

2018 AERONAUTICAL NOISE MANAGEMENT REPORT

-VANCOUVER AIRPORT AUTHORITY-

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INTRODUCTION

Vancouver Airport Authority (“Airport Authority”) is a community-focused and financially independent organization, governed by a community-based Board of Directors, which oversees the daily operations of the Vancouver International Airport (“YVR”) to ensure the airport runs safely and efficiently. As a community-focused organization, the Airport Authority is committed to a positive long-term relationship with our surrounding communities and is dedicated to operating YVR in a manner that minimizes negative impacts on the environment, while providing 24-hour airport services.

The Airport Authority took over management of YVR from Transport Canada in 1992 under a long-term lease agreement. Managing noise from aircraft operations has been a priority for us since assuming responsibility of YVR.

As with all work undertaken by the Airport Authority, we approach noise management using a sustainability framework, which integrates the economic, environmental, social and governance aspects of our business. This framework is essential to our success and provides a responsible approach for our business objectives and our commitment to the local community.

The objective of this report is to share information with the community about activities of the YVR Aeronautical Noise Management Program, and to facilitate informed dialogue between stakeholders involved in managing aircraft noise. Data and information compiled for this report also help to support discussions with members of the YVR Aeronautical Noise Management Committee (“ANMC”), a consultative forum for independently appointed community and industry representatives to share information and provide advice and input on the development of initiatives to the Airport Authority through a collaborative process.

2018 HIGHLIGHTS

The Airport Authority has a comprehensive noise management program to manage noise from aircraft and airport operations while balancing the need of 24-hour airport access in the region. Below is a summary of 2018 noise management work highlights.

2019-2023 YVR NOISE MANAGEMENT PLAN

Throughout 2018, the Airport Authority worked to develop a new 5-year Noise Management Plan (“NMP”) for the years 2019-2023. The 5-year NMP is an integral part of advancing the goals of the YVR Noise Management Program and is a requirement under the Airport Authority’s ground lease with Transport Canada. The last NMP was developed in 2013 and covered the years 2014-2018.

The new NMP was developed in close consultations with the members of ANMC. This is a key stakeholder group for the discussion of noise management activities at YVR, and membership on the Committee includes: staff and citizen representatives from Richmond, Vancouver, Delta, and Surrey; Musqueam Indian Band; Transport Canada; NAV CANADA; airlines; and industry associations.

To create the new NMP, the multi-stage process illustrated in Figure 1 was followed, and various supporting work was undertaken in each stage.

FIGURE 1: Process to Create the 2019-2023 YVR Noise Management Plan



Some of major tasks completed during the process included:

- Analysis of historical noise concerns received between 2014-2018
- Administration of community web questionnaire (summary below)
- Noise management practice review (summary below)

The new NMP identifies 12 areas of focus with supporting initiatives. Some of key initiatives include improving communication tools and developing a multi-year support and upgrade plan for the airport’s noise monitoring and flight tracking system.

The final draft of the NMP was submitted to Transport Canada for review and acceptance at the end of December 2018. The new NMP will be available on www.yvr.ca in early 2019.

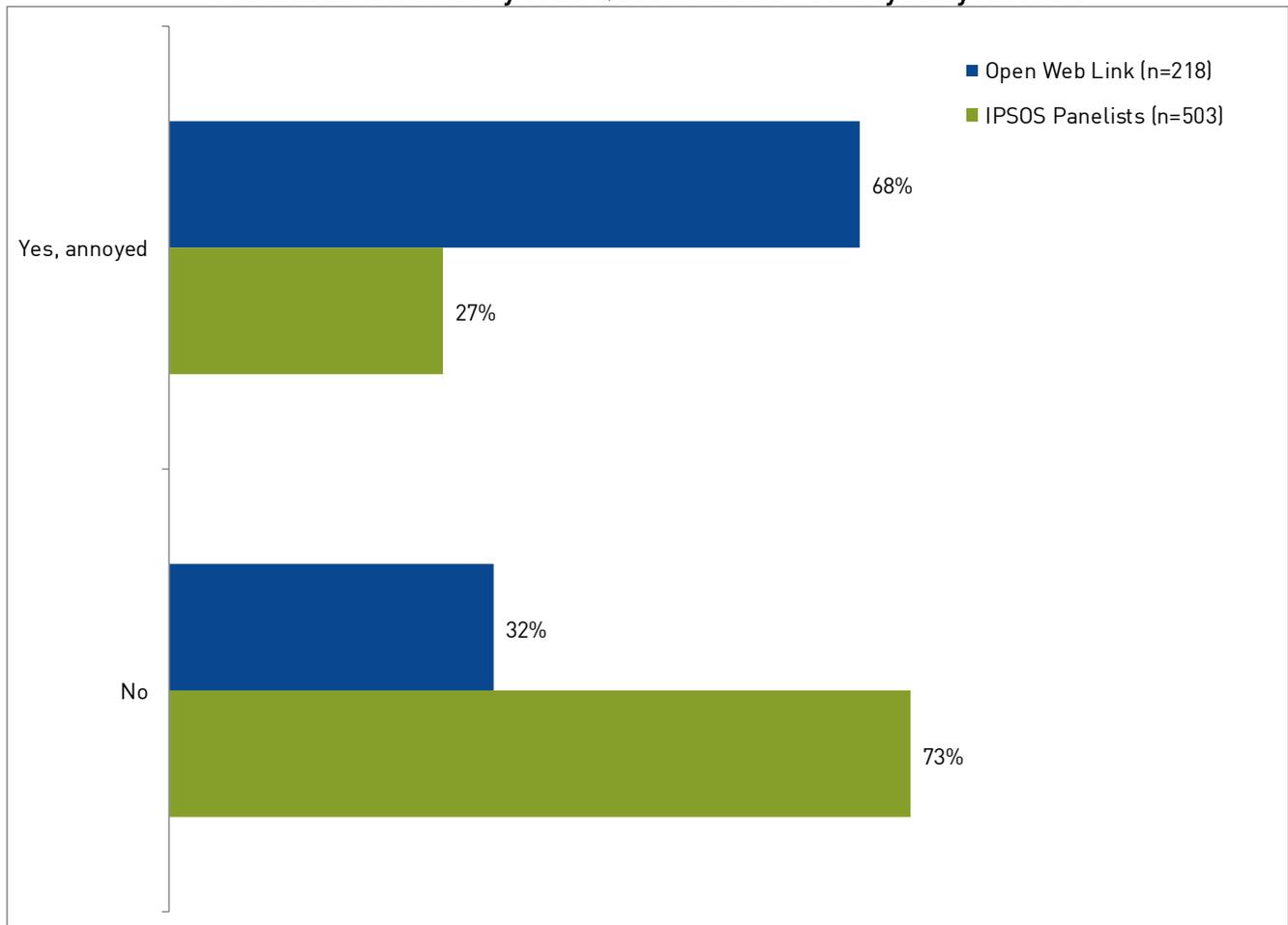
Community Web Questionnaire - Summary

To engage with the community in the process of creating the new NMP, the Airport Authority made available a community web questionnaire through IPSOS between March 13 and July 13, 2018. The questionnaire included 11 questions to help identify specific community concerns, solicit input on potential mitigation measures, and collect feedback on various aspects of the YVR Noise Management Program.

A total of 721 individuals completed the questionnaire, including 218 individuals who participated directly through the open web link and another 503 individuals from IPSOS' survey panelist group in the Lower Mainland.

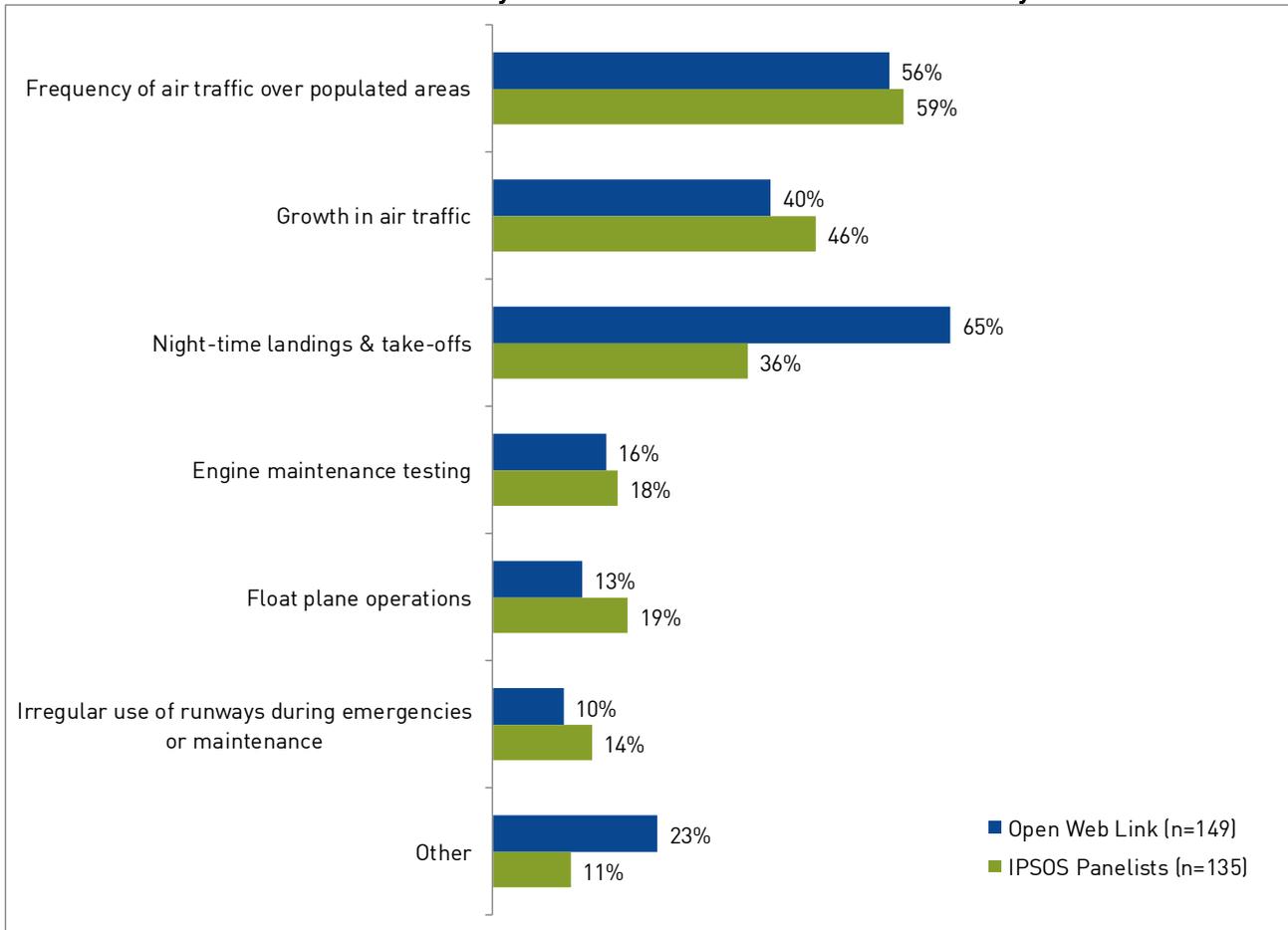
As illustrated in Figure 2, when asked whether they have been annoyed by aircraft in the past 12 months, 68% of 218 open web link respondents stated they have been annoyed, whereas 27% of 503 IPSOS panelists stated they have been annoyed.

FIGURE 2: Community Web Questionnaire – Annoyed by Aircraft



Of those individuals who were annoyed by aircraft, the top causes of annoyance were identified as frequency of air traffic over populated areas, growth in air traffic, and night-time landings and take-offs. These generally reflected the top issues identified through the analysis of noise concerns received between 2014 and 2017. Figure 3 illustrate further break down of various causes.

FIGURE 3: Community Web Questionnaire - Cause of Annoyance



When asked for suggestions on how to best address their issues of concern, top general responses included:

- Change or move flight paths
- Restrict night-time operations
- Reduce propeller aircraft traffic at the airport and move air traffic to other regional airports
- Further restrict maintenance run-ups and invest in different technologies to reduce run-up noise

All input and suggested ideas collected from the community and ANMC members were then reviewed and evaluated against the following criteria:

- Noise mitigation
- Impact on safety
- Impact on airport or aircraft operations
- Effects on emissions or Green House Gases
- Economic cost to industry
- Noise impact on other communities
- Impact on current and future airport capacity
- Alignment with the Airport Authority's mandate to provide 24/7 air services

Based on the results of the evaluation, 12 areas of focus and supporting work initiatives were identified to include in the new NMP.

Noise Management Practice Review

As part of the work to support the development of new NMP, the Airport Authority commissioned AirBIZ to complete a review of noise management practices at other international airports including: Toronto Pearson, Montreal-Trudeau; Seattle; Portland; Amsterdam; Frankfurt; Helsinki; London Heathrow; Manchester; Zurich; and Sydney.

The objective of the review was to inform ANMC members of practices at other airports and support discussions on identifying possible initiatives for the new NMP. While the review provided insight and information on possible ways to enhance communication with communities and helped shape some of the initiatives in the new NMP, the review also highlighted that noise management practices are often unique to each airport given the different operating environment, regulatory structure, and community issues, and a solution that works for one airport may not be applicable for use at other airports.

PORTABLE NOISE MONITORING AT MUSQUEAM

The Airport Authority set up the portable noise monitoring terminal at the Musqueam Indian Band Community Centre in September 2018 to help understand aircraft noise exposure in the area. Monitoring of aircraft noise in the area was identified during discussions with the Musqueam Community to provide an understanding of aircraft noise exposure. A detailed summary report on the monitoring data will be prepared in early 2019.

FLY QUIET AWARDS

The 2017 YVR Fly Quiet Awards were presented at the YVR Chief Pilots Meeting in May 2018. The goal of these awards is to raise awareness of noise issues within the aviation community. Eligibility criteria for the awards include:

1. The airline must not be in suspected violation of any of the published Noise Abatement Procedures.
2. The airline must have the lowest average annual noise level for their aircraft category as measured by the airport's Aircraft Noise & Operations Monitoring System.
3. The airline must operate a regular services at YVR.

The winners included: Horizon Air (propeller category); Jazz (narrow-body jets); and Xiamen Airlines (wide-body jets). Award winners for the past three years are presented in Table 1.

TABLE 1: YVR Fly Quiet Award Winners, 2015-2017

| YEAR | Propeller | Narrow Body Jets | Wide Body Jets |
|------|-----------|------------------|----------------|
| 2017 | | | |
| 2016 | | | |
| 2015 | | | |

YVR OPERATIONS IN REVIEW

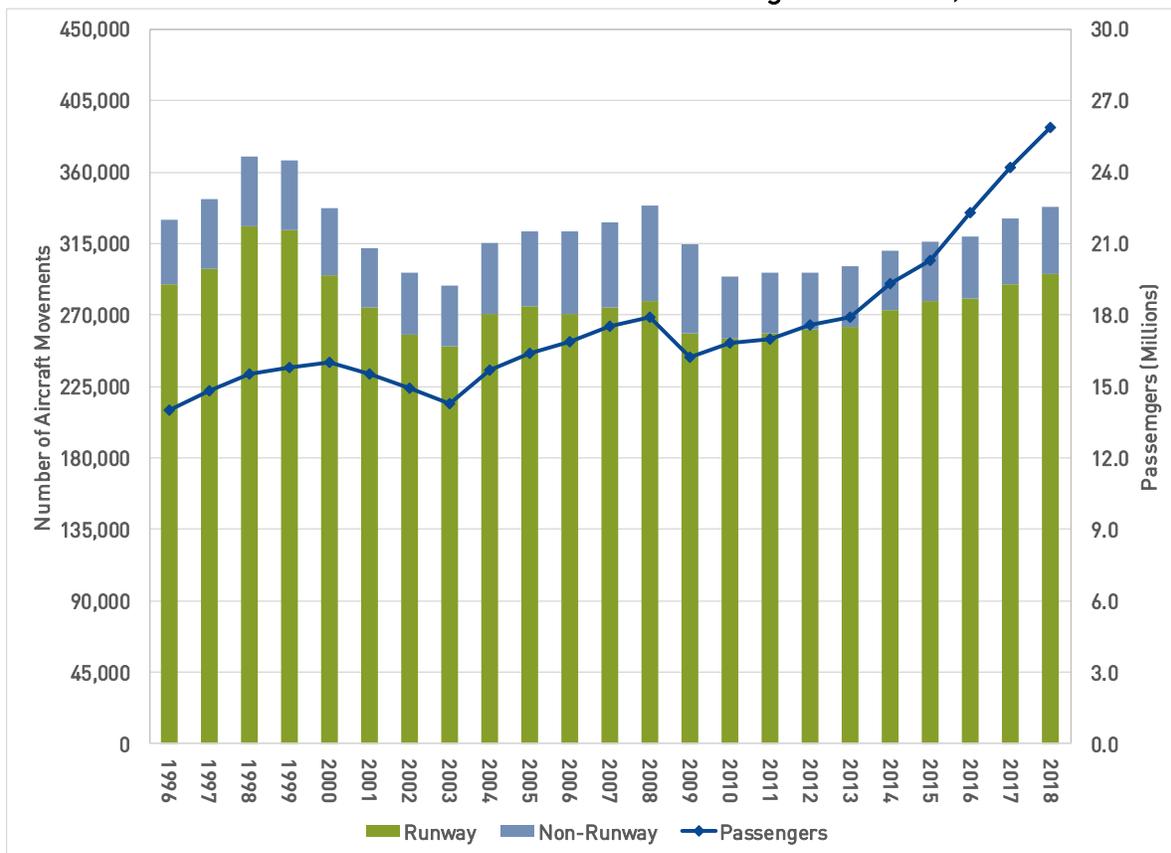
In 2018, YVR experienced growth in aircraft movements, cargo tonnage, and total passengers. Table 2 presents the annual operational statistics in 2018.

TABLE 2: Operational Statistics for YVR, 2018

| | | |
|----------------------|------------|-------------------------|
| Total Movements | 338,073 | 2.2% increase from 2017 |
| Total Cargo (Tonnes) | 338,180 | 7.9% increase from 2017 |
| Total Passengers | 25,936,907 | 7.3% increase from 2017 |

Figure 4 illustrates the historical trend of aircraft movements and passengers at YVR for the time period of 1996-2018. In 2018, the number of passengers surpassed its record in 2017 by 1.8 million while the total number of aircraft movements remained below the peak number of aircraft movements in 1998. This continuing trend indicates that the passenger growth rate is higher compared to the growth in aircraft movements – meaning aircraft are carrying more passengers and cargo per operation, which has the benefit of reducing noise and emissions.

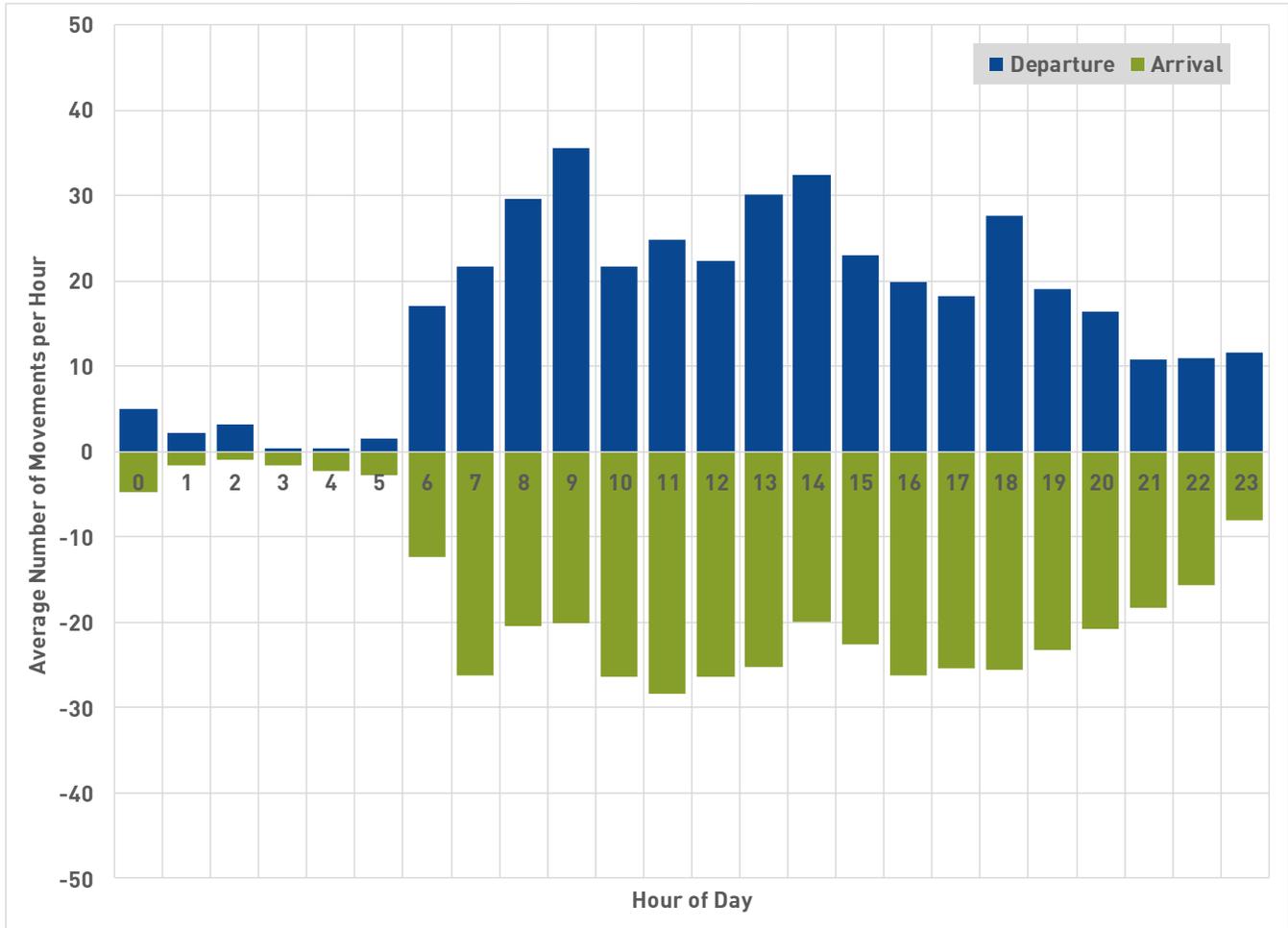
FIGURE 4: Annual Aircraft Movements¹ & Passenger Statistics, 1996-2018



¹ Aircraft movements in this chart include both runway and non-runway movements. Non-runway movements include helicopter and float plane operations using helipads and waterdrome at YVR.

In 2018, approximately 97% of aircraft movements occurred during the day-time hours² and approximately 3% of aircraft movements during the night-time hours³. Figure 5 illustrates the average hourly runway movements by arrival and departure in 2018. As illustrated, aircraft movements begin to increase at 6:00AM and arrival or departure peaks are experienced throughout the day.

FIGURE 5: Average Hourly Runway Movements, 2018



² For this report, day-time is defined as the time period between 6:00AM and Midnight.

³ For this report, night-time is defined as the time period between Midnight and 6:00AM.

PASSENGER MOVEMENTS AND FORECAST

2018 was another record year for YVR, as over 25.9 million passengers flew through the airport, representing approximately 1.7 million additional passengers or a 7.3% increase over the previous year. The year-over-year increase was primarily driven by the following:

- Over 720,000 or 6.1% more passengers travelled domestically. This was mainly due to a strong local economy in BC where both Air Canada and WestJet continued to increase domestic capacity at YVR. In addition, Flair Airlines entered the market providing service between YVR and Kelowna, Edmonton, and Calgary.
- Over 336,000 or 5.6% more passengers travelled to and from the United States. This growth was largely driven by Air Canada's new service to Sacramento and American Airline's new service to Chicago. Almost all airlines servicing the Transborder sector increased services in 2018, contributing to the overall growth.
- Over 394,000 or 9.6% additional passengers travelled to and from Asia Pacific. This growth was driven by strong average load factors (84.1% for the year) and a 2.6% increase in capacity. New service to Tianjin/Shenzhen and increased frequencies to Delhi and Melbourne by Air Canada also contributed to the growth.
- Over 151,000 or 9.4% additional passengers in the Europe sector was driven by new Air Canada services to Paris and Zurich.
- The Latin America sector saw the highest percentage increase at 23.8%, which represents over 177,000 additional passengers. The market has seen a significant growth in Mexico passengers since the Canadian government lifted the visa requirement for Mexican visitors to Canada in 2016. Aeromexico to Mexico City led in capacity growth, followed by Air Canada to Cancun and Puerto Vallarta.

The Airport Authority is forecasting approximately 27.2 million passengers in 2019. This represents approximately a 5% increase over 2018 and is anticipated to be supported by growth in all sectors.

OPERATIONAL SNAPSHOT – NIGHT OPERATIONS

Like most international airports around the world and all international airports in Canada, YVR is open 24-hours a day to serve travel and business demands of the region. While most aircraft movements occur during the day-time hours, some operations occur during the night-time hours. These movements at night are typically associated with passenger, cargo, and courier services.

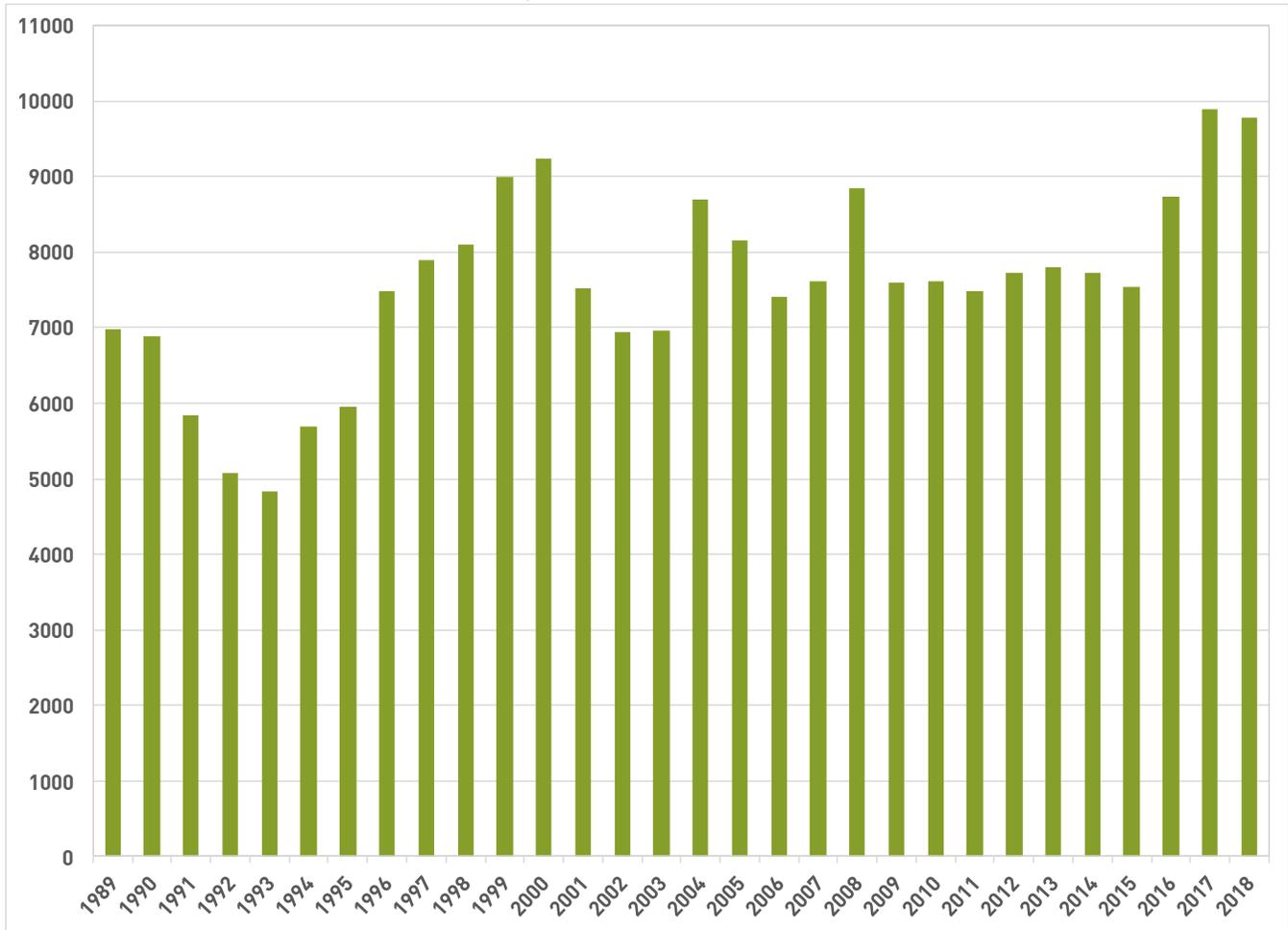
In 2018, there were 9,785 runway movements during the night-time hours. This equates to an average of approximately 28 movements per night between the hours of midnight and 6:00AM. Of these movements, approximately 52% were arrivals, which are generally quieter than departures. Table 3 summarizes the breakdown of the average nightly movements by aircraft type and operation.

TABLE 3: Average Nightly Movements by Aircraft Type and Operation, 2018

| Aircraft Type | Operation | |
|-----------------|-----------|-----------|
| | Arrival | Departure |
| Propeller | 3 | 2 |
| Business Jet | 1 | 1 |
| Narrow Body Jet | 8 | 2 |
| Wide Body Jet | 3 | 8 |

- Propeller aircraft include types such as the Dash-8, Navajo, Beech 1900, Saab 340, etc.
- Business jets include types such as the Citation, Learjet, etc.
- Narrow-body jets include types such as the A320, B737, CRJ, E190, etc.
- Wide-body jets include types such as the B787, B777, A350, A330, etc.

YVR has always been open 24-hours a day, including when the airport was managed by Transport Canada prior to the transfer to the Airport Authority in 1992. For comparative purposes, Figure 6 illustrates the annual night-time runway movements at YVR for the years 1989 to 2018. In 2018, the number of night-time runway movements decreased by approximately 1% compared to the previous year.

FIGURE 6: Annual Night-time Movements at YVR, 1989-2018


OPERATIONAL SNAPSHOT – JET FLEET MIX BY NOISE CERTIFICATION

The International Civil Aviation Organization (“ICAO”) is an agency of the United Nations and establishes principles and techniques for the planning and development of international air transportation to ensure safe and orderly growth. The ICAO Committee on Aviation Environmental Protection (“CAEP”) prescribes standards for noise with the goal of promoting reduction at the source. These standards are contained in *Annex 16: Volume I Environmental Protection - Aircraft Noise* and categorize jet aircraft as either Chapter 2, Chapter 3 or Chapter 4 depending on three measured noise levels (take-off, landing, and sideline) obtained during prototype development⁴.

⁴ To reduce aircraft noise exposure on communities, the Government of Canada legislated the phase-out of Chapter 2 jet aircraft over 34,000kg from operation in Canada by the year 2002. These aircraft are no longer permitted to operate in Canada and were either retired from operation or modified to meet Chapter 3 standards. A few exemptions were granted to aircraft operating from airfields in northern Canada.

The Chapter 14 noise standard was confirmed at the 9th meeting of CAEP in February 2013. This standard applies to new aircraft types over 55 tonnes (55,000kg) certified after 2017 and to new aircraft types less than 55 tonnes after 2020. To meet the Chapter 14 standard, aircraft must be at least 7 EPNdB (Effective Perceived Noise in Decibels) quieter than the current Chapter 4 standard. This reduction is cumulative over the three measurements points: take-off, landing, and sideline.

An analysis was performed on jet operations occurring in 2018 to determine the percentage of Chapter 3 and Chapter 4 movements. Table 4 below presents the results of the analysis by Gross Take-off Weight ("GTOW") of the aircraft. In 2018, 93% of all jet aircraft operating at YVR met Chapter 4 noise standards.

TABLE 4: ICAO Noise Certification of Jet Operations at YVR, 2018

| ICAO Noise Certification | All Jet Aircraft | GTOW < 34,000kg (n~11,150) | GTOW ≥ 34,000kg | |
|--------------------------|------------------|-------------------------------|----------------------------|-------------------------|
| | | | Narrow Body (n~123,470) | Wide Body (n~37,300) |
| Chapter 3 | 7% | 21% | 8% | 3% |
| Chapter 4 | 93% | 79% | 92% | 97% |

Approximately 90% of the jet aircraft operations occurring during night time hours between midnight and 6:00 AM met Chapter 4 noise certification standards.

The airline industry continues to invest hundreds of millions to upgrade their fleet to reduce both noise and emissions. Aircraft operating today are approximately 30 dB quieter (or a 90% reduction in noise footprint area) as compared to older comparable aircraft.

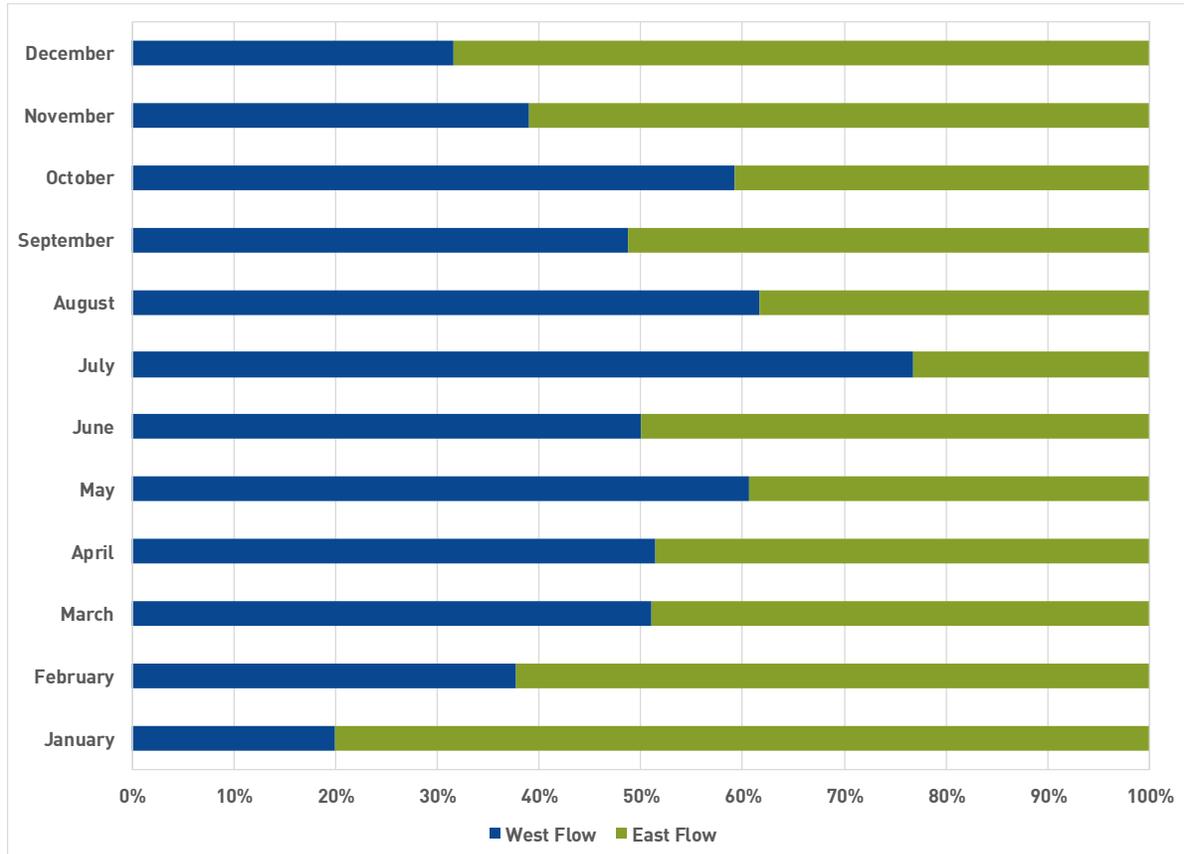
AIR TRAFFIC FLOW

YVR has two parallel runways and a crosswind runway. The parallel runways, which include the south runway (08R/26L) and the north runway (08L/26R), are aligned in an east-west direction with magnetic headings of 083° and 263°. The crosswind runway (13/31) is oriented in a northwest and southeast direction with magnetic headings of 125° and 305°.

The active runways are determined by wind conditions at the airport as aircraft must take-off and land into the wind for safety reasons. The predominant winds at YVR are typically in an easterly or westerly direction; therefore, the parallel runways are the primary runways in use. Based on historical observations, traffic flow in an easterly direction (Runway 08L and 08R) are more common during the fall and winter months, and traffic flow in a westerly direction (Runway 26L and 26R) are more common during the spring and summer months.

Figure 7 illustrates the monthly distribution between easterly and westerly flow on the parallel runways, and the seasonal trends can be observed with more dominant east flow during the fall and winter months and more dominant west flow during the spring and summer months. Overall, the wind conditions were balanced with 50% westerly flow and 50% easterly flow throughout 2018.

FIGURE 7: Monthly Distribution of Air Traffic Flow at YVR, 2018



The published YVR Noise Abatement Procedures prescribes westerly flow of traffic as the preferred mode of operation whenever possible to reduce noise exposure on the community as this puts departures, the noisiest type of operation, over the Strait of Georgia. In addition, NAV CANADA will attempt to accommodate two-way flow between the hours of 11:00PM and 6:00AM to keep both arriving and departing aircraft over the Strait of Georgia to minimize over-flights and noise on the community. However, the use of two-way flow is dependent on traffic volume, airfield activities, and weather conditions and cannot be used all the time.

RUNWAY USE

At YVR, the south runway is the main 24-hour runway. The north runway is normally closed between the hours of 10:00 PM and 7:00 AM (except during emergencies and airfield maintenance) and is used primarily for landings between 7:00 AM and 10:00 PM. The

crosswind runway is used infrequently and is mostly reserved for the periods of high crosswind conditions. Figure 8 and 9 illustrate the distribution of arrivals and departures on all runways in 2018.

FIGURE 8: Runway Arrival Distribution, 2018



FIGURE 9: Runway Departure Distribution, 2018



RUN-UPS

Transport Canada standards require that aircraft undergo regular maintenance to ensure safe operations. Engine run-ups are a critical part of maintenance work and involve running the engines at various power settings for a period of time to stress components and to simulate flight conditions. This ensures work has been done properly and that the aircraft is safe to return to service.

YVR RUN-UP DIRECTIVES AND PROCEDURES

To ensure a high level of safety on the airfield and to reduce community noise exposure from run-ups, the Airport Authority maintains directives and procedures that prescribe how, when, and where run-ups can be performed. Aircraft operators are required to request approval from the Airport Authority prior to performing a run-up, and approved run-ups are assigned a specific location and heading to ensure safety and to minimize noise impacts on surrounding communities. All maintenance run-ups are logged, and these records are routinely analyzed to track run-up activities and identify trends.

YVR RUN-UP ACTIVITY

There were a total of 4,739 run-ups performed at YVR in 2018. This is a 4% decrease compared to the previous year. Table 5 provides the number of run-ups performed each year at YVR between 2014-2018.

TABLE 5: Number of Run-ups Performed at YVR, 2014-2018

| Year | Number of Approved Run-ups |
|------|----------------------------|
| 2014 | 4,916 |
| 2015 | 4,653 |
| 2016 | 4,584 |
| 2017 | 4,939 |
| 2018 | 4,739 |

Operators performing run-ups can be divided into two distinct areas of the airfield - those located on the north airfield, and those located on the south airfield, with the south runway acting as the dividing line. In 2017, north airfield operators accounted for approximately 43% of all run-up activities at YVR and south airfield operators accounted for the remaining 57%. The run-ups by south airfield operators are generally performed on propeller aircraft, as many operators of propeller aircraft have their maintenance facilities on the south airfield.

In general, there are three different power settings associated with run-ups: idle; above idle; and full power. Full power run-ups are considered the noisiest because the engine is operated at maximum power. Run-ups performed at full power are less frequent and are often shorter

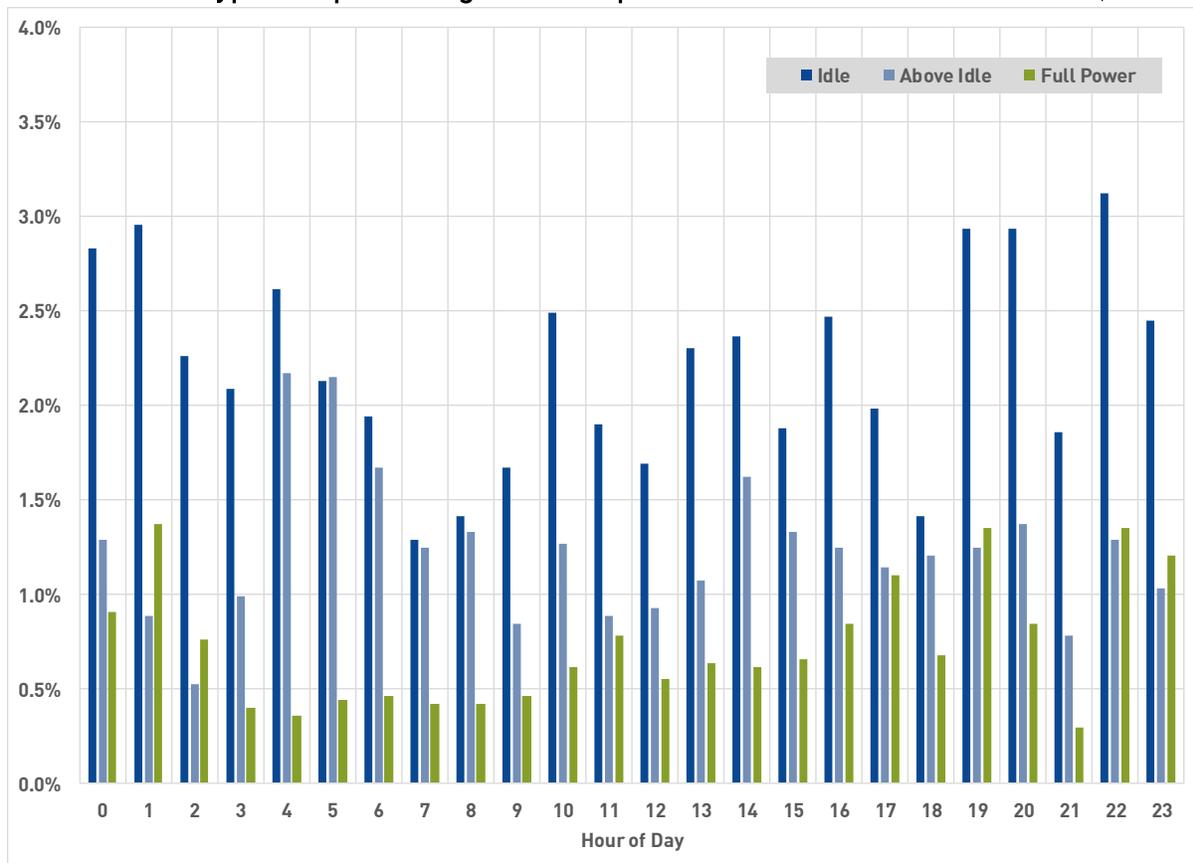
in duration when compared to idle and above idle run-ups. Operators endeavor to reduce the duration of full power run-ups as this results in increased wear on the engines and fuel consumption when running engines at full power. Table 6 provides a breakdown of run-up types and per cent total at YVR for 2018.

TABLE 6: Run-up Type (by power setting) Distribution, 2018

| Run-up Category | Percent Total of Runs |
|-----------------|-----------------------|
| Idle | 53% |
| Above Idle | 29.5% |
| Full Power | 17.5% |

Figure 10 provides a breakdown for all run-ups (n=100%) carried out at YVR in 2018 by power setting and hour of the day. While run-ups are performed at all times of the day, maintenance work on aircraft is often performed at night when crews have access to the aircraft because most aircraft are flying during the day. As such, the associated run-up also occurs at night to ensure the aircraft is airworthy to return to service in the morning. However, as illustrated, operators are consistently busy throughout the day with run-ups being carried out at all hours of the day.

FIGURE 10: Type and percentage of run-ups conducted for each hour at YVR, 2018



GROUND RUN-UP ENCLOSURE

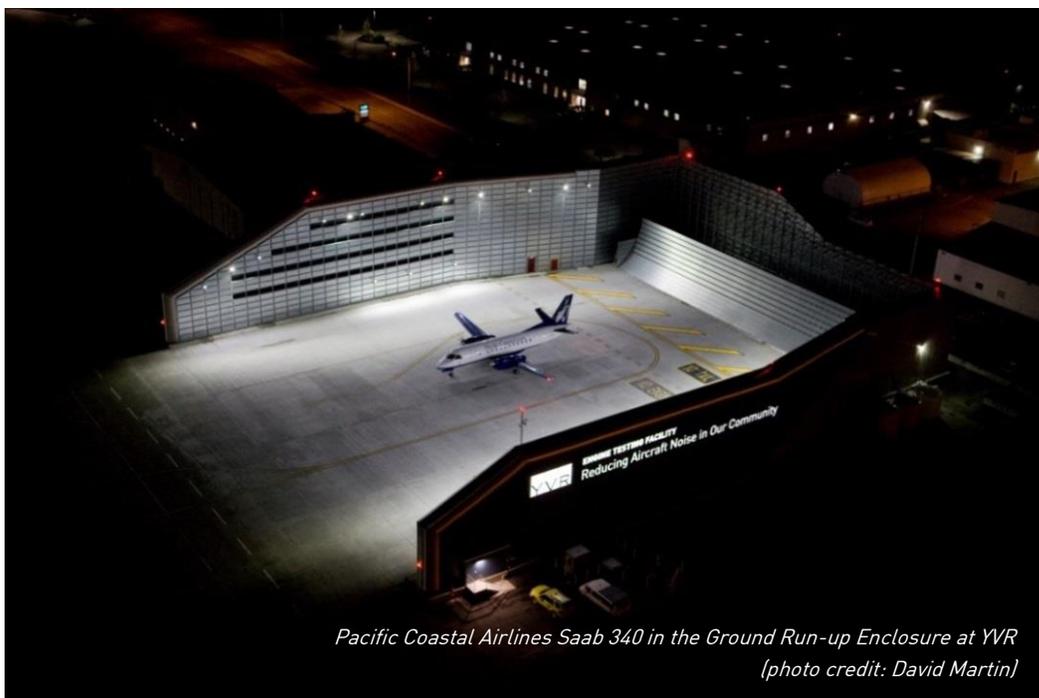
To reduce noise from the high number of propeller run-ups by operators located on the south airfield, the Airport Authority constructed Canada’s first Ground Run-up Enclosure (“GRE”) and the facility was opened in January 2012. While the GRE is designed to provide an average of 15 dBA noise reduction, the results will vary depending on the location of the receiver in relationship to the GRE.

The GRE facility is the preferred location for high power run-ups on the south airfield. In 2018, there were approximately 1,350 high power run-ups performed by south airfield operators, with about 76% of these performed in the GRE. Table 7 provides a more detailed breakdown of high power run-ups on the south airfield and their location in comparison with the GRE.

TABLE 7: South Airfield High Power Run-up Locations, 2017

| Power Setting | Location | Approx. % of South Airfield Run-ups |
|---------------|-----------|-------------------------------------|
| Above Idle | GRE | 57% |
| | Apron III | 42% |
| | Apron II | 2% |
| | Other | <1% |
| Full Power | GRE | 94% |
| | Apron III | 6% |

The GRE has reduced noise in the community and has been a great success with operators, who often request use of the facility for their run-ups due to its safe and controlled setting.



*Pacific Coastal Airlines Saab 340 in the Ground Run-up Enclosure at YVR
(photo credit: David Martin)*

NOISE CONCERNS

One of the goals of the YVR Aeronautical Noise Management Program is to provide the community with up-to-date information on airport operations and noise management efforts and initiatives. The community is able to contact the Airport Authority with their questions and concerns through a variety of means, including:

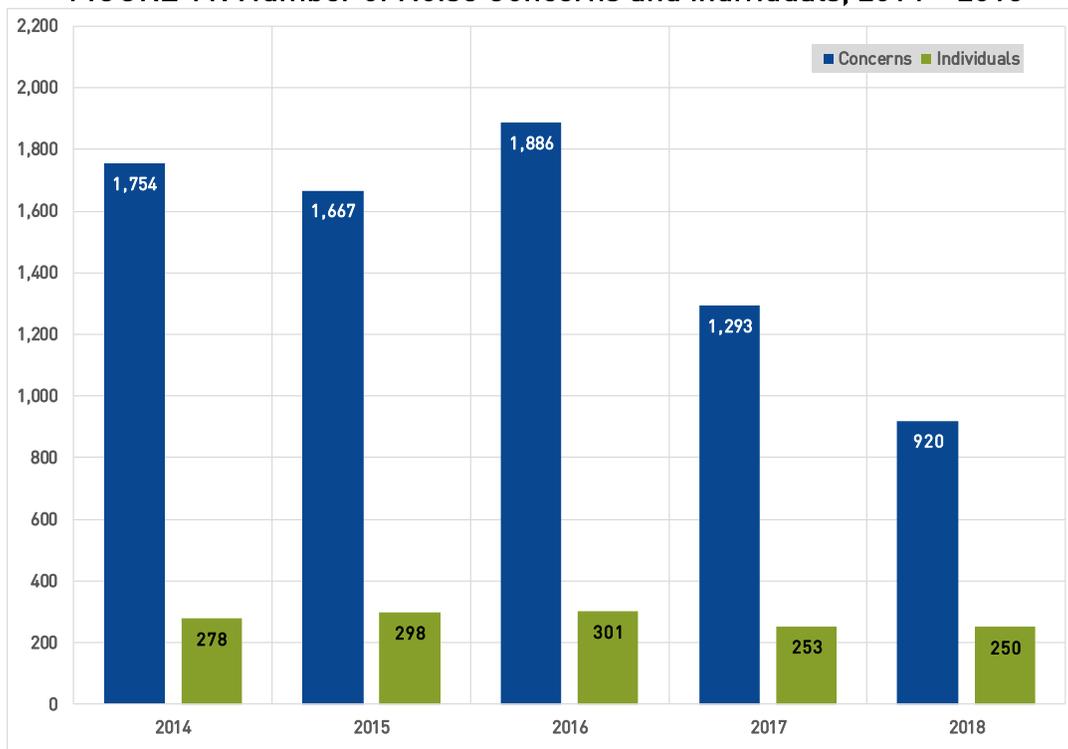
- Dedicated e-mail (noise@yvr.ca)
- YVR Website (www.yvr.ca)
- Real-time flight and noise tracking system ([WebTrak](#))
- YVR Noise Information Line (604-207-7097), 24-hours.

Information provided by residents and results of investigations are logged in a database, which is used to analyze and identify trends. The YVR Aeronautical Noise Management Committee is provided a summary of concerns at each meeting to review and discuss.

NUMBER OF CONCERNS

In 2018, the Airport Authority received 920 noise concerns from 250 individuals. This represents a 29% decrease in concerns and a 1% decrease in the number of individuals compared to 2017. Figure 11 presents a breakdown on the number of concerns and individuals for the past five years (2014-2018).

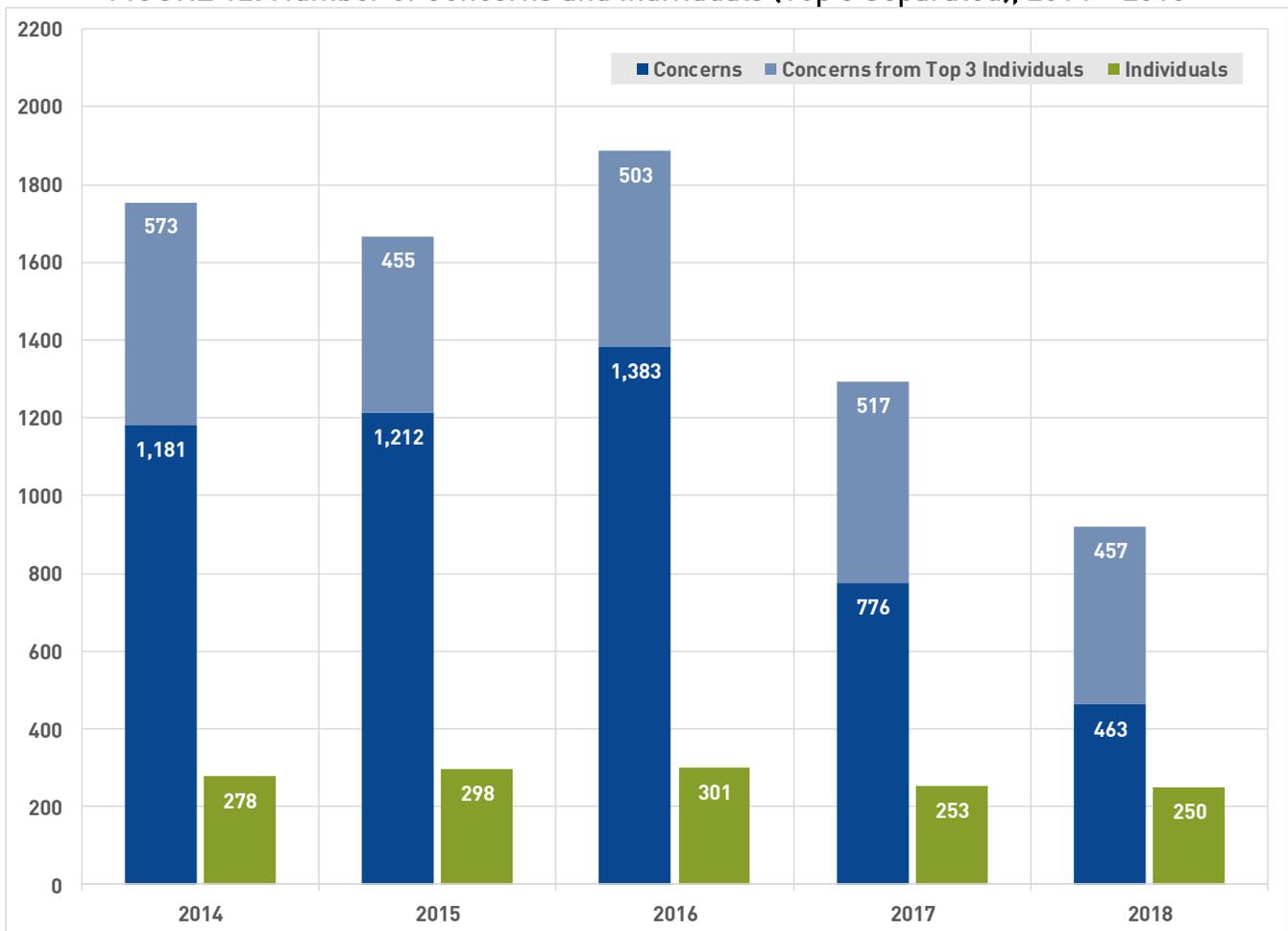
FIGURE 11: Number of Noise Concerns and Individuals, 2014 – 2018



There are several individuals who register multiple concerns throughout the year. In 2018, approximately 50% (n=457) of all concerns were received from three individuals.

Figure 12 provides a further breakdown of the number of concerns and individuals between 2014 and 2018 by separating the number of concerns submitted by the top three individuals each year.

FIGURE 12: Number of Concerns and Individuals (Top 3 Separated), 2014 – 2018



Facts about top three individuals in 2018 include:

- All three individuals reside within 7km from the airport.
- One individual registered 167 concerns mostly associated with night-time jet departures over the City and run-up activities.
- Two individuals registered a combined 290 concerns mostly related to jet departure routing and frequency over the City.

NOISE CONCERNS BY LOCATION

Whenever possible, individuals are asked to provide information on which city they live in to help determine where in the Lower Mainland concerns are originating from. Figure 13 shows the number of concerns and individuals for the various cities in the Lower Mainland.

FIGURE 13: Number of Concerns and Individuals by Location, 2018

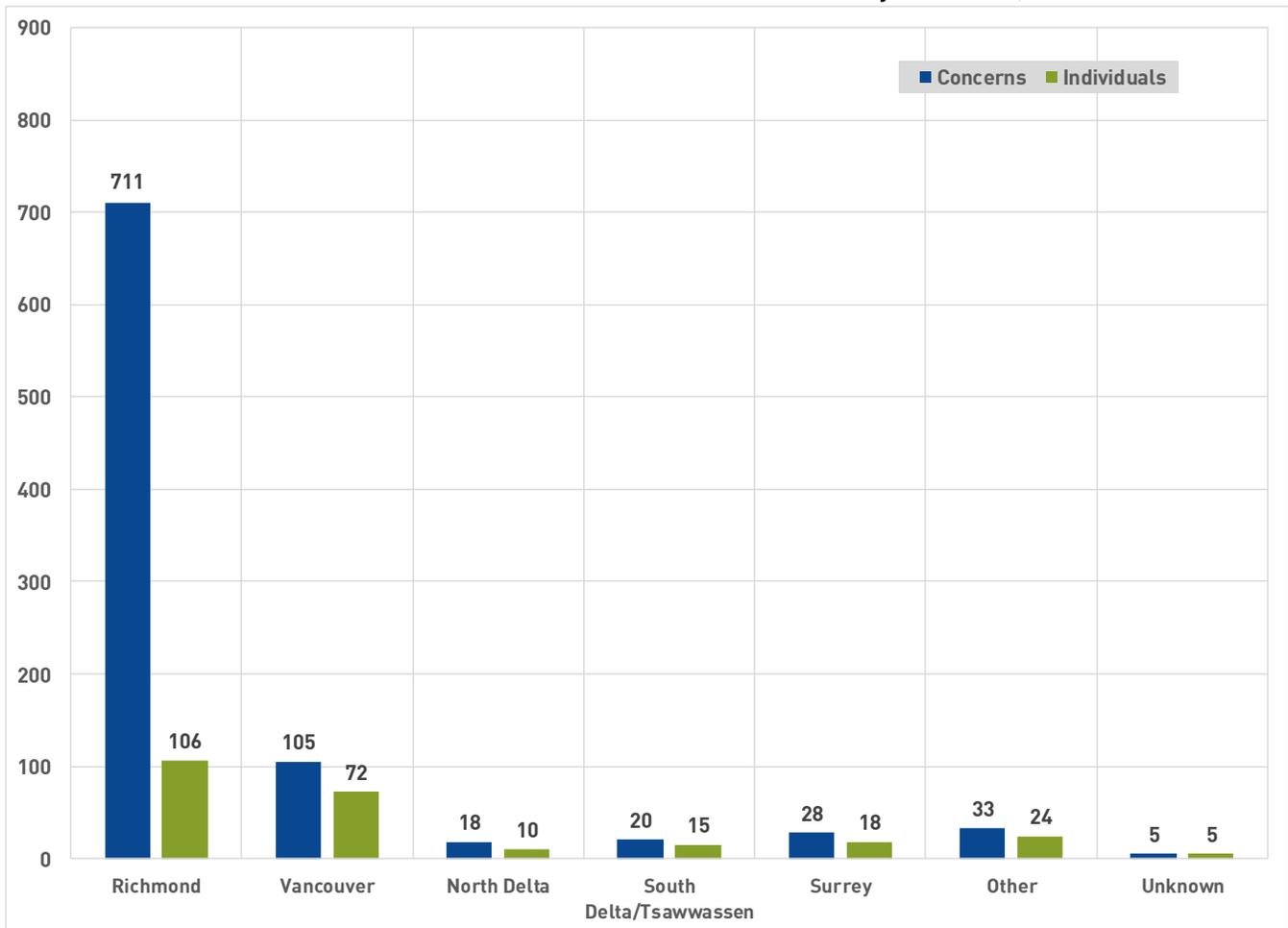
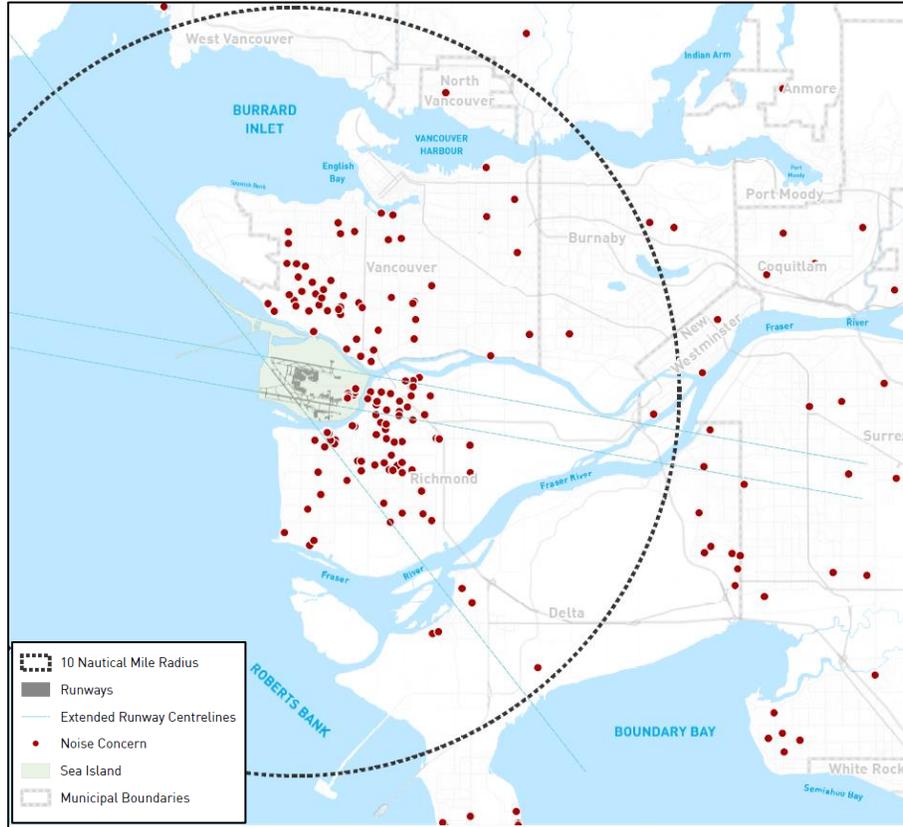
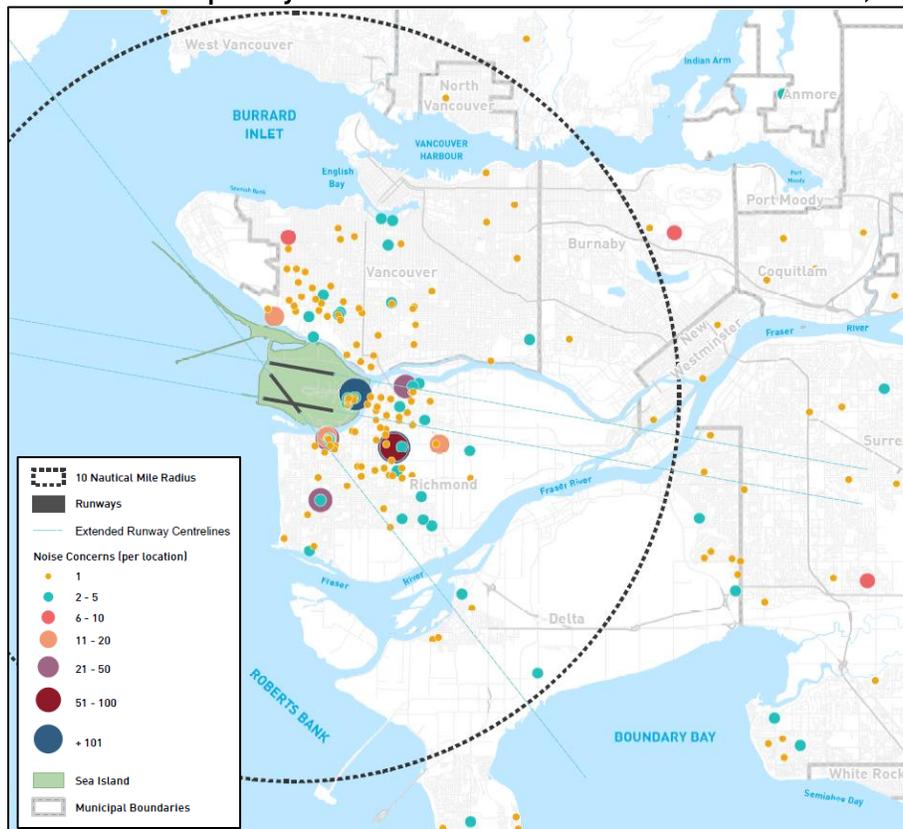


Figure 14 represents the geo-distribution of noise concerns in the Lower Mainland in 2018 based on address and postal code. Locations closer to the airport generally exhibit a greater density of noise concerns due to the lower altitude of aircraft and regularity of aircraft activity in these locations.

Figure 15 represents the geo-distribution and the frequency of concerns in the Lower Mainland from 2018. The size of each dot represents the volume of concerns originating from that postal code. As illustrated, while most individuals registering frequent concerns were in close proximity to the airport, some concerns were received from locations more than 10-nautical miles from the airport. Aircraft noise concerns from these areas are generally related to the general routing and flight paths over populated areas.

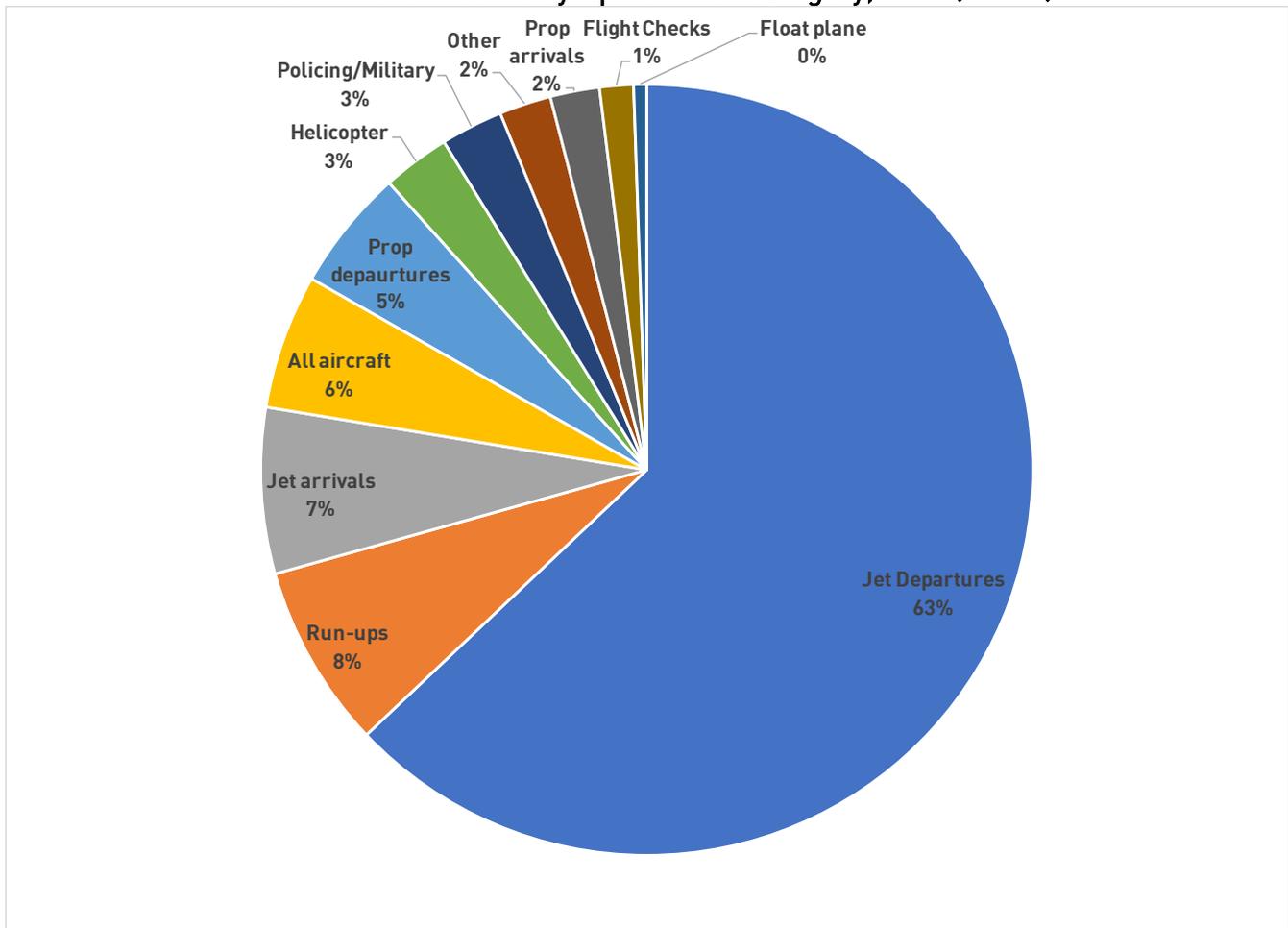
FIGURE 14: Geo-distribution of Noise Concerns, 2018

FIGURE 15: Frequency and Geo-distribution of Noise Concerns, 2018


NOISE CONCERN BY OPERATION TYPE

When reporting noise concerns, individuals generally provide details of date, time, and location of the noise event. Based on the information provided, each concern is categorized into an operation type such as jet departure, jet arrival, helicopter and run-ups. In some cases, the information provided by the individual is not sufficient to categorize the concern to a specific operation. In these instances, Airport Authority staff will review flight tracks and procedures to best categorize the nature of the concern. General concerns that cannot be matched against a specific operation type are categorized as “All aircraft”. Specific noise events that cannot be correlated to any aircraft activities at the time of event provided by the individuals are categorized as “Other”.

The nature of concerns varies greatly and often depends on where the individual is located with respect to the airport and flight paths. Figure 16 shows a breakdown of all noise concerns received in 2018 by operational category.

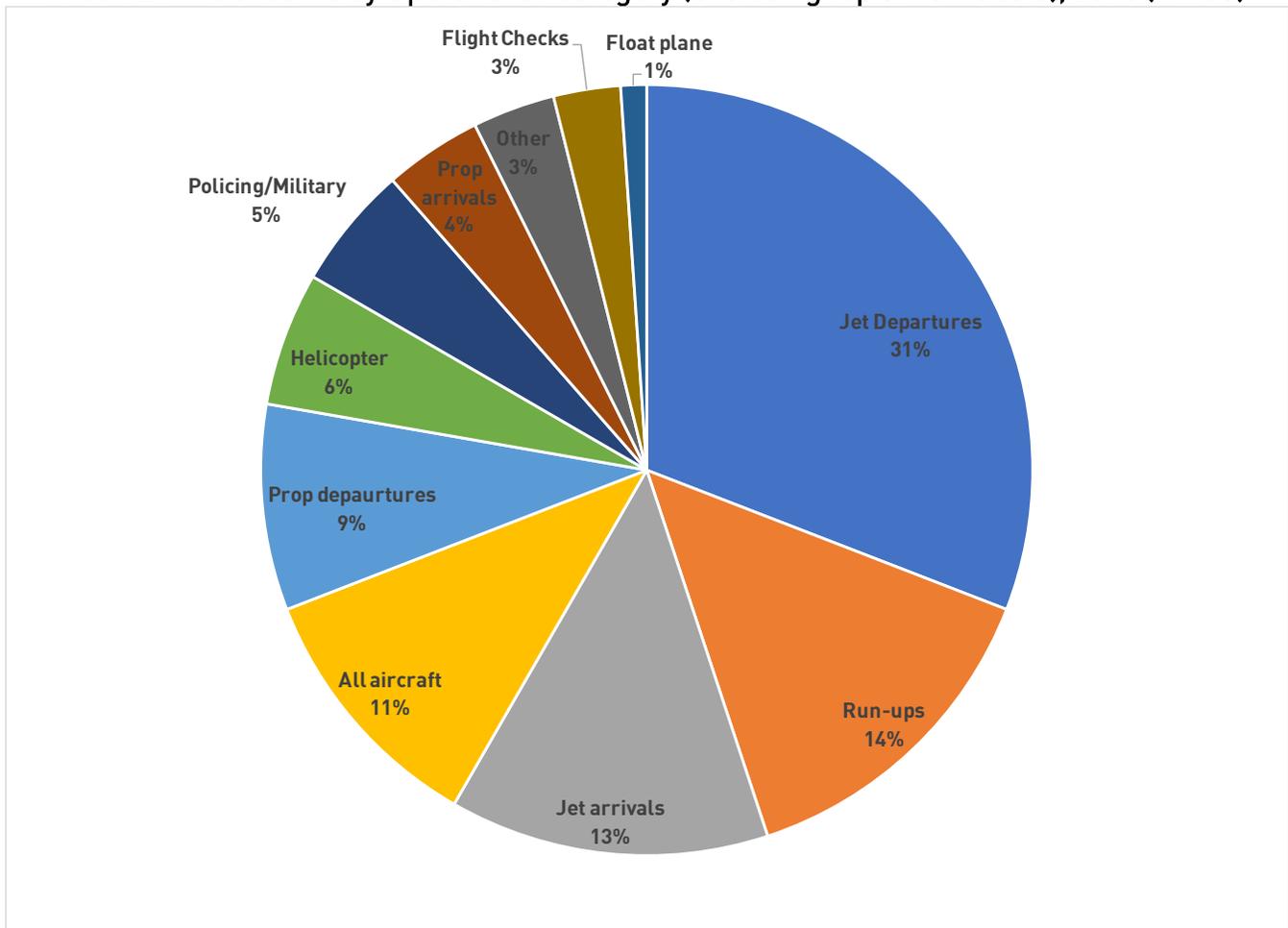
FIGURE 16: Concerns by Operational Category, 2018 (n=920)



As illustrated, top three operational categories associated with concerns in 2018 included jet departures, run-ups, and jet arrivals. While over 60% of all concerns were associated with jet departures, approximately 75% of these concerns were submitted by three individuals.

When a small number of individuals register multiple concerns, this can heavily influence the analysis. Therefore, to better understand the nature and trends of concerns from the other individuals, further analysis was done with the dataset that excluded the 457 concerns from the top three individuals. Figure 17 illustrates a breakdown of remaining 463 concerns received from 247 individuals by operation type.

FIGURE 17: Concerns by Operational Category (excluding top 3 individuals), 2018 (n=463)



The top three operational categories did not change compared to the previous analysis, and jet departures remained the top operational category, accounting for approximately 31% of the concerns. Further analysis is provided below:

- Approximately 85% of concerns related to jet departures originated from communities located within 10 nautical miles from the airport, where areas are exposed to jet aircraft take-offs at lower altitudes.

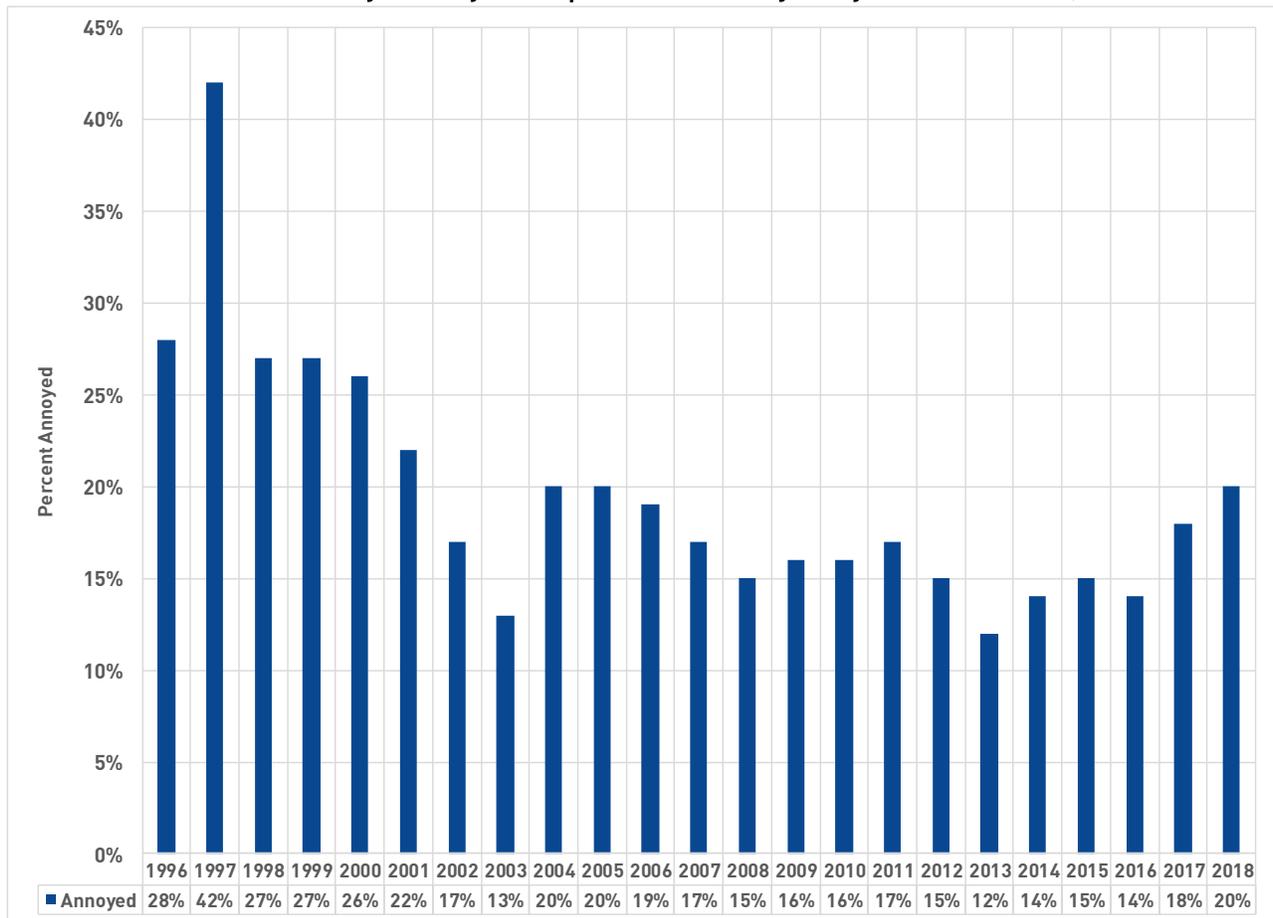
- Approximately 14% of all concerns were related to run-ups, and over 90% of these concerns were received from residents in Richmond. One individual registered approximately 58% of all concerns associated with run-ups.
- Approximately 13% of all concerns were associated with jet arrivals. Over 60% of these concerns were received from areas located further than 10 nautical miles from the airport.

COMMUNITY SURVEY

Since the mid-1990s, the Airport Authority has commissioned a third party survey to track public attitudes and opinions about YVR on a number of topics including aircraft noise. This community survey represents the opinions of approximately 1,000 residents from across communities of the Lower Mainland and provides one means to gauge the level of community annoyance triggered by aircraft noise.

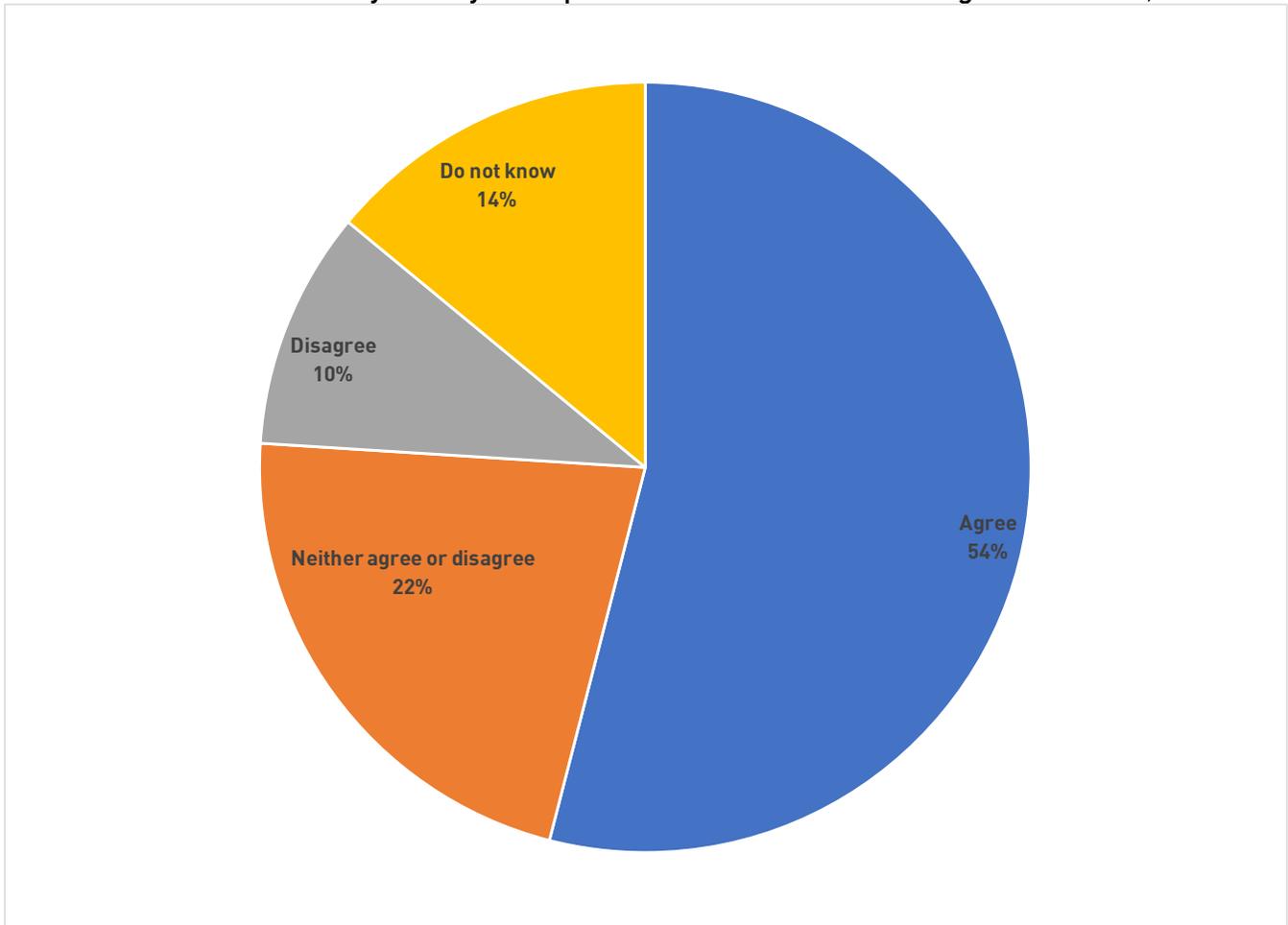
When asked, “*While you have been at home during the past year, have you been annoyed by aircraft noise in your neighbourhood?*” approximately 20% of the respondents in 2018 stated that they were annoyed by aircraft noise. Figure 18 illustrates the trend since 1996.

FIGURE 18: Community Survey - Respondents Annoyed by Aircraft Noise, 1996-2017



The community survey respondents are also asked to rate whether they agree or disagree with the statement “*YVR keeps aircraft noise in my neighbourhood at an acceptable level*”. In 2018, 54% of the respondents agreed with the statement while 10% of the respondents disagreed. Figure 19 provides the breakdown of responses.

FIGURE 19: Community Survey - Response to the YVR Noise Management Effort, 2018

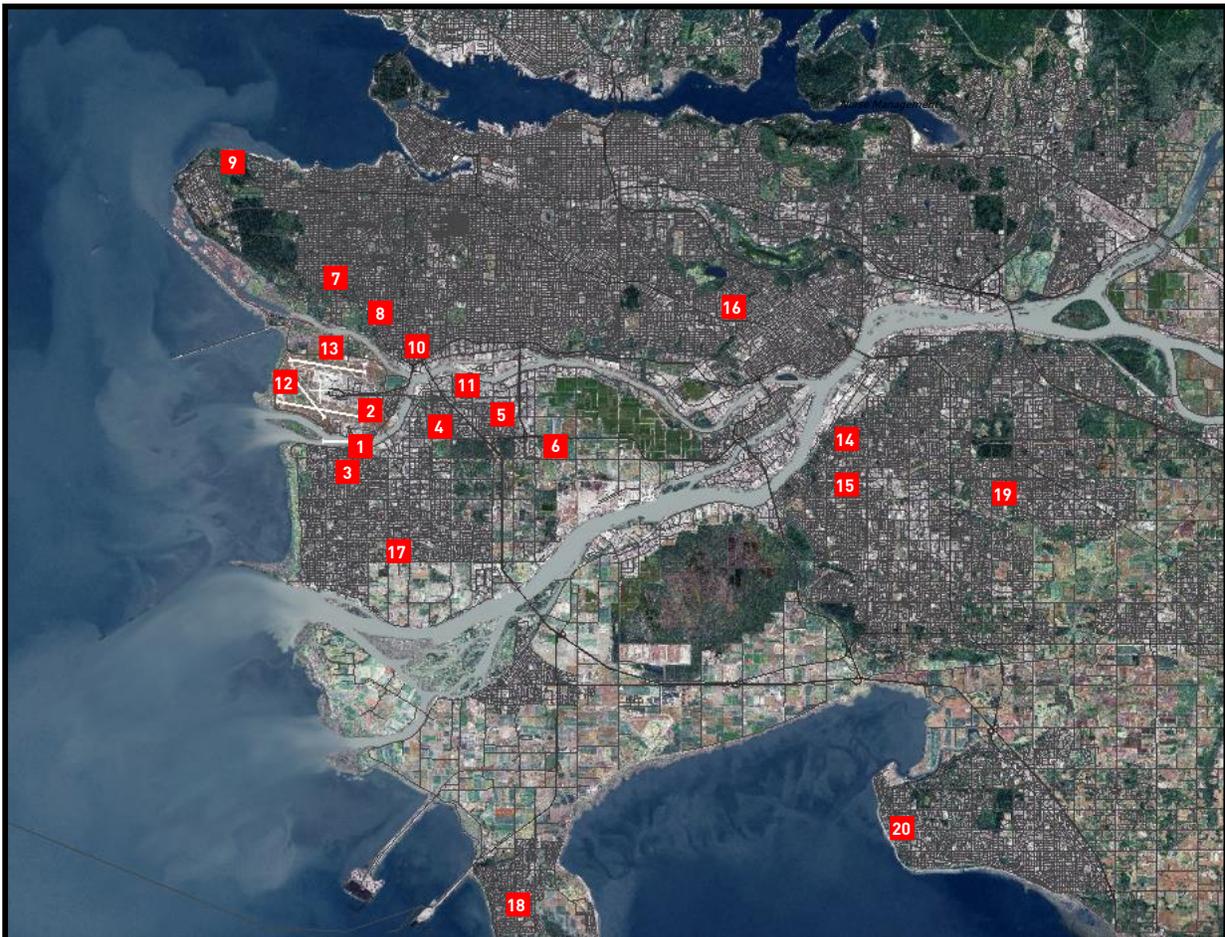


NOISE MONITORING DATA

The monitoring of noise levels and aircraft activity in communities around the airport is a major component of the YVR Aeronautical Noise Management Program. To achieve this, the Airport Authority uses the Aircraft Noise & Operations Monitoring System (“ANOMS”) provided by Brüel & Kjær. This system allows for an objective assessment of aircraft noise levels in the surrounding communities and allows for the identification of trends and checks for compliance with published procedures.

ANOMS combines noise data collected at Noise Monitoring Terminals (“NMTs”), radar flight tracking data provided by NAV CANADA, and mapping data from a Geographic Information System. ANOMS correlates flight track data with noise monitoring data collected at each NMT, which then allows an understanding of the contribution of aircraft noise at each site. Figure 20 illustrates the NMT network and their relationship to runways at YVR. In 2009, the Airport Authority replaced and upgraded all hardware at the NMT sites and expanded the network from 16 to 20 fixed NMTs.

FIGURE 20: NMT Locations in the Lower Mainland



ANNUAL AVERAGE NOISE LEVELS (LEQ)

There are numerous metrics available to assess noise. One common metric for community noise assessment is the equivalent sound level, or average noise level (“Leq”) measured over a given time period. Table 8 presents the annual average Leq, measured in units of A-weighted decibel or dBA, at each NMT location for the last five years. It is important to note that the average noise levels, presented below, include contributions from all sources in the community, including aircraft, motor vehicles, people, lawn mowers, barking dogs, etc.

TABLE 8: Annual Average Noise Level (in dBA), 2014-2018

| YEAR | NMT# 1 | NMT# 2 | NMT# 3 | NMT# 4 | NMT# 5 | NMT# 6 | NMT# 7 | NMT# 8 | NMT# 9 | NMT# 10 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 2014 | - | 65.0 | 52.7 | 60.6 | 58.5 | 69.4 | - | 55.4 | 50.3 | 54.4 |
| 2015 | 61.4 | 65.1 | 52.7 | 60.3 | 58.4 | 61.7 | 58.4 | 52.0 | 50.1 | 54.3 |
| 2016 | 61.2 | 65.3 | 53.0 | 62.4 | 58.4 | 58.1 | 58.4 | 55.8 | 51.3 | 56.7 |
| 2017 | 61.0 | 64.9 | 54.1 | 59.9 | 58.5 | 57.1 | 57.5 | 51.4 | 50.1 | 55.1 |
| 2018 | 61.3 | 66.3 | 52.8 | 60.5 | 58.5 | 57.4 | 58.4 | 54.2 | 50.4 | 56.3 |

| YEAR | NMT# 11 | NMT# 12 | NMT# 13 | NMT# 14 | NMT# 15 | NMT# 16 | NMT# 17 | NMT# 18 | NMT# 19 | NMT# 20 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 2014 | 60.8 | 74.7 | 61.0 | 65.7 | 53.1 | 54.5 | 54.0 | 57.5 | 55.7 | 54.3 |
| 2015 | 61.4 | 65.1 | 61.5 | 64.1 | 53.5 | 56.3 | 56.2 | 54.7 | 55.9 | 53.0 |
| 2016 | 60.6 | 66.9 | 61.4 | 56.1 | 53.8 | 54.6 | 54.1 | 53.8 | 56.3 | 56.1 |
| 2017 | 61.1 | 73.3 | 61.8 | 58.9 | 53.3 | 54.3 | 54.2 | 53.7 | 55.3 | 60.0 |
| 2018 | 60.9 | 72.8 | 62.1 | 56.4 | 55.0 | 54.3 | 53.0 | 54.3 | 56.5 | 52.9 |

SINGLE EVENT NOISE LEVEL

Another metric used to assess noise is the single event noise level (“SEL”), measured in dBA. For an aircraft fly-over, either a landing or take-off, the SEL represents the total acoustic energy above a prescribed reference threshold. In general, the SEL is typically 10 dBA greater than the maximum noise level experienced during the aircraft fly-over. The primary use of the SEL is to provide a comparison of noise events with different noise levels and durations.

While reference thresholds are set individually at each NMT according to the ambient noise levels in the area, thresholds are typically set between 65 and 70 dBA during the hours between 7:00AM and 10:00PM and between 55 and 60 dBA during the hours between 10:00 PM and 7:00 AM.

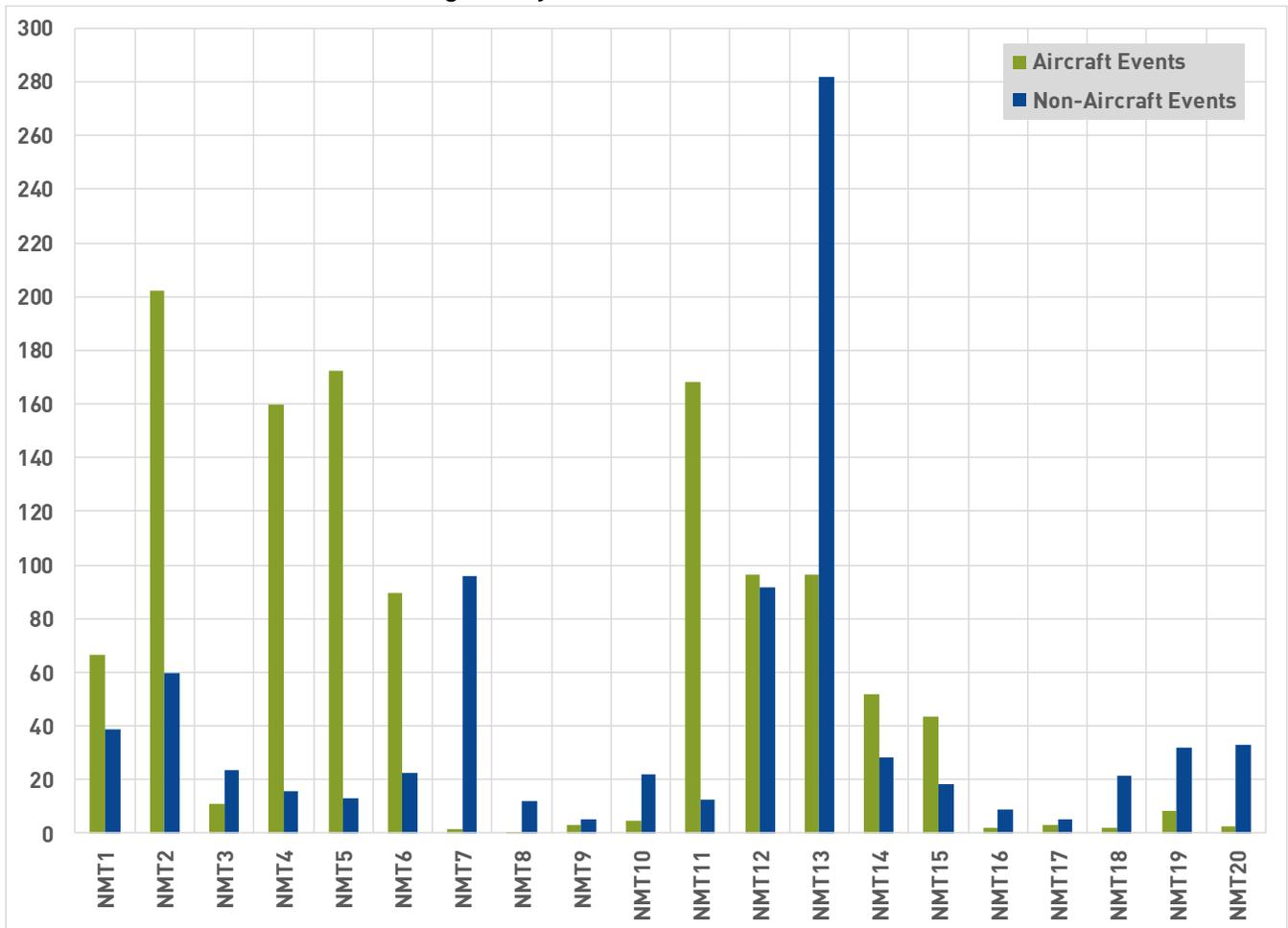
ANOMS categorizes noise events into types: correlated and uncorrelated. Correlated events are those associated with aircraft and uncorrelated events are those associated with other

sound sources in the community. For NMTs located close to flight paths, noise events are primarily associated with aircraft, whereas noise events at NMTs located farther away from the airport and flight path are primarily associated with non-aircraft sources.

Table 9 presents the 2018 daily average number of aircraft and non-aircraft noise events with a SEL above 70 dBA at each of the NMT locations. Figure 21 presents this same information graphically.

TABLE 9: Average Daily Number of Noise Events at NMTs, 2018

| NMT # | Name | Location | Average number of DAILY noise events > 70 dBA | | |
|-------|---------------------------|----------------------------------------------|-----------------------------------------------|--------------|-------|
| | | | Aircraft | Non-Aircraft | Total |
| 1 | Richmond Olympic Oval | 6111 River Rd., Richmond | 66 | 39 | 105 |
| 2 | Airside Burkeville | Templeton St., Richmond | 202 | 60 | 262 |
| 3 | Lynas Lane Park | Lynas Lane & Walton Rd., Richmond | 11 | 24 | 35 |
| 4 | Tomsett Elementary | Odlin Rd. and No. 4 Rd., Richmond | 160 | 16 | 176 |
| 5 | Bath Slough | Bath Rd. & Bath Slough, Richmond | 173 | 13 | 186 |
| 6 | Outer Marker | Westminster Hwy & No. 7 Rd., Richmond | 89 | 23 | 112 |
| 7 | Crofton School | W41st & Blenheim St., Vancouver | 1 | 96 | 97 |
| 8 | McKechnie School | W59th & Maple St., Vancouver | 1 | 12 | 13 |
| 9 | UBC | Northwest Marine Dr., Vancouver | 3 | 5 | 8 |
| 10 | Marpole | W67th & Cartier St., Vancouver | 5 | 22 | 27 |
| 11 | Bridgeport | No. 4 Rd. & Finlayson Dr., Richmond | 168 | 12 | 180 |
| 12 | West Sea Island | Airside YVR, Richmond | 97 | 92 | 189 |
| 13 | North Sea Island | Ferguson Rd., Richmond | 96 | 282 | 378 |
| 14 | Annieville-Delview Second | 9111-116th St., Delta | 52 | 28 | 80 |
| 15 | Alex Fraser Bridge | North Delta Rec. Ctr. 11415-84th Ave., Delta | 44 | 18 | 62 |
| 16 | Burnaby - St. Francis | 6610 Balmoral St., Burnaby | 2 | 9 | 11 |
| 17 | Maple Lane Elementary | Alouette Dr. & Tweedsmuir Ave., Richmond | 3 | 5 | 8 |
| 18 | South Delta - Tsawwassen | 53rd Street & 8A Ave., Delta | 2 | 22 | 24 |
| 19 | North Surrey | 82A Ave. & 146th St., Surrey | 9 | 32 | 41 |
| 20 | South Surrey | 20th Ave. & Ocean Forest Dr., Surrey | 3 | 33 | 36 |

FIGURE 21: Average Daily Number of Noise Events at NMTs, 2018


ENVIRONMENT – YVR Noise Management

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YVR Noise Information Line: 604- 207-7097

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Note on Reported Figures and Data:

The Airport Authority receives aircraft operations data from NAV CANADA. This data includes daily aircraft arrivals and departures at YVR as well as aircraft transiting through the Vancouver Control Zone. Every effort is made to verify and correct anomalies in the dataset, and numbers stated in this report may vary slightly from those reported by others.

Version 1.00

- MAR 25, 2019 -

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