than aircraft noise and engine testing

Map A4.1 of the NRMP shows the Airnoise boundary and two other Airport Effects Overlays that are based on future aircraft noise contours. These overlays define the areas within which land use controls apply to manage the effects of aircraft noise on noise sensitive activities and the potential reverse sensitivity effects on the Airport. Table 1 summarises the three overlays. Rules Rer.65, Inr.71 and SCr.69 in the NRMP set out acoustic insulation requirements for new noise sensitive activities within the Airport Effects Overlays.

Table 1: Summary of airport effects overlays in Map A4.1

Overlay	Associated Noise Level	Purpose
Airport Effects Advisory Overlay	55 -60 dB L_{dn}	For information purposes only. No controls apply.
Airport Effects Control Overlay	60 – 65dB L_{dn}	Land use restrictions apply in the zone rules for noise sensitive activities
Airnoise Boundary	65 + dB L_{dn}	Land use restriction apply in Designation DAA2 Aircraft noise required to comply with 65 dB L_{dn}

2.3.2 Land Use Controls Inside the Airport Effects Overlays

The Residential, Industrial and Suburban Commercial zone rules in the operative NRMP set out controls on noise sensitive development within the Airport Effects Control Overlay (60 – 65 dB L_{dn}). New dwellings and additions to existing dwellings are permitted subject to acoustic insulation requirements. Appendix 19 of the NRMP includes approved methods to achieve the acoustic insulation requirements. The Residential zone also sets a minimum lot size of 600 m^2 per residential unit inside the Airport Effects Control Overlay.

Inside the Airport Effects Advisory overlay (55 – 60 dB L_{dn}), no controls apply. This overlay is for information purposes to advise landowners that the area will be subject to the effects of aircraft noise.

The zone rules do not include development controls inside the Airnoise boundary. The Airnoise boundary defines the area of Designation DAA2 and includes restrictions and prohibitions for

activities within the 65 dB L_{dn} Airnoise boundary. Condition DAA2.4 prohibits new noise sensitive activities and requires that additions to existing residential units must be acoustically insulated.

3.0 ASSESSED RUNWAY EXTENSION OPTIONS

We understand that NAL's objectives for altering its existing designations are to:

- Extend the operational runway length in order to ensure that over the next 30 years the aeronautical capacity of the airport and runway system can safely and efficiently:
    - Provide increased operational resilience and flexibility;
    - Enable forecast demand and accommodate future aircraft types.
- Enable an efficient, flexible and sustainable approach to developing Airport infrastructure, facilities and services.
- Minimise the effects of aircraft noise impacts on the surrounding community as far as it is practicable whilst also minimising adverse environmental and cultural effects.

In light of these objectives, we have been asked to calculate future noise contours for two runway extension options and compare the noise effects. The two extended runway options that result in a 1510 m long runway are described further below.

3.1 Southern Extension (1510 m)

This option involves extending the runway by 163 m at the southern end as shown in Figure 1 and adding a 240 m Runway End Safety Area (RESA). The northern end would be unchanged except for the provision of a 240 m RESA.

We have modelled this configuration assuming the existing taxiway is unchanged other than a re-alignment to ensure it is parallel to the runway (so that the 'kink' in the middle of the taxiway by the terminal is removed).

Figure 1: Southern runway extension

3.2 Northern Extension (1510 m)

This option involves extending the runway northwards into the golf course as shown in Figure 2. In this configuration, the Runway 20 threshold moves northwards approximately 370 m and the Runway 02 threshold at the southern end also moves northwards approximately 207 m. A 240 m RESA is provided at each end to comply with Civil Aviation regulations.

We have modelled this configuration assuming the existing taxiway is unchanged other than to ensure it is realigned so that it runs parallel to the runway (straighten the 'kink' by the terminal). Aircraft would use the runway for taxiing as required. The Runway 02 start of roll position does not shift north but remains in the current location as this is where the taxiway joins the runway.

Figure 2: Northern runway extension

4.0 FUTURE AIRCRAFT OPERATIONS NOISE MODELLING

We have calculated future aircraft noise contours based on the two extended runway configurations and aircraft movement forecast for the 2050 financial year (FY50) prepared by Airbiz. The inputs to the noise contour model are summarised in the following sections.

4.1 Noise Modelling Software

Several computer based models have been developed to predict the level of aircraft noise on areas surrounding an airport. The model which until recently was the most widely used (and referenced in NZS 6805) is the Integrated Noise Model (INM). The INM was developed by the United States Federal Aviation Authority (FAA) and is a computer model designed to predict aircraft noise exposure in areas surrounding an airport.

The INM has been replaced by the Aviation Environmental Design Tool (AEDT) which is also produced by the US Federal Aviation Administration (FAA). The AEDT is now the required airport noise modelling tool in the USA and Australia. The INM is no longer supported and will not receive updates of new aircraft types and profiles in the future.

In New Zealand there is no national statutory requirements for noise modelling- and for Nelson, the NRMP does not define the software to be used. The noise modelling presented in this report has been calculated over the last few years predominantly using the INM as MDA has only recently switched to using AEDT as our primary airport modelling tool. We note that to date, the vast majority, if not all, airport noise boundaries contained in District Plans have been prepared using INM.

Our review of the AEDT shows that predicted noise levels are almost identical to the INM for the same operational scenarios. For the purpose of the comparative options analysis in this report, we consider the aircraft noise contours calculated using the latest INM version (INM 7d) are adequate and appropriate for comparison purposes at this time. We propose to update the calculated noise contours for the preferred runway option using the AEDT software.

4.2 Aircraft Movement Forecast

NAL has commissioned Tourism Futures International (TFI) to prepare passenger and aircraft movement forecasts through until the 2040 financial year (FY40). Two scenarios were forecast, one where the passenger fleet includes only turbo-prop aircraft out to 2040 and one where passenger jet aircraft are introduced in approximately 2030 to 2036. Airbiz has subsequently extended these forecasts out to year 2050 (FY50).

NAL considered whether to allow for narrow body jet passenger services but has decided to proceed on the basis that demand could also be met through the turbo-prop only forecast for FY50. Given this, jets have not been modelled as part of the fleet mix for the noise contours. The annual movement numbers by aircraft type for this forecast are listed in Table 2.

Table 2: FY50 forecast aircraft movements (annual total)

Aircraft Group	Aircraft Type	Annual Movements
Scheduled	ATR	33,442
	Saab-340	942
	Other Scheduled	4,088
Non-Scheduled	Turbo Prop	564
	Jet (private/business)	120
	GA - Piston Single Engine	6,540
	GA - Piston Twin Engine	1,289
	GA – Turbo Prop	1,532
	Helicopter – Piston	628
	Helicopter - Turbo	2,269
Total		51,414

4.3 Calculated FY50 Noise Contours for Runway Extension Options

We have calculated noise contours for the two extended runway configurations using the FY50 aircraft movement forecast in Table 2. The model includes the following assumptions:

- Straight flight tracks
- Average runway usage splits of 45% runway 02 and 55% runway 20
- Scheduled aircraft taxiing included
- Scheduled aircraft engine idling on apron and taxiways included
- Helicopter movements included

- An appropriate aircraft substitute has been selected in the noise model for ATR departures to better match noise measurements made at Nelson Airport. The substitute aircraft type is the Cessna 208 which is a smaller aircraft than the ATR but has a larger noise footprint in the model.

The modelled noise contours for the FY50 scenarios are included in the figures in Appendix D.

Figure 3 below compares the 65 dB L_{dn} contours for both options and the current Airnoise boundary.

Figure 3 shows that the northern extension option extends the 65 dB L_{dn} contour over more existing houses towards the north in comparison to the Operative NRMP and the southern option. The southern extension option covers more existing houses towards the south than the northern option but represents a reduction in the number of dwellings affected compared to the operative NRMP 65 dB L_{dn} contour. In the following sections of the report, we have applied acoustic evaluation measures to compare the noise effects of each option on the community. The results are summarised in Section 7.0.

Figure 3: Noise contours for southern and northern runway extension options

5.0 NOISE EFFECTS EVAUATION - METHODOLOGY

The purpose of this assessment is to evaluate the runway options against acoustic criteria and score each option using a seven-point scale. The first step is to formulate evaluation criteria necessary to understand the noise effects of each of the runway options. Then each of the options is assessed and scored against these criteria. A seven-point scale described below has been applied to score each option against each criterion.

Table 3: Seven-point evaluation scale

3.0	Significant Positive Effect
2.0	Moderate Positive Effect
1.0	Minor Positive Effect
0	Neutral or less than minor positive or adverse effect
-1.0	Minor adverse effect
-2.0	Moderate Adverse Effect
-3.0	Significant Adverse Effect

6.0 NOISE EFFECTS EVALUATION - ACOUSTIC CRITERIA

We have assessed the noise effects of the FY50 forecast on each of the runway options using the following measures:

- **Annoyance** – Number of people highly annoyed
- **Single Event Levels** – Number of houses affected by a noticeable to significant increase in single event noise and number of houses exposed to single event levels of 95 dB L_{AE} or greater
- **Number of houses** inside 55, 60 and 65 dB L_{dn} contours

For each of the criteria we have used a GIS layer of dwellings within the airport noise contours which we compiled using a combination of building footprint and street address data, satellite imagery and zoning maps. This layer is an approximation only. By applying a size threshold criterion to the building footprint data, and excluding buildings that are too small to be dwellings, a reasonable effort has been made to exclude utility buildings from the data. Industrial and Commercial buildings are excluded by their zoning. However, there is still a degree of uncertainty in the dwelling counts data presented. Notwithstanding this, such an analysis is considered appropriate in the context of this assessment.

Each of the acoustic evaluation criteria are described further in the following sections.

6.1 Annoyance

The noise associated with airports has historically caused annoyance in surrounding communities. Overseas research has endeavoured to analyse and develop noise metrics to help understand the complex relationship between community response and aircraft noise. Aircraft noise is different to a number of other environmental noise sources as it consists of a series of short duration intermittent noise events at moderately high noise levels (depending on proximity) with periods without noise in between.

Annoyance due to aircraft noise is influenced by many factors including, but not limited, to:

- How loud the noise is;
- How long the noise lasts for;
- How many times the noise occurs in a day/month/year;
- The time of the noise event (i.e. daytime vs. night-time);
- The frequency (or pitch) of the noise;
- Whether there is a change to the noise source;
- The receiver's attitude to the noise source.

No single noise metric can account for all of the factors that influence annoyance. Many studies have been carried out to determine the general relationship between aircraft noise levels and community annoyance. Most of these studies examine the relationship between annoyance and the Day/Night Level (L_{dn}) or Day/Evening/Night Level (L_{den}), as these metrics are shown to correlate best with annoyance.

The results of these studies are 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 4 below).

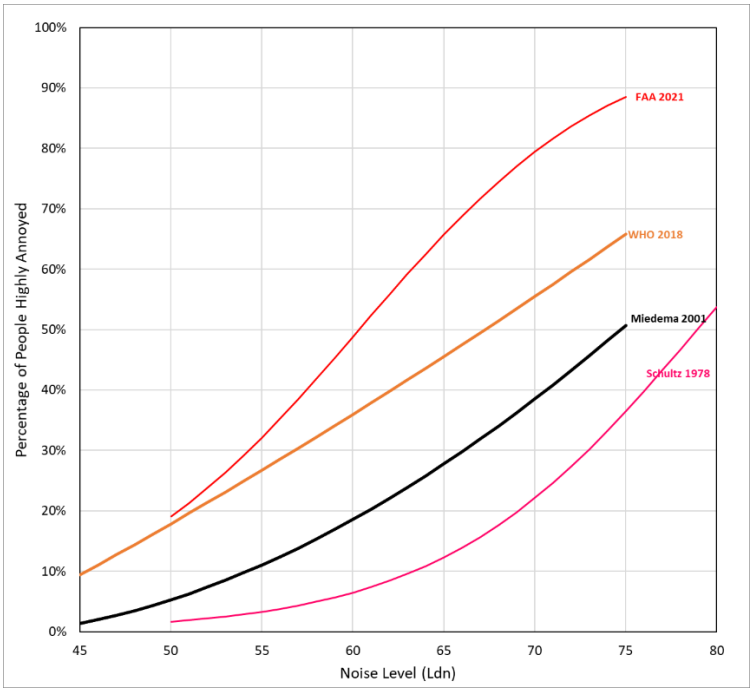
An early study carried out by Schultz in 1978 included various forms of transportation noise. In 2001 a comprehensive amalgamation of various transportation and noise studies was carried out by Miedema and Oudshoorn[1]. This study produced a dose-response curve that has been used widely for many years (Figure 4). More recently the research has been updated with two significant studies, one referenced by the World Health Organisation (WHO)[2] in 2018 which included 12 airports from around the world and one by the US Federal Aviation Administration (FAA)[3] in 2021 which included 20 airports in the USA.

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

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

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

Figure 4: Community response to aircraft noise



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.

To quantify and compare the effects of the two runway extension options, we have calculated the number of people predicted to be highly annoyed using the 2018 WHO curve for both the northern and southern runway extension options using the FY50 forecast noise contours.

To determine these numbers, the 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}). Applying a general occupancy rate of 2.5 people per household, 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 extent of the 50 dB L_{dn} contour.

6.2 Single Event Noise Levels

The L_{dn} metric used in the annoyance assessment considers the overall longer-term effects of aircraft noise experienced over several months. Residents also experience short duration effects of each aircraft noise event individually. When there is a change in aircraft activity, such as new aircraft types or a runway extension, residents may notice a change in single event noise levels.

For this options assessment we have used the sound exposure level (L_{AE} or SEL) metric to quantify noise from individual aircraft events. L_{AE} is the noise level of one second duration that has the same total sound energy as the aircraft noise event. L_{AE} takes into account the level and duration of an event and differs from the L_{Amax} metric which is the maximum noise level occurring during the aircraft noise event.

For each of the runway options we have calculated the L_{AE} at surrounding houses for arrivals and departures of the largest frequent passenger aircraft at the Nelson, the ATR. We have then calculated the change in L_{AE} compared with the same operations on the current runway. We have disregarded increases or decreases in L_{AE} of 1 to 4 dB as these are not appreciable changes. Instead, we have quantified the number of houses predicted to experience a noticeable to significant increase

in single event noise for each runway option (≥ 5 dB L_{AE}). We have characterised the subjective impact of a noise level increase in decibel bands as follows:

- 5 – 8 dB is an appreciable increase
- 9 – 12 dB is a significant increase subjectively twice as loud
- > 12 dB is a substantial increase subjectively more than twice as loud

The sample area analysed is the extent of the 80 dB L_{AE} contour for each future runway configuration.

In addition to quantifying the change in single event noise, we have considered the number of houses affected by particularly loud events of 95 dB L_{AE} or greater. At Nelson Airport there is a night-time restriction on single event noise from individual aircraft operations to manage sleep disturbance effects in the community. The restriction applies between midnight and 6 am and prohibits aircraft that are louder than 95 dB L_{AE} outside the Airnoise boundary from operating during this time. As this criterion is currently in Nelson Airport's noise management framework, we have adopted it for the runway options assessment to define 'noisy events'. It provides helpful context to the change in single event level analysis. For example, a significant increase in L_{AE} would be tempered if the level itself is reasonably moderate (i.e. < 95 dB L_{AE}).

6.3 Number of Houses Inside Moderate to High L_{dn} Noise Contours

In addition to assessing annoyance and change in single event noise, we have quantified the number of houses (using the same GIS layer as described above) inside the 55, 60 and 65 dB L_{dn} contours bands to compare the runway options.

NZS 6805 identifies areas inside the 55 dB L_{dn} contour as moderately adversely affected by aircraft noise and where new residential activity should be avoided or acoustically insulated. Areas inside the 65 dB L_{dn} contour are significantly affected and NZS 6805 recommends new residential activity is prohibited and existing dwellings are acoustically insulated.

As discussed above, the NRMP defines an Airport Effects Advisory Overlay (AEAO) at 55 dB L_{dn} and an Airport Effects Control Overlay (AECO) at 60 dB L_{dn} where new residential activity is required to be acoustically insulated. New residential activity is prohibited inside the 65 dB L_{dn} Airnoise boundary.

Since the NRMP defines airport noise overlays or boundaries at 55, 60 and 65 dB L_{dn} we have used these noise contour bands to compare the number of houses affected by the two runway options and the difference relative to the operative NRMP overlays.

7.0 NOISE EFFECTS EVALUATION - RESULTS

7.1 Annoyance

Figure 5 and Table 4 below summarise the calculated annoyance effects based on the FY50 forecast for the two runway extension options using the WHO 2018 dose response relationship.

Figure 5: Number of people highly annoyed based on WHO 2018 dose response relationship

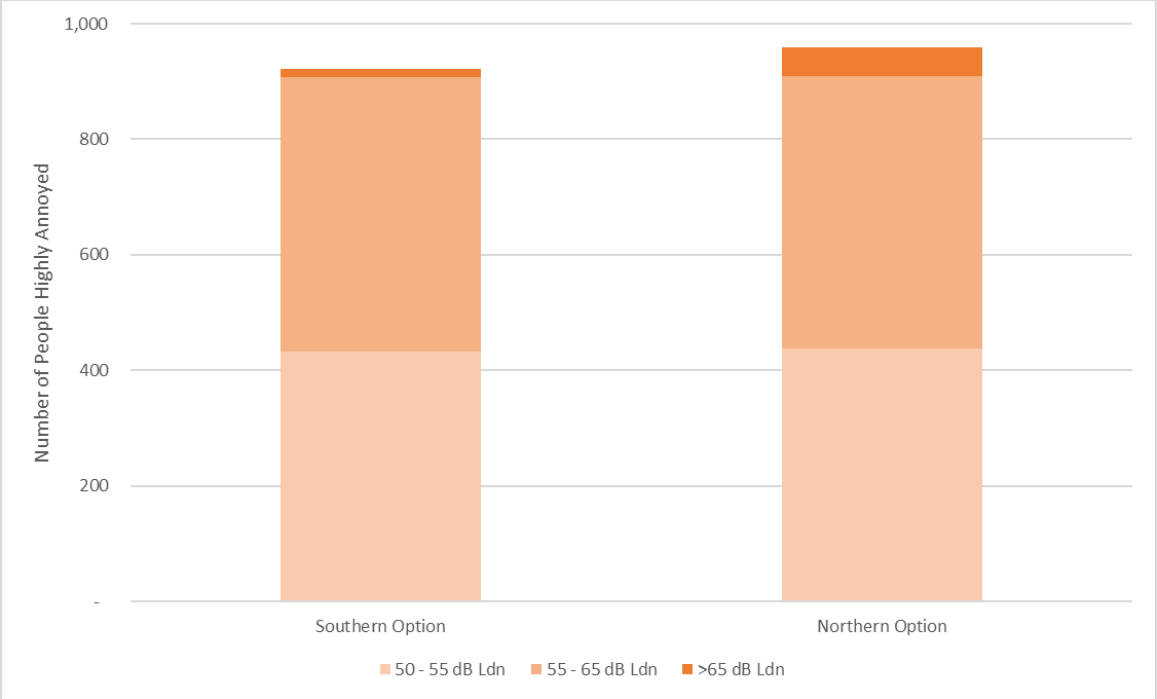


Table 4: Number of people highly annoyed based on WHO 2018 dose response relationship

	Number of People Highly Annoyed	
Noise Level (dB L_{dn})	**FY50 South Extension**	**FY50 North Extension**
50 – 55	432	439
55–65	476	471
> 65	13	50
Total	**921**	**960**

Both of the runway extension options result in a large number of people predicted to be highly annoyed by aircraft noise with slightly more affected by the northern extension option, particularly in the >65 (dB L_{dn}) range. The effects can be partially mitigated by acoustically insulating dwellings, however the impact on outdoor living cannot be mitigated. Based on the operative NRMP, the total number of people highly annoyed would be greater than either of the runway extension options. Therefore, both options result in an overall decrease in annoyance compared with the current noise boundaries.

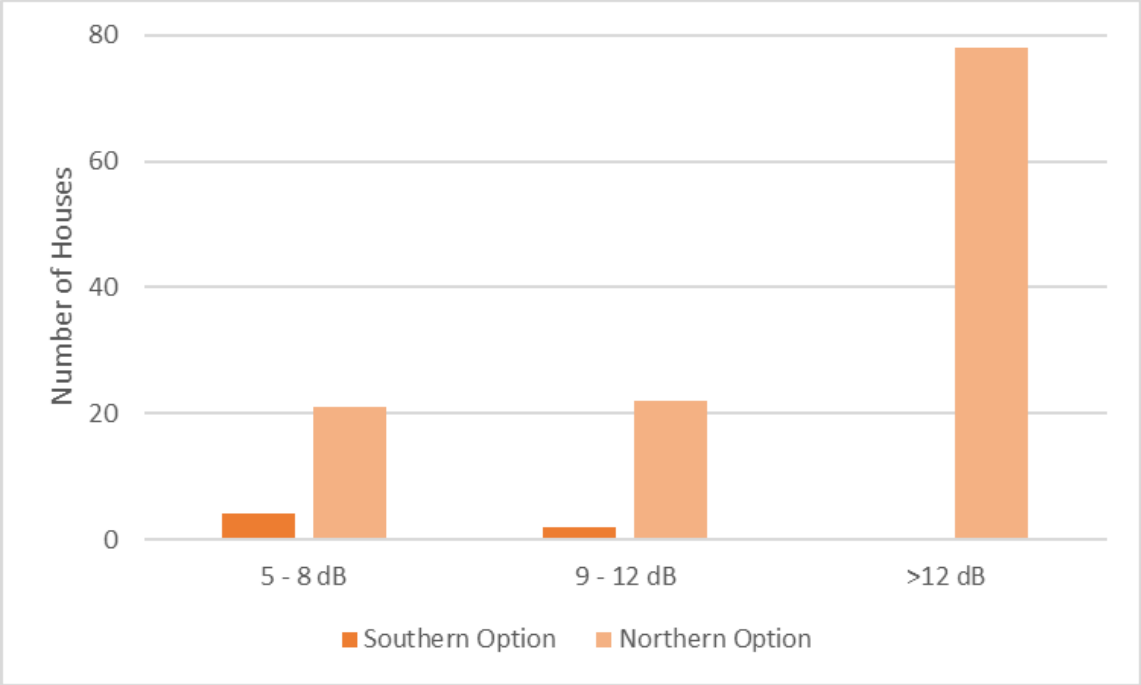
Using the 7-point scale we score both options as a moderate adverse effect (-2).

7.2 Single Event Levels

Our analysis shows that the change in single event noise for arrivals is predicted to be ≤ 2 dB L_{AE} for both runway options. Therefore, both runway extension options result in a less than minor increase in arrival noise (a score of 0 on the seven-point scale).

For departures, Figure 6 shows the number of houses impacted by an appreciable, significant or substantial increase in single event noise for each runway extension option.

Figure 6: Increase in single event noise for ATR departures



The southern extension option results in a small number of houses experiencing an appreciable or significant increase in single event level for departures due to the southern runway end moving closer to existing houses. We score the southern option as a moderate adverse impact (-2) for the increase in L_{AE} criterion.

The northern extension option results in more houses experiencing a significant or substantial increase in single event level for departures due to the northern runway end moving closer to existing houses. We score the northern option as a significant adverse impact (-3) for this criterion.

Table 5 summarises the number of houses impacted by 'noisy aircraft events' for each runway option (defined by $L_{AE} \geq 95$ dB). This provides context to the increase in noise levels shown in Figure 6 as we see that although a significant increase in L_{AE} is predicted for departures, these events do not exceed 95 dB L_{AE}.

For arrivals, both runway options show an appreciable number of houses experiencing 'noisy events' which is similar to the current situation. The northern option affects slightly more houses, but the difference is not significant. We score both options as a moderate adverse impact (-2) for the ≥ 95 dB L_{AE} criterion.

Table 5: Number of houses impacted by 'noisy events'

Criterion	Southern Option # Houses Impacted	Northern Option # Houses Impacted
$L_{AE} \geq 95$ dB for departures	0	0
$L_{AE} \geq 95$ dB for arrivals	55	64

7.3 Number of Houses Inside Moderate to High L_{dn} Noise Contours

Figure 7 compares the numbers of houses impacted by the moderate to high L_{dn} noise contour bands for the runway extension options.

Figure 7: Number of dwellings inside FY50 L_{dn} noise contours

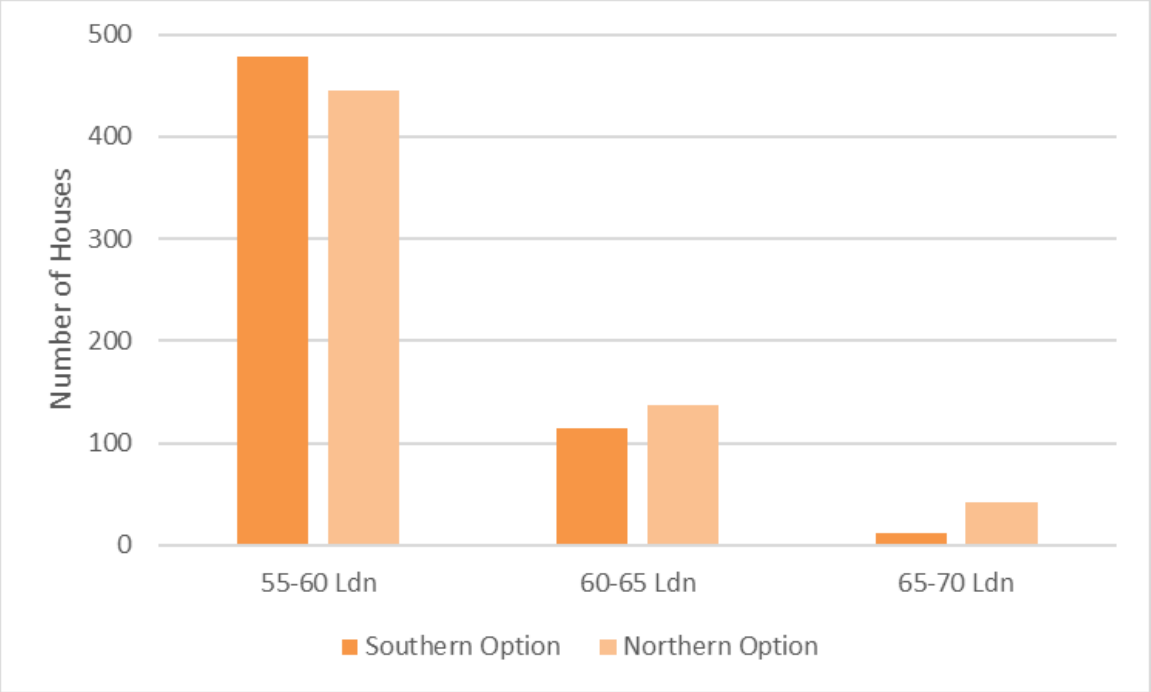


Table 6 summarises the number of houses in each of the noise contour bands for the Operative NRMP and the two runway extension options, as well as the change in number of dwellings affected compared to the Operative NRMP.

Table 6: Number of dwellings in the airport noise contours

	Number of Dwellings				
Noise Level (dB L_{dn})	**Operative NRMP**	**FY50 South Extension**	**Change**	**FY50 North Extension**	**Change**
55–59	705	479	-226	445	-260
60-64	300	115	-185	137	-163
65-69	16	11	-5	42	+26
Total	**1021**	**605**	**-416**	**624**	**-397**

Overall, future aircraft noise around Nelson Airport is predicted to affect fewer houses compared with the operative NRMP boundaries due to a quieter modern aircraft fleet. The NRMP boundaries were calculated over 20 years ago using older aircraft types than those currently operating at Nelson. The current fleet, which is forecast to operate for some years yet, is generally quieter than the aircraft used in the NRMP boundaries. This quieter fleet has been used to calculate noise contours for both runway options in the options analysis.

For the southern extension option there would be fewer houses affected in all three noise contour bands. For the northern extension option there would be an increase in the number of houses inside the highest noise band (i.e. 26 more houses inside 65 dB L_{dn}) but fewer in the other bands.

There is only a marginal difference in the total number of houses affected by the southern and northern runway extension options, (605 houses compared with 624 houses) however the northern option has more houses in the > 65 dB L_{dn} band where aircraft noise effects are significant. The effects can be partially mitigated by acoustically insulating dwellings, however the impact on outdoor living cannot be mitigated.

For the 7-point scale, we score the southern extension option as a moderate adverse effect (-2) and the northern extension option as a significant adverse effect (-3) due to the greater number of houses inside 65 dB L_{dn}. We have not assessed the reduction in affected houses compared with the operative NRMP as a positive effect as this is not a result of the runway extension, rather it is a result of a more modern quieter aircraft fleet compared to that used for the NRMP airport noise overlays and Airnoise boundary.

7.4 Seven-Point Evaluation Summary

Table 7 summarises our scores for each of the acoustic criteria based on the seven-point scale in Table 3. From these, an aggregate score for each runway extension option has been calculated. The southern extension option results in a moderate adverse noise impact and the northern extension option results in a moderate to significant adverse noise impact. As noted in the table, many of the effects can be partially mitigated which will be considered in a separate report.

Table 7: Summary of runway options acoustic evaluation using 7-point scale

Criterion	Southern Option	Northern Option	Comment
Annoyance	-2	-2	Both options result a similar number of people being highly annoyed
Increase in single event noise (L_{AE})	-2	-3	Both options result in increased departure noise, however, the northern runway extension results in a larger number of people experiencing a significant increase in noise level.
Houses with $L_{AE} \geq 95$ dB	-2	-2	Both options experience an appreciable number of houses experience 'noisy events'
Houses inside contours (55, 60, 65 dB L_{dn})	-2	-3	Both options have a similar number of houses affected by the runway extension, but for the northern option, there are more houses at higher noise levels.
Aggregate Score	-2	-2.5	

8.0 CONCLUSION

We have quantified and compared the noise effects of two runway extension options for Nelson Airport (without mitigation). Our assessment was based on an FY50 forecast of aircraft operations activity. We considered three acoustic evaluation criteria: annoyance, single event noise and number of houses inside L_{dn} aircraft noise contours. Applying a seven-point scale we have evaluated the

significance of the positive or negative noise effects for each acoustic criterion and aggregated the score for each runway option.

Based on the seven-point scale we developed, the outcome of our assessment was:

- The southern runway extension option scored -2 which is a moderate adverse effect.
- The northern runway extension option scored -2.5 which is partway between a moderate and significant adverse effect.

Overall, we have determined that the northern runway extension option would have slightly more adverse effects, and that from a noise perspective the southern extension is preferable.

There are range of measures which can be employed to mitigate the effects of aircraft noise and these will be considered in a separate report.

APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
SPL or L_P	Sound Pressure Level A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 μPa RMS) and expressed in decibels.
SWL or L_W	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
dB	Decibel The unit 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)
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{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}.
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 6803:1999	New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction 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 DESIGNATION DAA2 TEXT

DAA2 designation DAA2

DAA2.i Airnoise boundary controls

DAA2.1 designating authority

DAA2.1.i Nelson Airport Ltd

DAA2.2 reason for designation

DAA2.2.i An airnoise boundary has been defined around Nelson Airport to protect the operational capability of the airport, while at the same time minimising adverse environmental effects from aircraft noise on the community.

DAA2.2.ii The purpose of the airnoise boundary is to identify the area of aerodrome operations where noise sensitive activities are prohibited.

DAA2.3 nature of the works

DAA2.3.i Noise from aircraft operations at Nelson Airport will be managed so that the rolling three month average 24 hour night-weighted sound exposure does not exceed 65 Ldn (109 Pasques) at or outside the airnoise boundary. This approach is in accordance with NZS 6805:1992 Airport Noise Management and Land Use Planning, which will apply to airport operations.

DAA2.3.ii Ldn is the primary measurement adopted to conform with the methods of sound measurement to be adopted for an indicative monitoring system to ensure ongoing compliance. The equivalent Pasques measurements are also cited for transparency and ease of alternative calculation. Monitoring and reporting shall be in accordance with an Airport Noise Monitoring Plan.

DAA2.3.iii Airport Noise Monitoring Plan means a plan developed by the Airport Authority in consultation with the Nelson Airport Noise Environment Advisory Committee for the measurement of aircraft noise levels for the purposes of assessing compliance with noise limits. The plan shall be lodged with the Council, and shall be reviewed and updated as necessary. Principally, the plan shall contain information on:

a) Noise measurement procedures and Standards
b) Procedures for calculating and assessing compliance for rules DAA2.3.i and DAA2.6.ii
c) Reporting of compliance assessment to Nelson Airport Noise Environment Advisory Committee and Council
d) Timeframes for implementation and review of the monitoring plan

DAA2.3.iv Aircraft operations which involve:

a) aircraft landing in an emergency or the operation of emergency flights required to rescue persons from life threatening situations or to transport patients, human vital organs or medical personnel in a medical emergency
b) aircraft using the airport due to unforeseen circumstances as an essential alternative to landing at a scheduled airport
c) flights required to meet the needs of a national or civil defence emergency declared under the Civil Defence Act 1983
d) flights certified by the Minister of Defence as necessary for reasons of National Security in accordance with section 4 of the Act.

shall be excluded from the calculation of the three month average.

DAA2.4 restrictions

DAA2.4.i Any new activity, other than an airport related activity or golf course, shall not be permitted inside the Ldn 65 (109 Pasques) airnoise boundary.

DAA2.4.ii New or relocated residential, school, hospital and other noise sensitive activities are prohibited inside the Air Noise Boundary.

DAA2.4.iii No alterations or additions to existing residential unit shall be permitted inside the Air Noise Boundary without appropriate acoustic insulation to ensure a satisfactory internal noise environment. Such insulation shall be certified by a suitably qualified and experienced acoustic engineer.

DAA2.5 environmental effects/mitigation measures

DAA2.5.i The imposition of an airnoise boundary at Nelson Airport is intended to protect the operational capability of the aerodrome and to manage the noise environment to maintain and, where possible, enhance community health and welfare. The airnoise boundary is a mitigation measure to protect noise sensitive activities from the adverse effects of aircraft noise. A detailed Assessment of Environmental Effects (AEE) is incorporated in a separate document entitled Nelson Regional Airport Environmental Management Plan (October 1996) which evaluates all the resource management issues and assesses environmental effects for airport activities.

DAA2.5.ii An alternative to designation of the Airnoise boundary is its inclusion as part of an airport protection zone in the Planning Maps and incorporation of appropriate planning controls as part of this Plan. This procedure has been proposed as part of the District Plan process in other districts where the airport is in a rural locality or where the airport authority owns all the land inside the Airnoise Boundary. However, where there are existing residential properties inside the Ldn 65 (109 Pasques) contour, as in this case, it is considered that the designation procedures afford private property owners maximum protection in terms of buy out rights and compensation in relation to existing properties under the flight path at the western end of the runway. Furthermore, designation retains the area affected by airport operations in the control of the Airport Authority whose function is to manage airport operations in a safe and efficient manner. Alternative time frames for the designation were evaluated and a period up to and including Year 2020 is deemed reasonable in view of existing and projected growth figures, the long term unsuitability of residential use at Grace Street and the amount of existing zoned residential land which has been identified as being noise affected by the year 2020.

DAA2.6 night aircraft movements noise restrictions

DAA2.6.i Noise restrictions for night aircraft movements are to apply at Nelson airport. For the purposes of these restrictions "night movements" are defined as a flight to or from the airport occurring between the hours of 12:00 midnight and 6:00 am and not comprising aircraft operations permitted under DAA2.3.iv. All other flights shall be included in calculation of aircraft noise in accordance with DAA2.3.i.

DAA2.6.ii Aircraft taking off or landing at the Airport between the hours of 12 midnight and 6am shall not exceed SEL 95 dBA in any residential zone outside of the Airnoise Boundary. Compliance with this rule shall be assessed in accordance with the procedures set out in the Airport Noise Monitoring Plan.

DAA2.6.iii Exemptions for individual flights from the requirements of DAA2.6.ii may be given by the Nelson Airport Noise Environment Advisory Committee to be constituted and maintained under the Nelson Regional Airport Environmental Management Plan (October 1996). Such exemptions are intended to be granted for special events requiring additional air services to accommodate members of the public attending. Requirements for grant of exemptions are:

a) An application in writing to the Committee, detailing the event and additional air service proposed.
b) Such application is to be publicly notified by the Committee which shall take into account any submissions or representations made in writing in relation to the application in determining whether it shall be granted and any terms that shall apply.
c) Exemption may be granted for a maximum of 24 movements (12 landings and 12 takeoffs) in any 12 month period.

DAA2.7 independent air noise compliance audit

DAA2.7.i There shall be an independent compliance audit of aircraft noise management by the Nelson Airport Ltd at Nelson airport to be conducted at five yearly intervals during the continuance of this designation. The audit will review compliance with the terms of this air noise designation and the adoption and implementation of ongoing best management practices to minimise air noise in the environs of the airport and its surrounding area and to review the methods and procedures set out in the Airport Noise Monitoring Plan.

DAA2.7.ii The audit shall be conducted by such party or parties as the Noise Environment Advisory Committee may unanimously nominate, but failing such a nomination then by such party as may be nominated by the Director of Civil Aviation.

DAA2.7.iii The audit shall be publicly notified and opportunity shall be given to all interested parties to make submissions or representations to the party conducting the audit for consideration as part of such audit process. Nelson Airport Ltd will facilitate and fully co-operate with the audit process and meet all reasonable audit costs incurred.

DAA2.7.iv The audit findings and recommendations shall be publicly notified and Nelson Airport Ltd will use its best endeavours to observe and implement any findings or recommendations that may be made by the auditor.

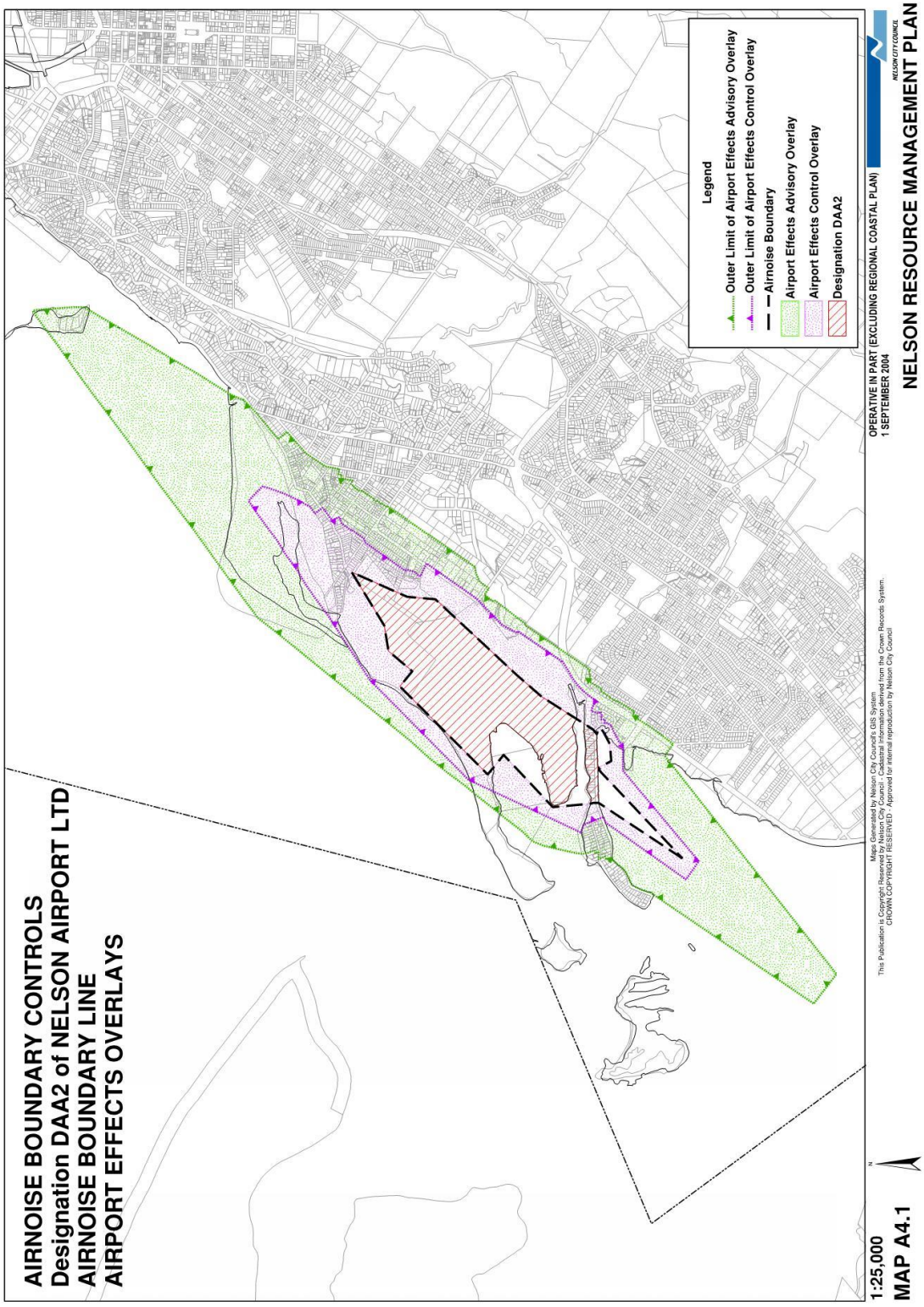
DAA2. 8 explanatory statement

DAA2.8.i The extent of the airnoise (65 Ldn) (109 Pasques) boundary is shown on Planning Map A4 of the Nelson Resource Management Plan, comprising land owned by Nelson Airport Ltd and residential properties at the southwestern end of main runway 02/20.

DAA2.8.ii This designation is for the period up to and including Year 2020 pursuant to Section 184(i)(c) of the Act to the extent not given effect to before the end of that period.

DAA2.8.iii Consultation occurs on a continuing basis with Nelson City Council, Civil Aviation Authority, Airways Corporation of New Zealand, and airline operators.

APPENDIX C NELSON RESOURCE MANAGEMENT PLAN MAP A4.1



APPENDIX D PREDICTED NOISE CONTOUR FIGURES

NELSON AIRPORT

MARSHALL DAY Acoustics

Figure E1: Nelson Airport - Southern Runway Extension Option FY50 Forecast

Prepared by: Laurel Smith
Date: 30/11/2022

Scale @ A3: 1:20,902
0 0.1 0.2 0.4 0.6 0.8 km

N

NELSON AIRPORT

MARSHALL DAY Acoustics

Figure E2: Nelson Airport - Northern Runway Extension Option FY50 Forecast

Prepared by: Laurel Smith
Date: 30/11/2022

Scale @ A3: 1:20,902
0 0.1 0.2 0.4 0.6 0.8 km

N

NELSON AIRPORT

MARSHALL DAY Acoustics

Figure E3: Nelson Airport - Northern and Southern Runway Extension Options FY50 Forecast

Prepared by: Laurel Smith
Date: 30/11/2022

Scale @ A3: 1:13,377
0 0.05 0.1 0.2 0.3 0.4 km

N