Auckland Airport

MARSHALL DAY Acoustics

AUCKLAND AIRPORT
2023 FINANCIAL YEAR ANNUAL NOISE MANAGEMENT REPORT

25 August 2023

Cover Photo: Robert de Bock

EXECUTIVE SUMMARY

Designation 1100 requires Auckland International Airport Limited (AIAL/the Airport) to report on its aircraft noise monitoring programme. The programme involves continuous 'on the ground' monitoring of aircraft noise levels at three sites, noise contour calculations for actual and projected aircraft activity, engine testing noise monitoring and noise complaint monitoring. This report has been prepared by Marshall Day Acoustics and provides an overview of the noise monitoring programme for FY23 (1 July 2022 – 30 June 2023).

AIR TRAFFIC RECORDS

Flight numbers have been steadily recovering following the significant disruption caused by the COVID-19 pandemic. Compared with FY22, operations increased by 70%, with night-time movements (10pm – 7am) up 95% and daytime movements up 67%. This increase from FY22 is partly due to the New Zealand international border fully reopening in early FY23.

Night-time movements made up 12% of the total movements in FY23 with the remaining movements (88%) occurring in the daytime. The runway usage during FY23 was 53% Runway 23L and 47% Runway 05R. This is a difference of 17% from the historical average runway split of 70%/30% (in favour of Runway 23L). This difference is driven by weather conditions.

MONITORED NOISE LEVELS

The three permanent noise monitors are located on the outer boundary of the High Aircraft Noise Area (HANA). Measurements from the noise monitors demonstrate compliance with the 65 dB L_{dn} noise limit at the outer boundary of the HANA. Compared with FY22, the measured noise levels for FY23 have increased by 4.0 dB at Puhinui School, 3.2 dB at the Velodrome, and 3.9 dB at Prices Road.

All noise monitors calibrated satisfactorily throughout FY23. The Velodrome Monitor had one day of missing data when its equipment was upgraded.

2023 ACTUAL NOISE CONTOUR (ANC) – ACTUAL ACTIVITY

The calculated noise contours based on actual FY23 aircraft operations show compliance with the 60 and 65 dB L_{dn} limits at all locations along the Moderate Aircraft Noise Area (MANA) and HANA boundaries respectively.

2024 ANNUAL AIRCRAFT NOISE CONTOUR (AANC) – PROJECTED ACTIVITY

The projected Annual Aircraft Noise Contours for FY24 (2024 AANC) represent activity occurring in the coming financial year. They show an increase (1.8 dB) in noise compared with the previous financial year (2023 AANC). However, these levels for FY24 are still lower than the pre-pandemic 2020 AANC levels (1.1 to 2.4 dB lower).

NOISE MANAGEMENT PACKAGE

AIAL utilises the AANC to identify properties eligible for the noise mitigation packages required under Designation 1100. Given the 2024 AANC is smaller than the 2020 AANC, all properties within the 2024 AANC have previously been offered a noise mitigation package. This was also the case for the last three years, but AIAL has continued to make offers to all properties within the HANA of the existing runway. The Airport has advised that in FY24 it intends to apply the 2020 AANC for the noise mitigation packages, which is larger than the 2024 AANC.

ENGINE TESTING

Noise from engine testing activities has been compliant with the relevant noise limits throughout FY23. The highest recorded L_{dn} at each of the three compliance locations was 47 dB, which is 8 dB below the permissible noise limit.

NOISE COMPLAINTS

The trend of flight numbers back towards pre pandemic levels is expected to give perceptions of increasing Airport noise. This appears to be reflected in part in the complaints received in FY23.

There were 539 complaints received in FY23 made by 51 complainants. We note that there are three main complainants that complained a combined total of 397 times (74%). The total number of complaints received has increased by 486% when compared to FY22. The total number of people complaining has increased by 96% when compared to FY22.

The complaints for FY23 were predominantly from East and South Auckland, with the remainder mostly spread across Central and West Auckland. Most people made less than 5 complaints with six people making more than 5. The three most frequent complainants are in the suburbs of East Tāmaki, East Tāmaki Heights and Titirangi. The airport has met with the two most frequent complainants from East Auckland to discuss their concerns.

During FY23 weather conditions necessitated unusually high Runway 05 usage (departures to the east), which when combined with the recent increase in flight numbers appears to have caused an increase in perceived disturbance and corresponding complaints.

NOISE REDUCTION INITIATIVES

The noise reduction initiatives in FY23 have been summarised in Section 9.0. The primary initiatives were:

- Raising LOSGA from 6000 feet to 7000 feet for night flights,
- A flight path change for flights departing to South Australia on Runway 05R for Category C aircraft (Airbus A320 or Boeing 737) between 2300 and 0700 and,
- Adding a sixth Noise Monitor in East Tamaki.

TABLE OF CONTENTS

1.0 INTRODUCTION

Designation 1100 provides a comprehensive framework within which the Airport operates. The designation sets out noise performance criteria and noise management obligations for the Airport to meet. Condition 5(d) requires AIAL to undertake the following:

- Monitor noise from aircraft operations near the boundary of the High Aircraft Noise Area (HANA) to demonstrate that the Day/Night level of 65 dB L_{dn} is not exceeded outside the HANA
- Use recognised noise modelling software and noise monitoring data to calculate whether the noise from aircraft operations exceeds 60 dB L_{dn} anywhere outside the Moderate Aircraft Noise Area (MANA)
- Calculate noise levels to ensure compliance with Condition 10 relating to the Noise Mitigation Programme

Condition 13(b) requires the Airport to calculate and report on the noise level from engine testing activities and Condition 9(c) requires the airport to report on the noise complaints it receives.

AIAL is required to prepare an Annual Noise Management Report which summarises the measurements and modelling and identifies past and future initiatives for noise reduction.

This report has been prepared by Marshall Day Acoustics and provides an overview of the noise monitoring programme for the 2023 financial year (July 2022 to June 2023) including:

- A review of the noise monitoring system, calibration, and results
- Calculation of noise contours for actual aircraft activity – the Actual Noise Contour (ANC) – to determine compliance with the HANA and MANA boundaries
- Calculation of the projected aircraft activity – Annual Aircraft Noise Contours (AANC) – to determine the extent of offers for the noise mitigation programme in the coming year
- Summary of past and future initiatives to reduce noise in the community

A summary of the air traffic records for the 2023 financial year has also been included in this report along with flight path diagrams, calculation of noise from engine testing activities and a summary of noise complaints received.

A glossary of terminology is given in Appendix A.

2.0 AIR TRAFFIC RECORDS

Table 1 shows a summary of aircraft movement numbers at Auckland Airport during FY23 (July 2022 to June 2023) with FY22 data (July 2021 to June 2022) included for reference.

Table 1: Aircraft movement numbers

	FY22	FY23	Difference	% Change
Total Movements	82,543	140,506	+57,963	+70%
Daytime Movements (7am to 10pm)	73,937	123,683	+49,746	+67%
Night-time Movements (10pm to 7am)	8,606	16,823	+8,217	+95%

To give broader context: FY23 movements represent a 23% decrease from FY19 movements (181,356), which was the last financial year not affected by the COVID-19 pandemic. These movement records are from the Airport's noise monitoring system which uses air-traffic data provided by Airways Corporation NZ[1].

Overall, aircraft activity during FY23 increased by 70% when compared to the previous year. Night-time movements increased by 95% and movements in the daytime increased by 67%. Night-time movements made up 12% of the total movements in FY23 with the remaining 88% of movements occurring in the daytime.

FY23 is the third complete financial year following the start of the pandemic. The New Zealand international border fully reopened on the 1st of August 2022. Airport activity is not yet at FY19 levels but continues to recover.

Figure 1 shows the aircraft movements broken down by broad aircraft type for the previous two financial year periods and FY19. For FY23, 56% of total flights were jet aircraft and 43% were turboprops.

Figure 1: Proportion of aircraft movements by aircraft type

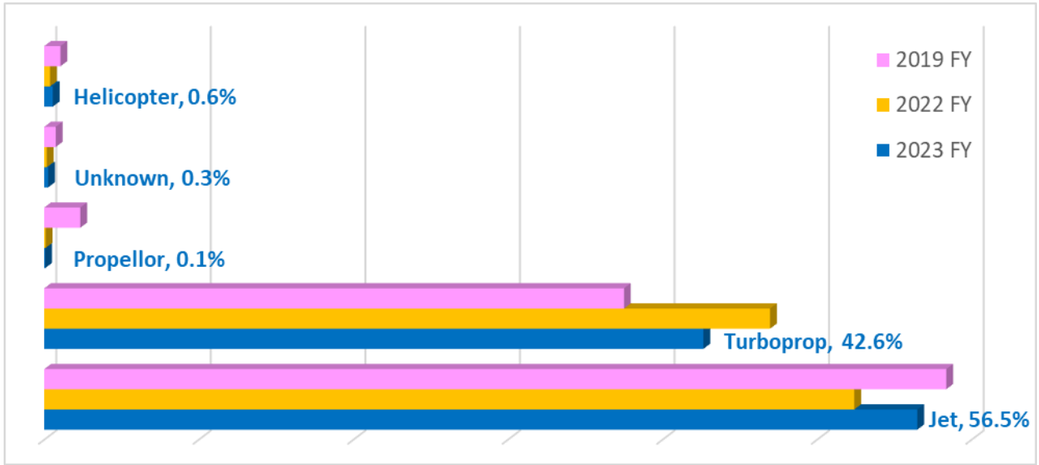


Table 2 below shows the runway usage for FY23. The typical average runway split is 70% Runway 23 (arrivals from the east, departures to the west) and 30% Runway 05 (arrivals from the west, departures to the east). Prevailing weather meant the runway usage for FY23 was significantly different to the typical split with 53% Runway 23 usage and 47% Runway 05 usage. There were also a small number of helicopter movements airside which were not associated with a runway.

Table 2: Runway usage

	Typical Runway Split	FY23 Runway Split	Deviation
Runway Mode 23	70%	53%	17%
Runway Mode 05	30%	47%	

[1] We note that aircraft movement numbers from the monitoring system are lower than those reported on the Airport's website. There was a discrepancy of 3,915 movements for FY23 which is a -2.7% difference. The cause of this discrepancy is being investigated by Casper, but we consider it would have a negligible impact on noise levels reported from the monitoring system.

3.0 FLIGHT PATHS

The flight paths that aircraft utilise are variable and depend on the aircraft type, aircraft weight, destination/origin, the weather at the time, other air traffic in the area, and other factors. One major factor that influences flight paths is the wind direction. In Auckland, the prevailing wind is from the southwest and under these conditions aircraft use Runway Mode 23 where departing aircraft take off towards the west over the Manukau Harbour and arriving aircraft land on the eastern end of the runway, overflying Papatoetoe.

In FY23, the busiest day for Runway Mode 23 was on 03 March 2023. The actual flight paths for this day are shown in Figure 2 daytime (7am – 10pm) and Figure 3 night-time (10pm – 7am). Each flight path changes colour with altitude. Larger versions of these figures are shown in Appendix B along with day/night-time figures for the busiest easterly wind day or "Runway 05 day" (06 April 2023).

Figure 2: Individual flight paths for the busiest RW23L day (7am - 10pm) in FY23

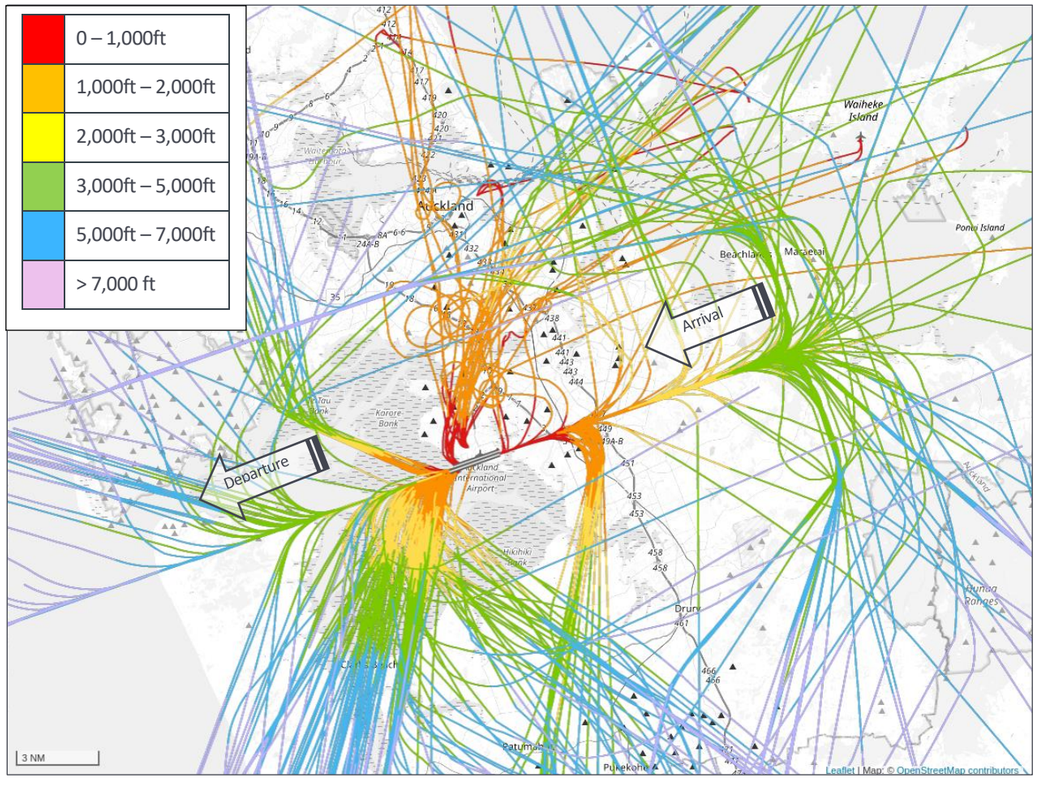
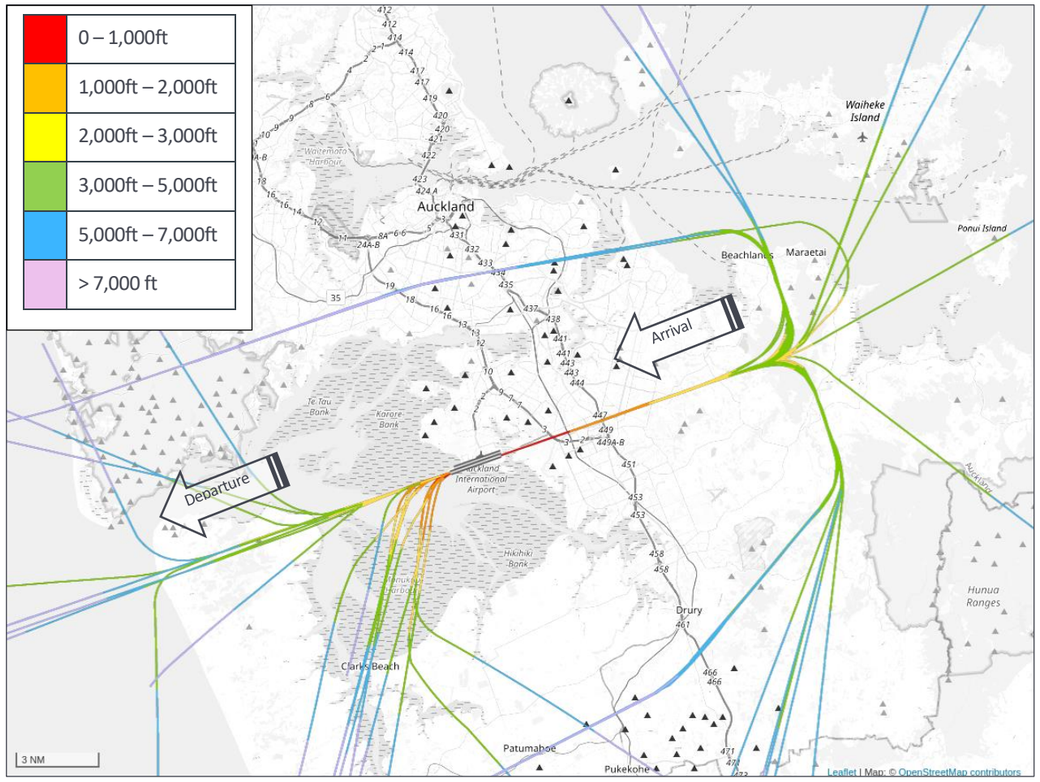


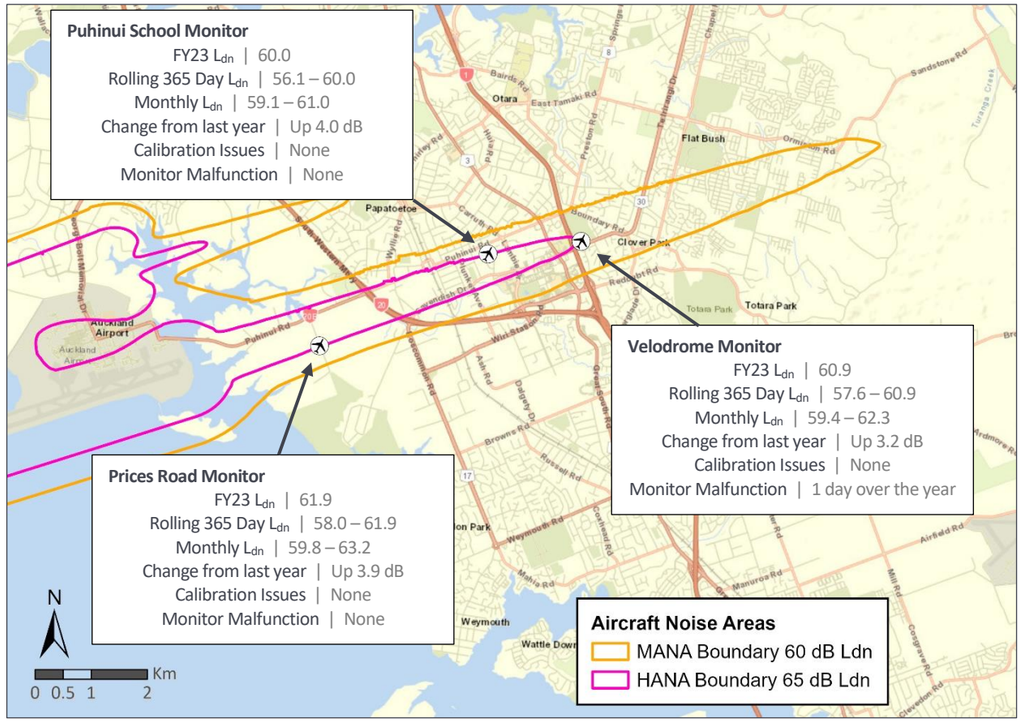
Figure 3: Individual flight paths for the busiest RW23L night (10pm - 7am) in FY23



4.0 MONITORED NOISE LEVELS

AIAL has three permanent noise monitors located on or close to the boundary of the HANA at Puhinui School, the Velodrome, and Prices Road. The location of the monitors is shown in Figure 4 along with a summary of the monitoring results for FY23. The noise limit at the boundary of the HANA is 65 dB L_{dn} (365-day average). Appendix C provides information on how the captured noise data is processed and analysed.

Figure 4: Noise monitor summary



All monitors calibrated satisfactorily throughout FY23, however there was one day with missing data. This was on 30 June 2023 when the Velodrome Monitor was upgraded. The monitor's sound level meter and microphone were upgraded to new equipment.

Table 3 shows the FY23 measured noise levels increased by 3 - 4 dB from FY22. A change in noise level of 1 to 2 dB is generally imperceptible to the human ear, 3 to 4 dB is a just-perceptible change, and 5 to 8 dB is a noticeable change. Note that the levels from FY23 were 0 - 1.2 dB lower than in FY19.

Table 3: Measured noise levels

Monitor Location	FY22 (dB Ldn)	FY23 (dB L_{dn})	Difference (dB)
Puhinui School	56.0	60.0	+4.0
Velodrome	57.7	60.9	+3.2
Prices Road	58.0	61.9	+3.9

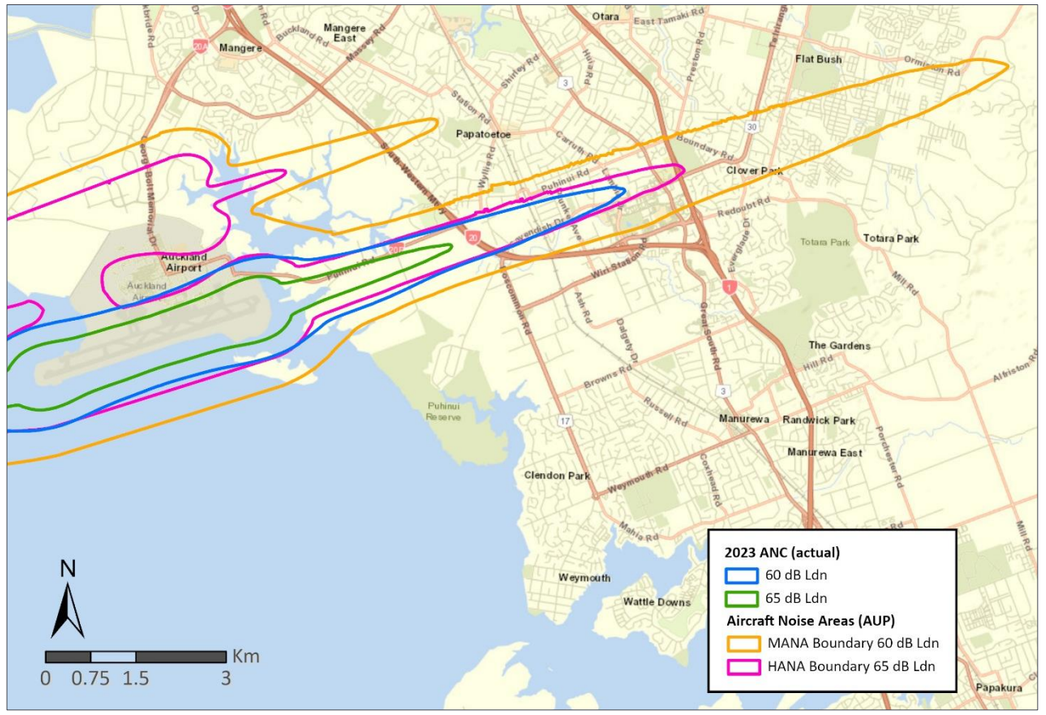
5.0 2023 ACTUAL NOISE CONTOUR (ANC) – ACTUAL ACTIVITY

The ANC noise contours represent the actual aircraft activity occurring in FY23. The purpose of these noise contours is to assess compliance with the MANA and HANA each year. The noise contours have been calculated using the latest version of the FAA Integrated Noise Model (INM version 7.0d) and the aircraft movement data obtained from the noise monitoring system. Appendix C provides information on how the data is processed for calculation.

Figure 5 shows the calculated 60 and 65 dB L_{dn} contours for FY23. The HANA and MANA boundaries are also shown. Noise from aircraft operations must not exceed 65 and 60 dB L_{dn} at the HANA and MANA boundaries respectively. The calculated noise contours show that noise from aircraft operations in FY23 readily complied with the limits at the HANA and MANA boundaries.

To give broader context, Appendix D shows the 2023 ANC compared with the 2019 ANC (pre-pandemic).

Figure 5: 2023 Actual Noise Contour (ANC)



It is important to verify the noise model against the measured levels to ensure an acceptable tolerance. Table 4 lists the calculated noise level at each monitoring site compared with the actual measured noise level for FY23. In this case the model is within 2 dB of the measured levels at the three monitoring locations. This is generally accepted as a reasonable tolerance for a compliance assessment.

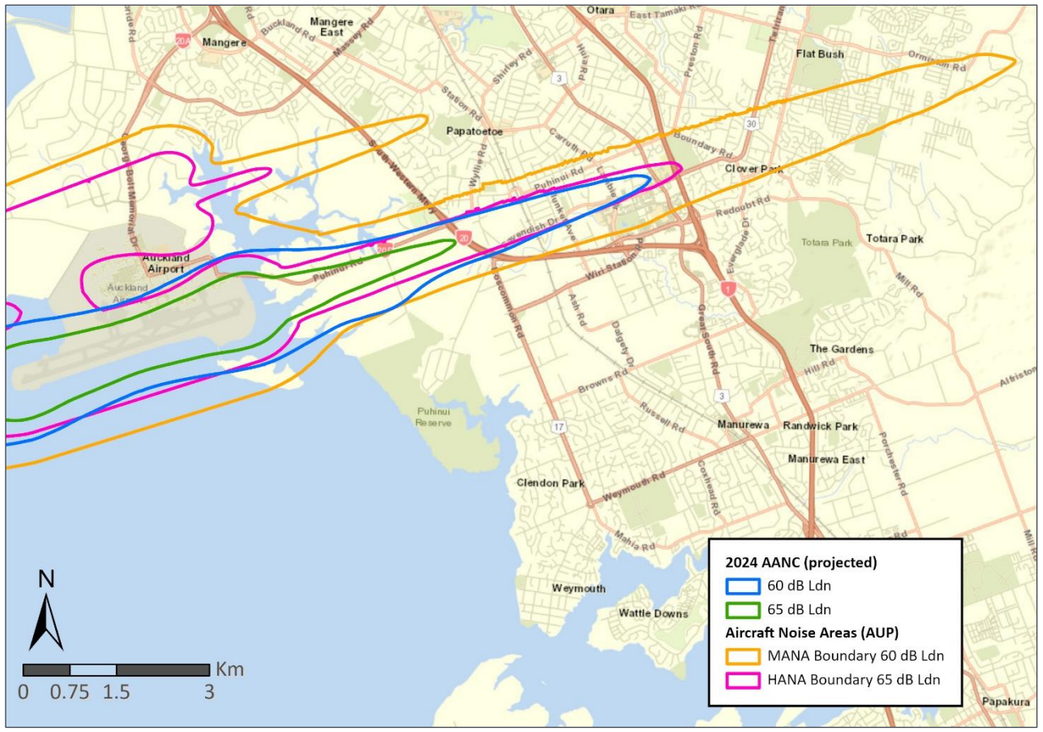
Table 4: Calculated and measured noise levels (actual activity FY23)

Monitor Location	Measured Noise Level L_{dn} (dB)	Calculated Noise Level L_{dn} (dB)	Difference (dB)
Puhinui School	59.8	58.7	+1.1
Velodrome	60.7	58.9	+1.8
Prices Road	61.6	61.3	+0.3

6.0 2024 ANNUAL AIRCRAFT NOISE CONTOUR (AANC) – PROJECTED ACTIVITY

The Annual Aircraft Noise Contours (2024 AANC) are anticipated to be published in September 2023 and represent noise from aircraft activity predicted to occur in the coming year. The purpose of these noise contours is to identify which properties are eligible to receive an offer for noise mitigation treatment in accordance with Condition 10 of Designation 1100. Figure 6 shows the 2024 AANC contours compared to the HANA and MANA.

Figure 6: 2024 Annual Aircraft Noise Contour (AANC)



The AANC are also calculated using INM. The projected aircraft activity has been based on actual aircraft movements for the 12 months ending 30 June 2023. A predicted growth factor provided by Auckland Airport has been applied to this data to represent movement numbers for the forthcoming year.

Condition 10 of Designation 1100 sets out that qualifying[2] properties in the MANA become eligible for the mitigation offer if the property falls inside the 60 dB L_{dn} contour of the AANC. Qualifying properties inside the HANA become eligible for the offer if the property falls inside the 65 dB L_{dn} contour of the AANC.

The 60 dB and 65 dB L_{dn} 2024 AANC contours have increased from the 2023 AANC but remain smaller than the 2020 AANC (calculated from the last financial year pre-pandemic). Therefore, all properties have previously been offered mitigation and no new mitigation offers are explicitly required. This was also the case in the last three years, but AIAL has continued to make offers to all properties within the HANA of the existing runway. The Airport has advised that in FY24 it intends to use the 2020 AANC for the noise mitigation packages given it is larger than the 2024 AANC contours. Further details are provided in Section 9.0.

Appendix E shows the 2023 AANC compared to the 2024 AANC. The 2024 AANC contours are larger than the 2023 AANC, as it is predicted that the number of flights will further increase as air travel continues to recover from the COVID-19 pandemic.

Table 5 lists the predicted noise levels at the monitoring sites for the 2023 AANC and 2024 AANC. The noise levels in the 2024 AANC are imperceptibly higher than the 2023 AANC (a change of 1 to 2 dB is generally imperceptible to the human ear).

Table 5: 2023 and 2024 AANC calculated noise levels (projected activity)

Monitor Location	2023 AANC (dB Ldn)	2024 AANC (dB L_{dn})	Difference
Puhinui School	57.5	59.3	+1.8
Velodrome	57.6	59.4	+1.8
Prices Road	60.7	62.5	+1.8

[2] Meets the Existing Building definition in Designation 1100

7.0 ENGINE TESTING

Engine testing noise emissions are limited to 55 dB L_{dn} (7 day rolling average) and 75 dB L_{Amax} (10pm – 7am) received in the "Identified Area" shown in Figure 1 of Designation 1100. Noise emissions from engine testing activities are calculated and assessed monthly for compliance at three key locations in the Identified Area (Res1, Res2, and Res3). The calculations are based on records of engine testing activity provided by the airport users and established noise levels relating to each type of test.

Figure 7 shows the lowest, highest, and average 7 day rolling L_{dn} noise level at each of the three compliance locations for FY23. The highest L_{dn} calculated for the three compliance locations was 47 dB, which is 8 decibels below the noise limit.

Figure 7: FY23 Engine testing monitoring summary

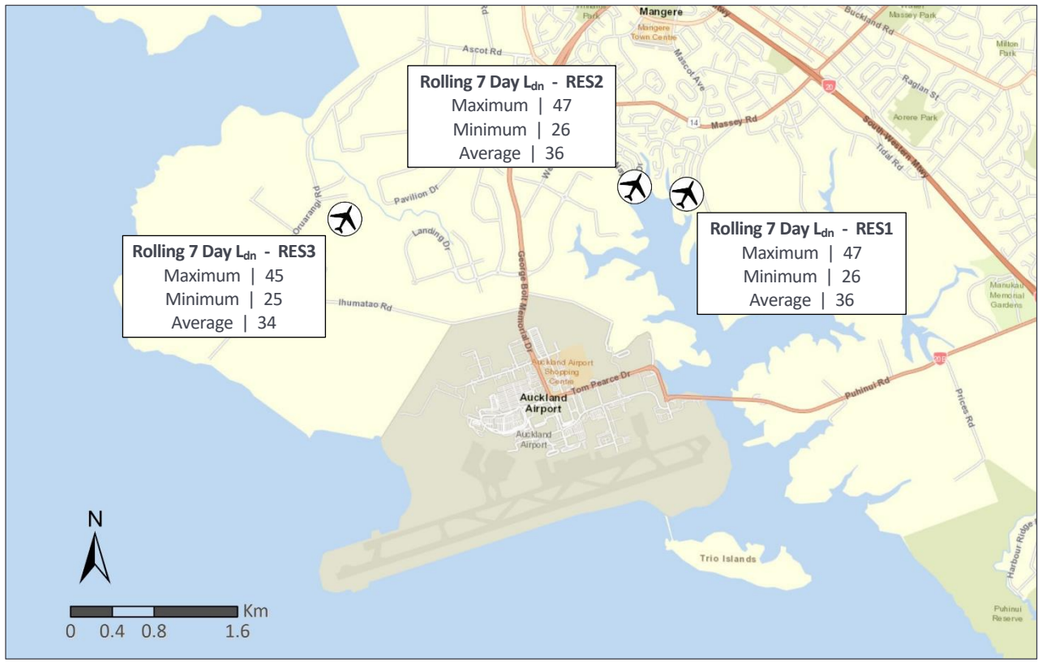


Figure 8 shows a graph of the 7-day rolling L_{dn} noise level at the three compliance locations for each day. Generally, the noise levels were below 40 dB L_{dn}.

The purpose of the L_{Amax} limit is to control the maximum noise level during engine testing at night to protect against sleep disturbance. The L_{Amax} level during a test depends on the aircraft type, power setting and propagation conditions but is not affected by the duration of testing. It has been previously ascertained that aircraft undergoing engine testing at Auckland Airport comply with the 75 dB L_{Amax} limit at the three compliance locations for all power settings.

Figure 8: Engine testing noise emissions (Rolling 7 Day L_{dn})

8.0 NOISE COMPLAINTS

People may make multiple complaints during the year and each complaint could relate to either a specific aircraft overflight or a more general issue such as increased overflights at night. Therefore, the terminology used in this report when summarising the statistics is as follows:

- The number of 'complainants' (number of people who complain)
- The number of 'generic' noise complaints (e.g. "there was more aircraft noise last night")
- The number of 'specific' event complaints (e.g. "the flight at 6:25pm last night was particularly noisy")
- The number of 'question' noise enquiries (e.g. "can you tell me more about how noise is managed at the airport")

The trend of flight numbers back towards pre pandemic levels is expected to give perceptions of increasing Airport noise. This appears to be reflected in part in the complaints received in FY23.

During FY23 the airport received 539 noise complaints from 51 people, 492 (91%) of these were specific complaints, 39 (7%) were generic complaints, and 8 (11) were question enquiries (of which 10 were regarding the Noise Mitigation Package).

The complaints for FY23 came predominantly from West and East Auckland, with the remainder coming mostly from the Central Suburbs and South Auckland.

Table 6 overleaf shows the noise complaints and number of people complaining over the past 5 years.

Table 6: Summary of complaints since 2019

	FY19[3]	FY20	FY21	FY22	FY23
No. Complaints	905	261	83	89	539
No. People Complaining	132	65	49	26	51

There was a spike in complaints in FY23. We note that there were three main complainants that complained a combined total of 397 times (74%). The total number of complaints received in FY23 increased by 450 (486%) when compared to FY22. The total number of people complaining in FY23 increased by 25 (96%) when compared to FY22.

Figure 9 shows the number of complaints made in each month of FY22 and FY23. The number of complaints received per month ranged between 5 and 172 in FY23. The complaints received each month in FY23 was higher than in FY22 for eleven months, except August where it was lower by 1 complaint. Figure 10 shows the number of people that complained in each month of FY22 and FY23. Each month the number of people making the complaints ranged between 2 and 13 during FY23.

Figure 11 shows the specific complaints at night-time (10pm-7am) compared with daytime for each month in FY23.

Figure 9: Aircraft noise complaints in FY22 and FY23

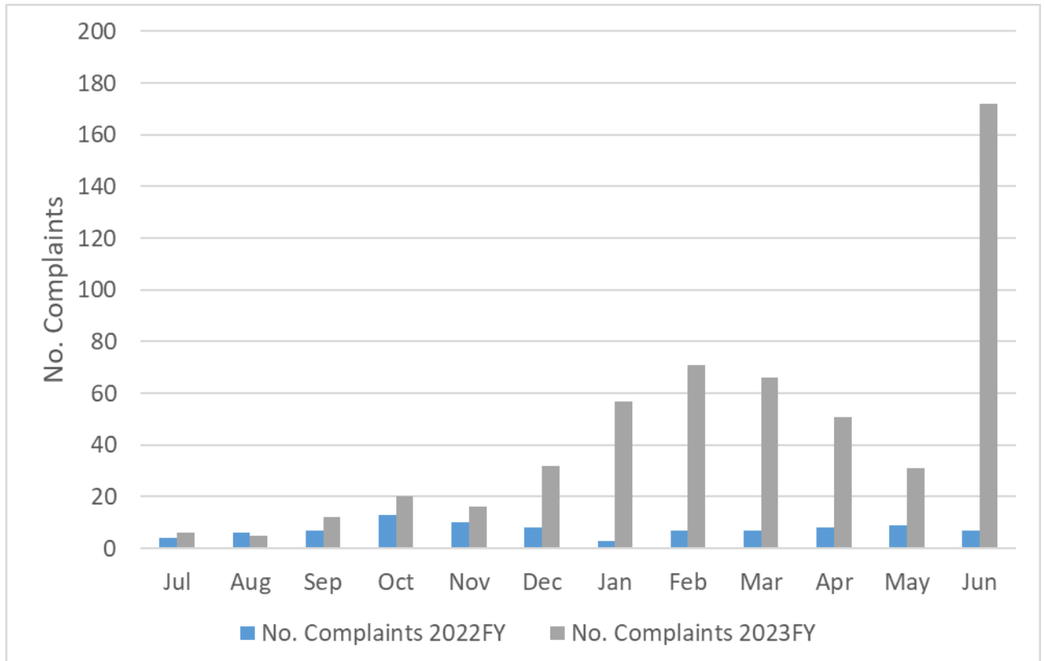


Figure 10: Number of people complaining about aircraft noise in FY22 and FY23

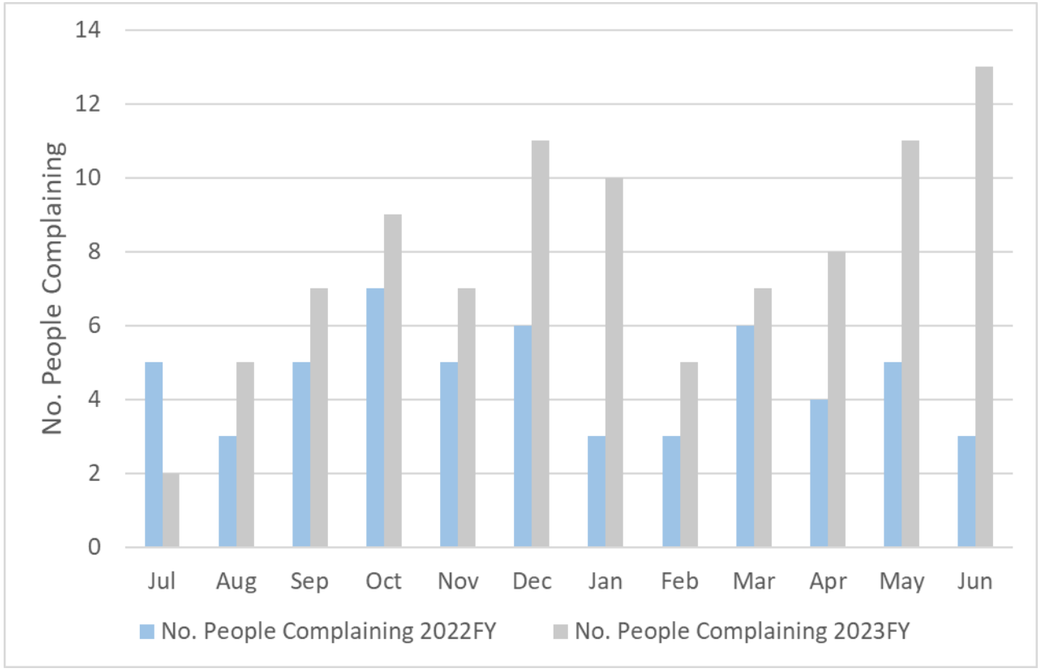
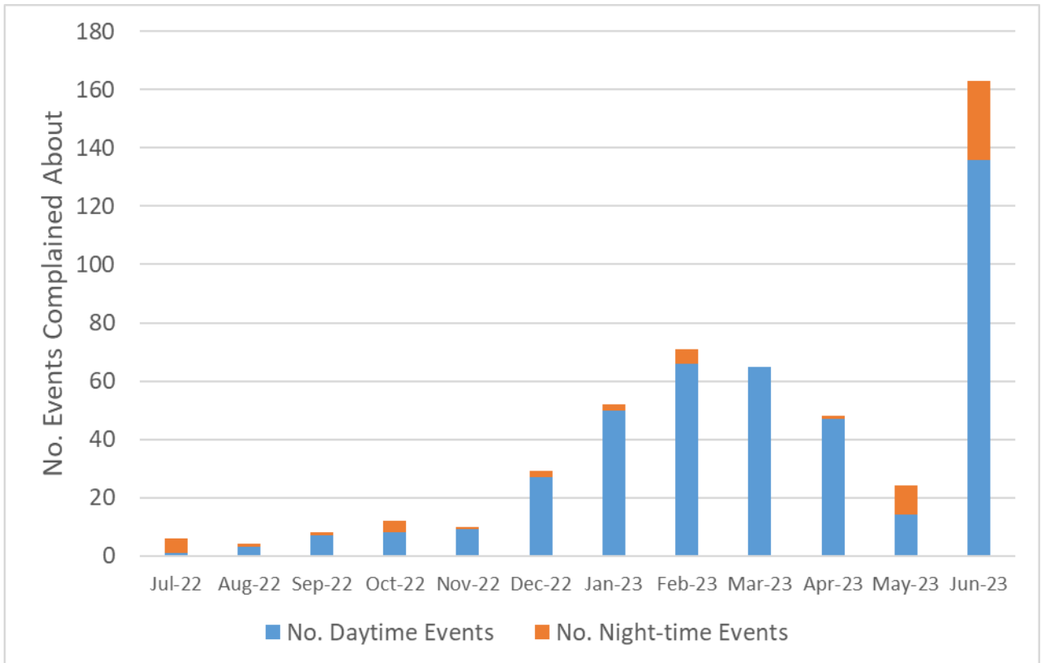


Figure 11: Number of specific complaints in FY23 (by time of day)



[3] An unusual spike in noise complaints arose in 2019 as one person made 318 complaints in one three month period

Daytime flights made up 88% of the aircraft overflights complained about in FY23 with the remaining 12% relating to aircraft events at night-time.

This year there is a weak correlation between complaints and frequency of aircraft movements.

This is depicted in Figure 12 which graphs the number of specific aircraft noise complaints and the number of aircraft operations per hour. The orange bars show the number of complaints that related to an aircraft operation in each hour of the day in FY23, and the grey line shows the average daily aircraft operations that occurred in each hour of the day.

Figure 12: Specific complaints by hour vs aircraft operations by hour

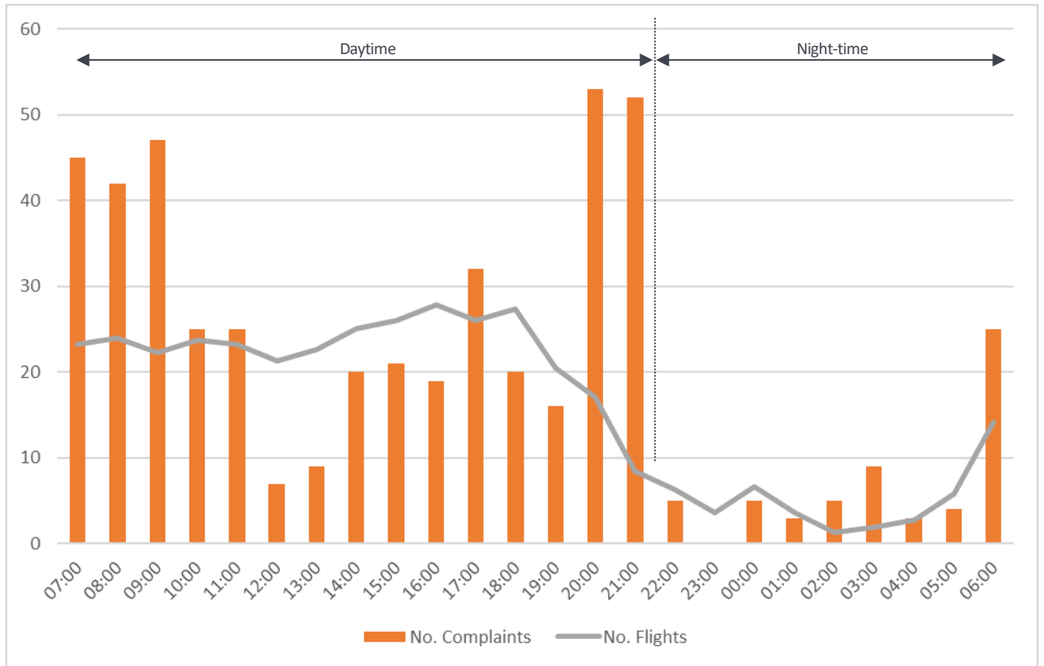


Figure 13 shows the percentage usage of Runway 05 compared to the number of specific complaints. In all months except February and March 2023, there is a general correlation between runway use and the number of complaints received.

Historically it has been found that the airport receives a higher number of complaints when Runway 05 is used (departures over East Auckland). The increased disturbance caused when Runway 05 is in use is most likely because flights more frequently overfly the Central and Eastern suburbs under these conditions, but also because these flight tracks are not normally as prevalent. Departure flight tracks are also more dispersed and therefore overfly a larger area of the central and eastern suburbs than arrivals. This is demonstrated by comparing the flight tracks in Appendix B. Departures also have a different noise character and can be louder than arrivals as the aircraft are climbing under power.

Figure 13: Number of aircraft noise complaints vs. usage of RW05

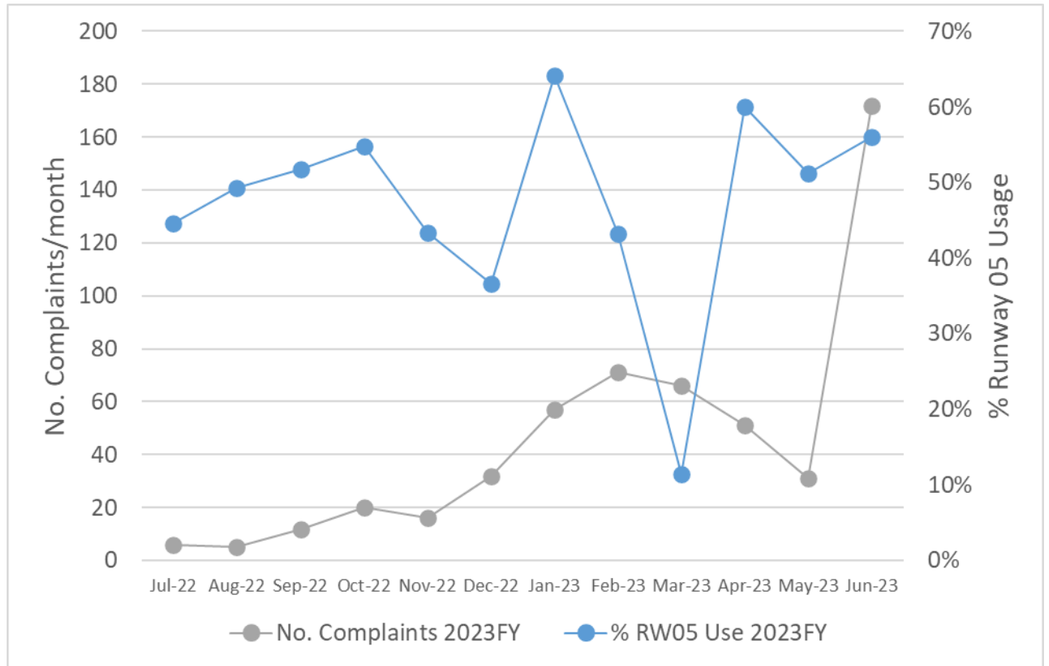


Figure 14 shows the number of complaints received by area. Appendix F gives more detail on the number of complaints received from each suburb. The three main complainants are residents in the suburbs of East Tāmaki, East Tāmaki Heights and Titirangi. These residents made the largest number of complaints (74%) with the remaining complainants spread over 23 other suburbs.

Figure 14: Complaints by area

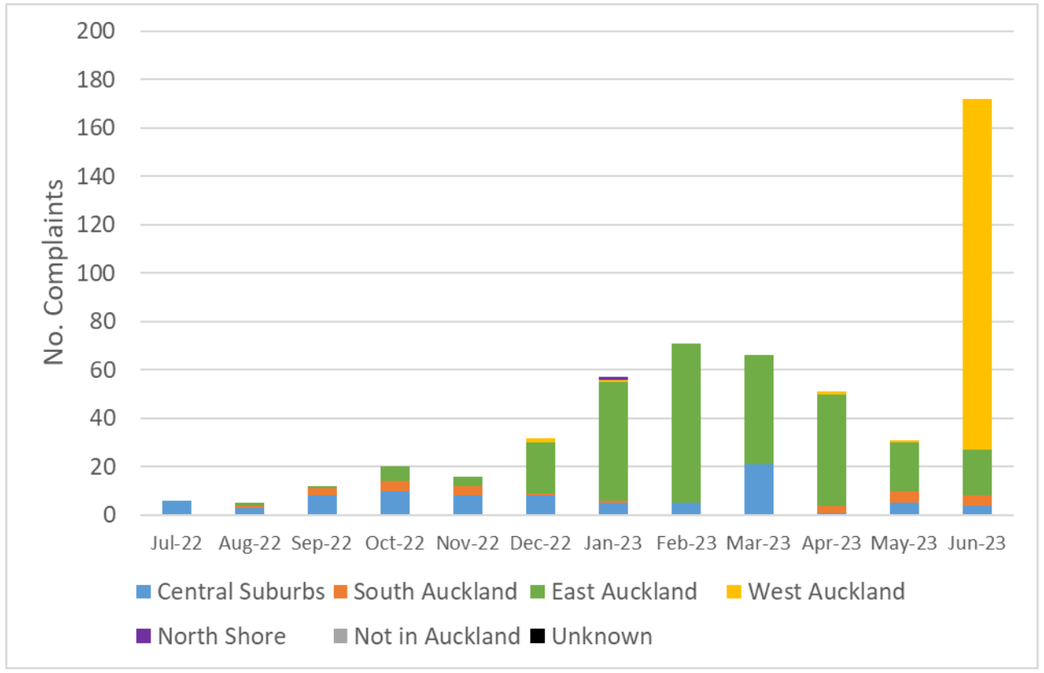
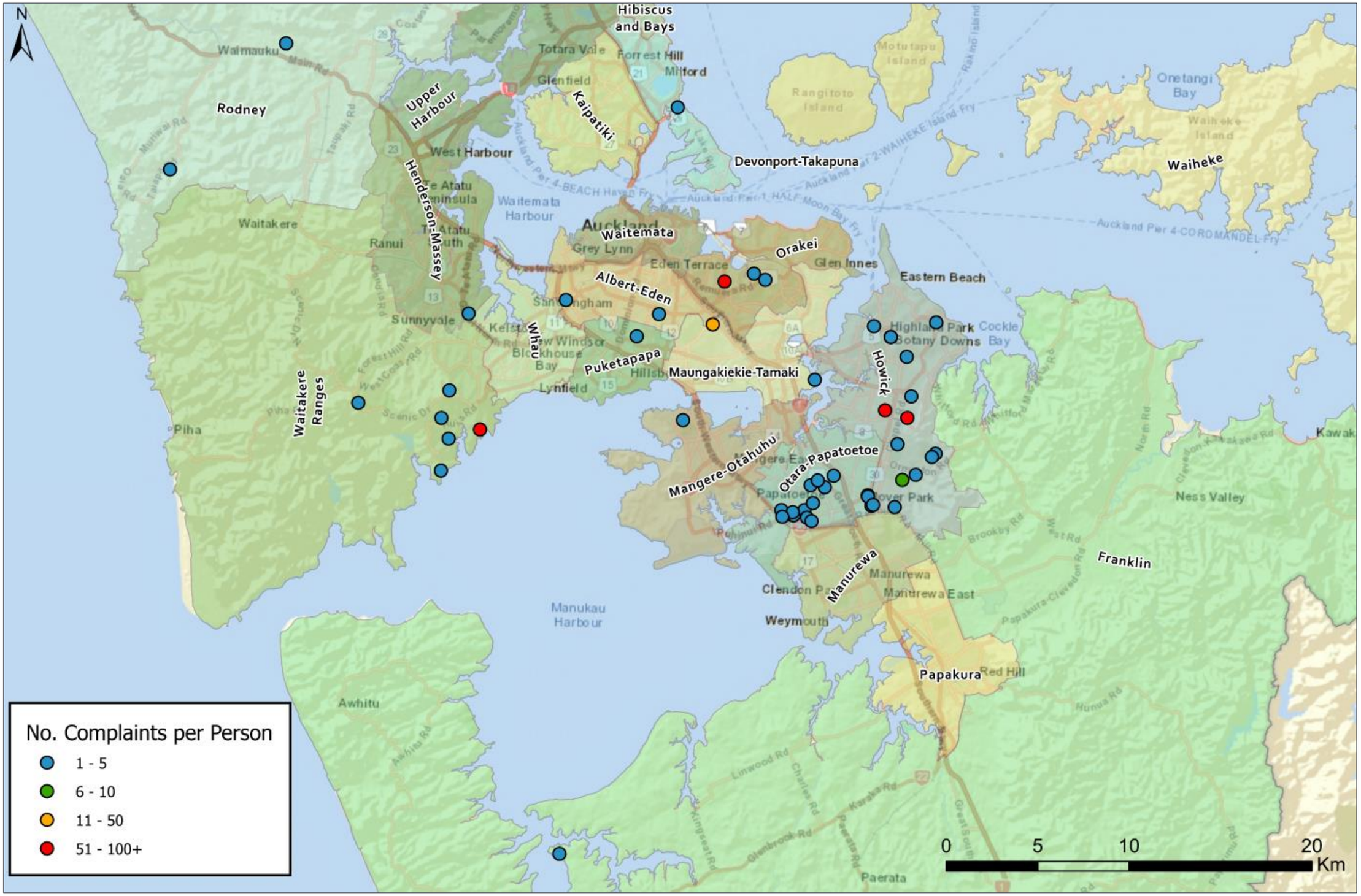


Figure 15 overleaf shows the locations of people complaining in FY23 coloured to represent the number of complaints made by that person. The local board outlines are also shown.

The map shows that the locations of complainants are mostly spread over East and South Auckland, with some in Central Auckland and West Auckland, and one in the North Shore. Most people made 5 or less complaints (blue dots), with six people making more than 5 complaints during FY23.

Figure 15: Number of complaints per person in FY23



9.0 NOISE REDUCTION INITIATIVES

Condition 9(b) requires AIAL to report on any initiatives to reduce aircraft noise in the community for both the financial year being reported on and the forthcoming financial year. AIAL is required to detail the outcomes of initiatives investigated in the financial year being reported on.

FY23 noise reduction initiatives

In July 2022, Air New Zealand conducted simulation flights to test aircraft crossing over LOSGA at 7000 feet, 1000 feet above the current altitude of 6000 feet. From the simulation it was concluded that it is possible to cross over LOSGA at a higher altitude and that this is unlikely to cause any unintended consequences. Auckland Airport worked with the Civil Aviation Authority and Aeropath to implement the change which was published in the AIP for August 2023.

At the December 2022 ANCCG meeting, Airways New Zealand presented a planned flight path change to South Australia on Runway 05R for Category C aircraft (Airbus A320 or Boeing 737) departures between 2300 and 0700. The new trial had aircraft turning right at 500ft after take-off which meant the aircraft would avoid flying over the residential areas of Manukau, Flatbush, Totara Park, and Takanini and instead fly and climb over the Manukau Harbour. The trial took place between February and June 2023. At the June 2023 ANCCG meeting Airways New Zealand explained that the trial flights could only take place between the hours of 2300 and 0700 due to complications with Domestic flight arrivals during the day. A software update was completed on 14 June 2023 to allow for automatic assignments of these flights to this flight path when Runway 05R is in use. Approximately six to eight aircraft per night depart using the shorter departure path, significantly reducing noise over the residential areas of South Auckland.

An additional temporary noise monitor has been installed in August in East Tāmaki to monitor the noise levels of the Green SMART Track approach for arrivals and departure routes on Runway 05R during easterly wind conditions.

Future noise reduction initiatives

There are currently no additional noise reduction initiatives planned or discussed during the June ANCCG meeting.

10.0 NOISE MITIGATION PROGRAMME

Condition 10 of Auckland Airport Designation 1100 sets out the requirements for how Auckland Airport should mitigate the effects of aircraft noise within specified noise contours through the implementation of a Noise Mitigation Programme.

While flight numbers are trending back towards pre COVID-19 levels, the FY24 AANC remains significantly reduced by comparison to FY20 AANC. As a result, all properties within the forecast high and medium noise areas have previously been offered noise mitigation packages. Nevertheless, Auckland Airport has decided to make the 2023/2024 offers to all properties that qualified under the 2020 AANC.

The initiatives and improvements made to the Noise Mitigation Programme in previous years will continue to be implemented as part of the 2023/2024 offer and will include:

- Continued efforts to reach homeowners and tenants when making annual offers by sending offers to both the homeowners address as well as the physical address of the property. This will likely improve tenant awareness of the programme.
- Letters sent to eligible properties will be Airport branded and include text advising that the letter relates to the Noise Mitigation Programme and that they are eligible. This will likely better entice the recipient to open the letter.
- The placement of community notices in areas within the AANC as well as the development of social media content which can be shared by all interested community groups on various social media platforms.
- Holding more public and accessible “Community Information Sessions”. In previous years, Community Information Sessions were by invite only, i.e. to those that had received an offer letter from Auckland Airport. However, as part of increasing awareness of the programme, Auckland Airport proposes to provide these sessions in a public space such as a library located within the eligible area. Auckland Airport also proposes to allow interested homeowners to book a time to call the Noise Mitigation Programme manager (either via phone or video call) which will accommodate those who are unable to physically attend the Community Information Sessions.
- An improved “close-out” process following the installation of a noise mitigation package, which will include post-installation audits, homeowner sign-off that the works are satisfactory and the issue of an Auckland Airport branded folder containing key contacts, warranty and maintenance information and operation manuals.

APPENDIX A GLOSSARY OF TERMINOLOGY

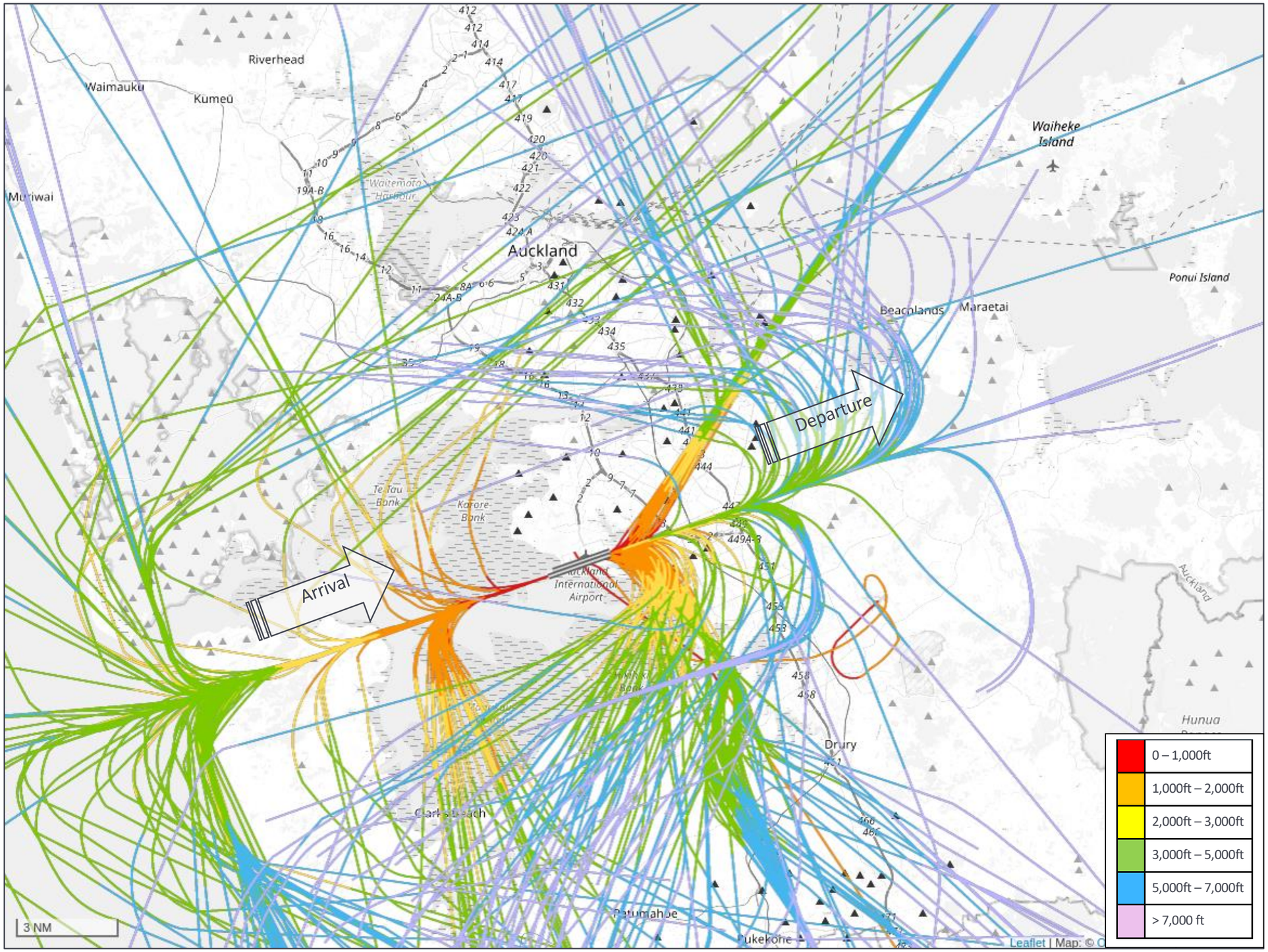
dBA	A measurement of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
L_{eq}	The time averaged sound level (on a logarithmic/energy basis) over the measurement period (normally A-weighted).
L_{dn}	The day-night sound level which is calculated from the 24-hour L_{eq} with a 10 dBA penalty applied to the night-time (2200-0700 hours) L_{eq} (normally A-weighted).
L_{max}	The maximum sound level recorded during the measurement period (normally A-weighted).
Noise	A sound that is unwanted by, or distracting to, the receiver.
Ambient Noise	Ambient Noise is the all-encompassing noise associated with any given environment and is usually a composite of sounds from many sources near and far.
NZS 6805:1992	New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning"
ANC	The Actual Noise Contour represents the actual activity that occurred in the relevant financial year. Detailed further in Section 5.0
AANC	The Annual Aircraft Noise Contour represents the activity projected to occur in the relevant financial year. Detailed further in Section 6.0

APPENDIX B FLIGHT TRACK DIAGRAMS

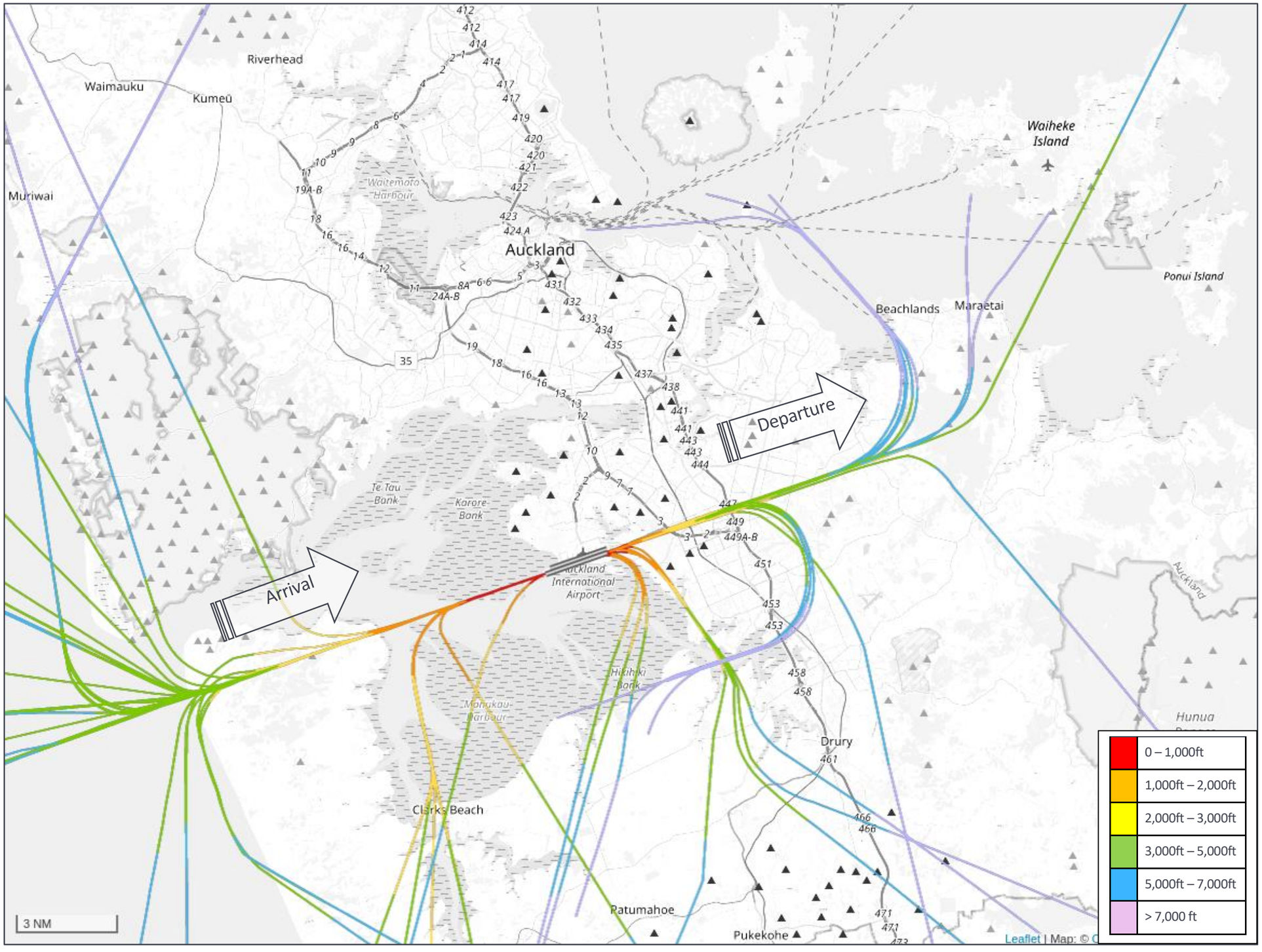
B1 Individual Flight Paths for the Busiest RW23L Day (7am - 10pm) in FY23 (3-Mar-23)

B2 Individual Flight Paths for the Busiest RW23L Night (10pm - 7am) in FY23 (3-Mar-23)

B3 Individual Flight Paths for the Busiest RW05R Day (7am - 10pm) in FY23 (6-Apr-23)



B4 Individual Flight Paths for the Busiest RW05R Night (10pm - 7am) in FY23 (6-Apr-23)

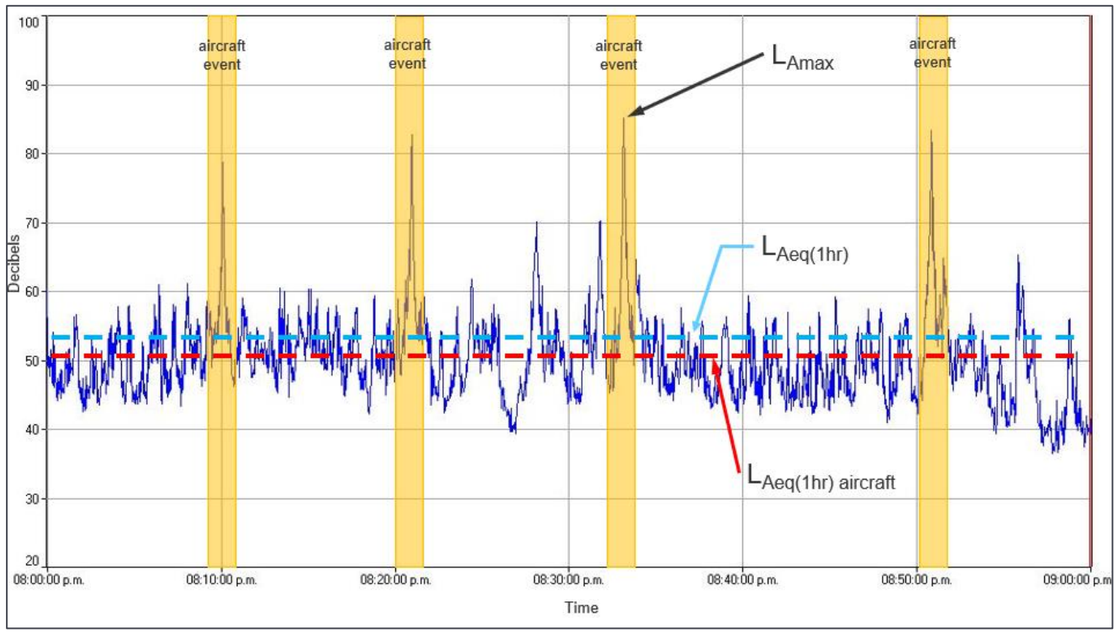


APPENDIX C SCIENCE OF NOISE MONITORING AND NOISE CONTOUR CALCULATIONS

How We Monitor Aircraft Noise

Most outdoor noise sources such as roads, quarries, and airports change throughout the day. Figure C1 shows a sample of an hour long environmental noise measurement with the noise level on the y axis and time on the x axis. The blue trace in Figure C1 shows the L_{Aeq} measured every second.

Figure C1: Hypothetical example of hourly average noise level ($L_{Aeq(1hr)}$) from aircraft flyovers



The noise level fluctuates throughout the hour between 40 and 85 decibels and therefore a statistical measure is needed to quantify the noise source. A range of metrics are used to quantify environmental noise. Each of these metrics tells us something about the noise source in question.

L_{Aeq} is the time averaged sound level over the measurement period and is the most common descriptor for environmental noise. Most general environmental noise limits use the L_{Aeq} descriptor.

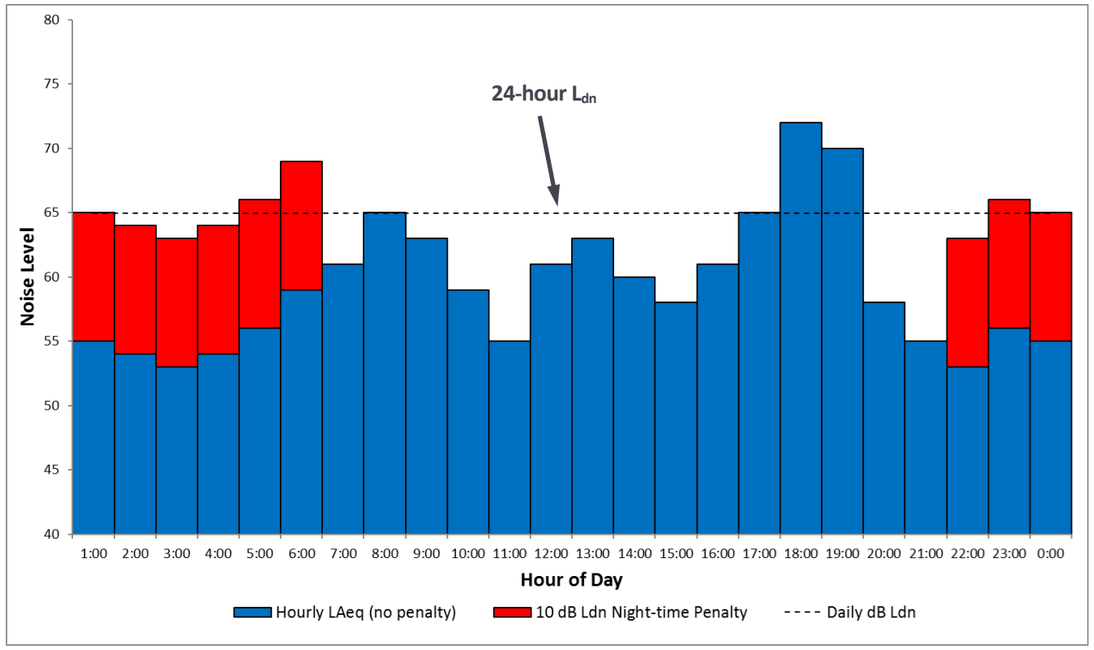
L_{Amax} is the maximum sound level during the measurement period. Most general environmental noise limits include an L_{Amax} noise limit at night. However, transportation noise sources generally are not controlled by L_{Amax} limits.

Aircraft noise is a series of discrete events with periods in between where there is no aircraft noise. The data in the graph includes four aircraft flyovers indicated in yellow. The dashed light blue line is the average sound level (L_{Aeq}) from all sources over the hour. The dashed red line is the average sound level (L_{Aeq}) from aircraft events only over the hour.

Auckland Airport's noise limits are based on a metric called L_{dn} (the day/night weighted average noise exposure). This is the average (L_{Aeq}) noise level from aircraft events over a 24-hour period with a 10 dB 'penalty' weighting during the night (10pm – 7am). Figure C2 shows how the night weighting is applied to calculate L_{dn}.

Like almost all New Zealand's international and regional airports, Auckland Airport's noise management framework is based on New Zealand Standard *NZS 6805:1992 Airport Noise Management and Land Use Planning*. NZS 6805 recommends noise boundaries based on the L_{dn} metric. International research in the US and Europe has found that the L_{dn} metric correlates well with community annoyance to aircraft and other transportation noise.

Figure C2: Hypothetical example of L_{dn} calculation

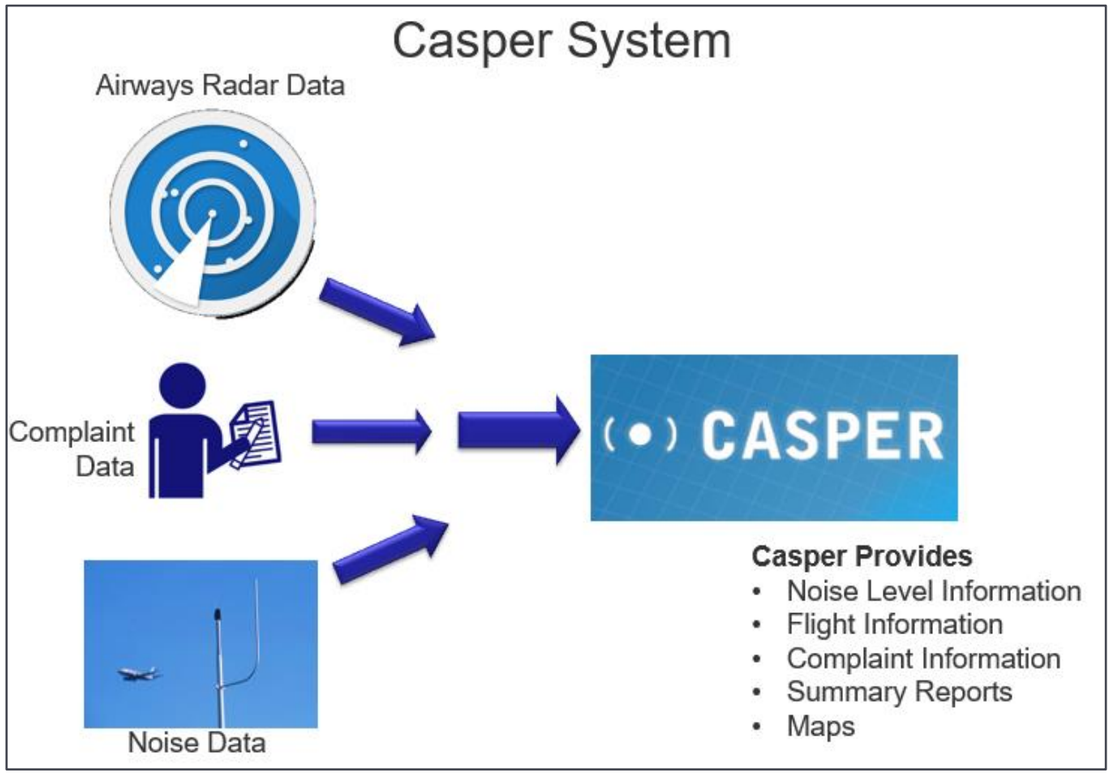


At Auckland Airport, noise levels from aircraft operations are measured continuously in the community at three locations. These are the three permanent monitoring locations on or close to the HANA boundary required under Designation 1100. The monitoring software identifies possible aircraft events based on defined noise level and duration criteria designed to exclude lower level ambient noise sources. The noise events are then correlated to aircraft flyovers using radar data from Airways to identify whether an aircraft was present at the time a noise event was registered. The correlated aircraft noise events are then used to calculate the L_{dn} noise level for each noise monitor.

Auckland Airport's noise monitoring system is supplied and operated by an independent provider Casper. Casper also provides the three permanent noise monitors and two of the five additional temporary noise monitors analysed in this report. MDA provide the remaining three temporary monitors. Temporary noise monitors have been used by Auckland Airport at various locations over time in response to ANCCG recommendations.

All eight noise monitors connect to the Casper noise monitoring system which combines and correlates data from the noise monitoring terminals, Airways aircraft flight data, and noise complaints from the public. Marshall Day Acoustics has access to Casper's web platform which provides much of the information used to prepare the annual and quarterly noise reports. Figure C3 graphically lays out the Casper inputs and details some outputs.

Figure C3: Casper system details



How We Model Aircraft Noise

Several computer based models have been developed internationally to predict the level of aircraft noise on areas surrounding an airport. The model used for Auckland Airport is the Integrated Noise Model (INM). The INM applies calculation algorithms specifically for aircraft noise prediction set out in ECAC Doc 29[4] and SAE AIR 1845[5] and includes a database of noise levels and operating procedures for most commercial, general aviation, military, and rotary aircraft.

The INM program calculates L_{dn} noise contours for an average day. For Auckland Airport the average day is determined by averaging 12 months of aircraft movements. This data is extracted from the Casper monitoring software which has details of every aircraft movement including:

- Aircraft type
- Time of Day (daytime 0700-2200 or night-time 2200-0700)
- Departure, arrival
- Runway
- Flight track
- Destination (affects aircraft weight)

Marshall Day Acoustics has built a base model in INM of Auckland Airport runways and typical flight tracks. To calculate the average day of aircraft operations for the noise model, all the aircraft movements over 12 months that share the same parameters above are summed and then divided by 365.

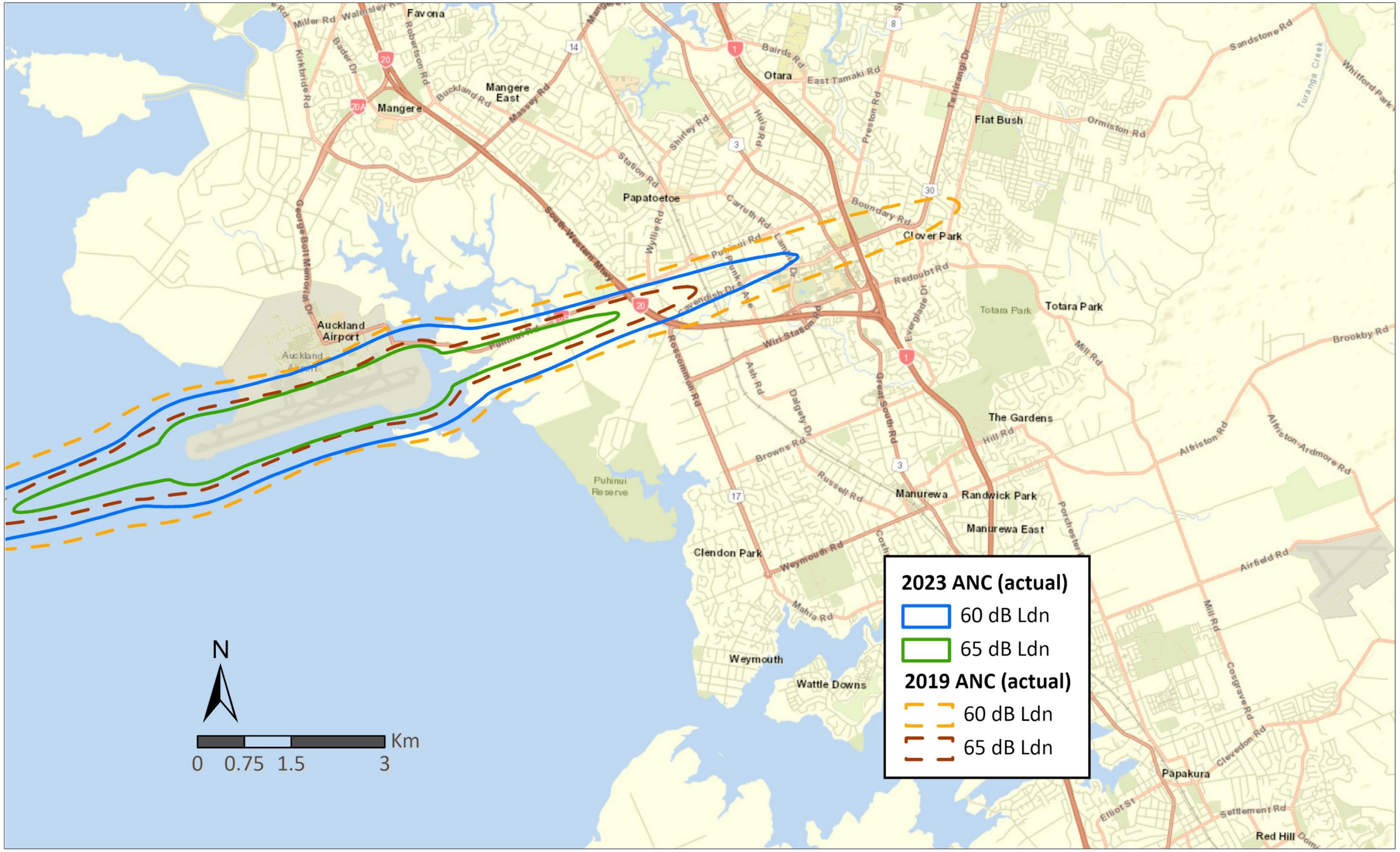
The INM uses its database of noise and operating procedures to calculate the noise level at a large number of grid points (which represent the geographical points around the airport where noise is calculated) by summing the 'noise energy' from each aircraft movement during the average day's operation. The 'noise energy' is calculated using the hourly L_{eq} value, night-weighted by +10 dB and then averaged over 24 hours to give the daily L_{dn} value at each grid point. The grid points with equal noise level are then joined graphically to give a plot of L_{dn} noise contours (e.g. all grid points with a level of 60 dB L_{dn} are joined with a line which becomes the 60 dB L_{dn} contour). This is how the ANNA, MANA, and HANA contours were calculated for the AUP (using projected aircraft movements in the far future), and how the ANC (Section 5.0) and AANC (Section 6.0) contours are calculated annually for this report.

Over 20 years Marshall Day Acoustics has undertaken calibration studies to compare the modelled noise levels with measured levels from the monitoring system for individual aircraft types and operations. Adjustments have been made to the model inputs with respect to take-off procedures and weights to calibrate the model to better represent measured levels.

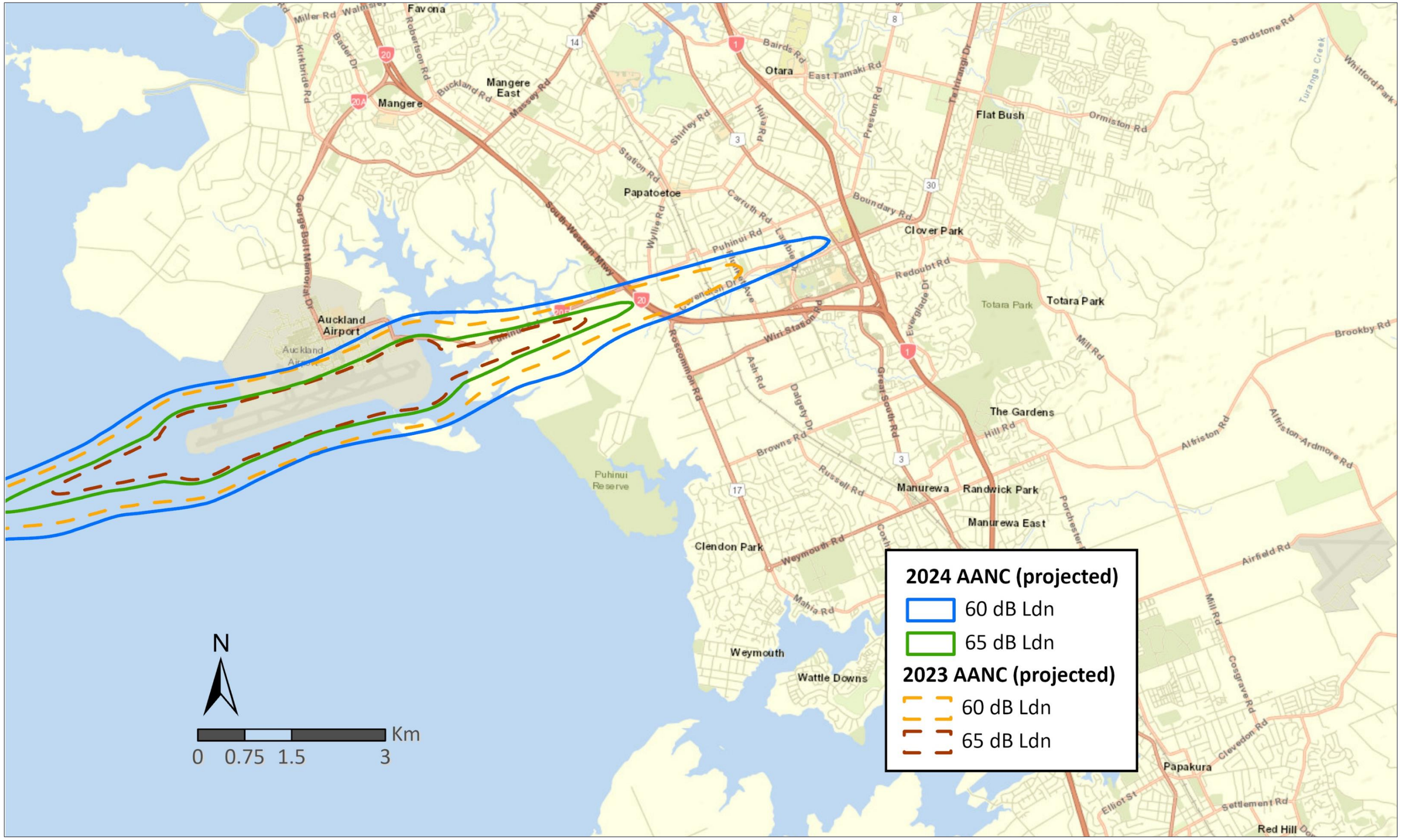
[4] European Civil Aviation Conference Doc 29 Report on Standard Method of Computing Noise Contours Around Civil Airports. https://www.ecac-ceac.org/about-ecac

[5] SAE International - Procedure for the Calculation of Airplane Noise in the Vicinity of Airports. SAE International, formerly named the Society of Automotive Engineers, is a United States-based, globally active professional association and standards developing organization. https://www.sae.org/about

APPENDIX D 2019 & 2023 ANC COMPARISON



APPENDIX E 2023 & 2024 AANC COMPARISON



MARSHALL DAY Acoustics

Auckland Airport

APPENDIX F NOISE COMPLAINTS BY SUBURB

Suburb	No. Complaints
Botany Downs	1
Clover Park	4
Cockle Bay	1
Dannemora	1
East Tamaki	72
East Tamaki Heights	186
Epsom	1
Farm Cove	1
Flat Bush	13
Glenbrook	1

Suburb	No. Complaints
Glendene	1
Greenlane	18
Highland Park	3
Kumeu	4
Laingholm	2
Mangere	2
Manukau	2
Meadowbank	1
Mount Albert	2
Mount Roskill	1

Suburb	No. Complaints
Mount Wellington	1
Muriwai	1
Papatoe	1
Papatoetoe	16
Remuera	59
Saint Johns	1
Takapuna	1
Titirangi	141
Waiatarua	1