POST-IMPLEMENTATION COMMUNITY IMPACT REVIEW

Assessing the implementation of airspace changes at Toronto Pearson International Airport

To reduce environmental and noise impacts on communities

SUMMER 2020

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NAV CANADA

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ABOUT NAV CANADA

NAV CANADA is a private not-for-profit company, providing air traffic control, airport advisory services, weather briefings and aeronautical information services for over 18 million square kilometres of Canadian domestic and international airspace.

As the country's air navigation services provider, our primary responsibility is to ensure the safety of aircraft in Canadian-controlled airspace. We achieve this by maintaining a world-leading safety record and by leveraging traffic management tools that enhance our operational resiliency. These applications help strengthen the safety, efficiency and sustainability of aviation in Canada.

At the same time, NAV CANADA looks beyond the skies to serve the communities in which we live and work – including efforts to mitigate aircraft noise and reduce our environmental footprint.

This includes supporting measures put in place by Transport Canada and airport authorities to manage noise emissions, working with stakeholders through community and noise consultative committees at airports across the country, as well as exploring new navigation technologies that enable a quieter descent profile.

18 million km²
Airspace managed by NAV CANADA

2.4+ million
litres fuel burn avoided

6+ million kg
GHG emissions reduced

PURPOSE & BACKGROUND

Purpose
This review examines the implementation of new nighttime instrument approach procedures, new nighttime departure procedures and the increased use of Continuous Descent Operations at Toronto Pearson International Airport (CYYZ).

In doing so, the post-implementation review looks at operational usage, community feedback, and environmental and noise impacts of the newly implemented procedures. These three separate airspace changes belong to a family of six noise mitigation initiatives, which were studied and proposed by NAV CANADA and the Greater Toronto Airport Authority (GTAA) to affected Greater Toronto Area residents. Idea 3 was not included in this review as per the Airspace Change Communications and Consultation Protocol, and was implemented on April 27, 2017.

The period between February 28, 2019 and January 24, 2020 was examined.*

**The aviation industry has been significantly impacted by the COVID-19 global pandemic; as a result, the traffic levels attained during the measurement period are higher than those being observed in 2020.*

Background on the Six Ideas
The Six Ideas is a collaborative initiative between the GTAA and NAV CANADA that dates back to 2015 and represents our collective commitment to identifying aircraft noise reduction opportunities in residential areas across the Greater Toronto Area. This multi-year engagement plan was extensively studied to understand potential impacts, community benefits, and operational feasibility given the demand forecast for Toronto Pearson. Where possible, both organizations looked for opportunities to minimize the total number of people impacted by aircraft noise.

NAV CANADA committed to proposing adjusted procedures for landing and taking-off at the airport during nighttime hours as well as leveraging a technique that enables a quieter final approach profile.

As these initiatives had the potential to result in flight path and runway utilization changes, the *Airspace Change Communications and Consultation Protocol*, was used to guide the associated consultation approach. Regular communication and consultations enabled us to understand and balance the needs of all stakeholders while delivering on safety and efficiency. In total, over 400 residents from 27 communities participated in the multi-meeting public consultation process.

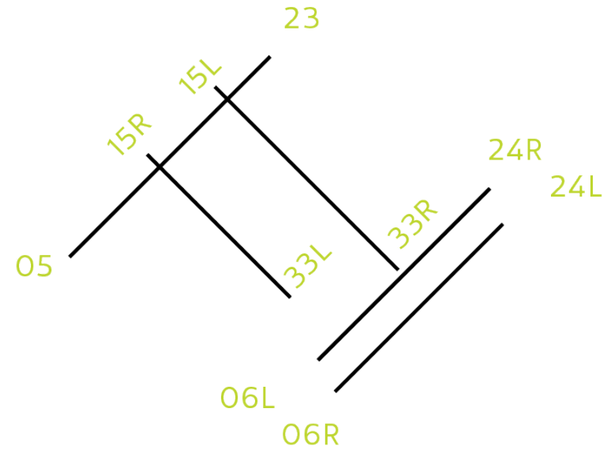
To learn more about the Six Ideas, please visit ***torontopearson.com/conversations.***

TORONTO PEARSON INTERNATIONAL AIRPORT (CYYZ)

Canada's busiest airport
Toronto Pearson is Canada's busiest airport. In 2018, 49.5 million passengers travelled through the airport and 473,000 flights were handled. An extensive list of scheduled and charter flights provides the Toronto region with non-stop and same-plane service to more than 175 cities around the world.

The Greater Toronto Airports Authority (GTAA) is the operator of Toronto Pearson. The GTAA continues to focus on growing Toronto Pearson's status as an international gateway: enhancing the customer experience, safety, security, the success of our airline partners and the regional economy.

The GTAA believes being a good neighbour means balancing operations by engaging with communities that surround the airport.



How Toronto Pearson runways are selected
Toronto Pearson has five main runways and 30 taxiways. Runway selection is a complex process, where the safety of aircraft is the priority. The flight patterns and distribution of aircraft highly depend on weather conditions, with aircraft needing to take off and land into the wind for safety reasons.

Criteria used to assign runways include predominant wind directions at the airport; other weather conditions at the airport (i.e. wind speed, low visibility); weather phenomena near the airport (wind aloft, thunderstorms);the availability and/or conditions of runways and taxiways (maintenance work, snow removal); type of inbound aircraft; time of day; operational efficiency and capacity requirements; taxiway infrastructure; and the airport's preferential runway system.

Weather can affect flights in many ways – for example, a runway may be selected to avoid flying through turbulent weather. During calm winds, any of the five runways at Toronto Pearson can be used, and so factors such as capacity needs or runway availability come into play.

Idea

01

NEW NIGHTTIME APPROACHES

BACKGROUND

While traffic levels are significantly lower at night than during the day, aircraft noise events can be more noticeable for some residents during these periods as ambient community and household noise levels are typically lower. Lower demand and fewer aircraft in Toronto Pearson airspace at night provide opportunity to employ routes that better avoid populated areas and impact fewer people.

In November 2018, NAV CANADA introduced new nighttime arrival procedures that better avoid these residential areas by using Area Navigation (RNAV), a satellite-based navigation technology. RNAV allows aircraft to fly a defined route using station referenced navigational aides (usually satellites) or on-board navigational equipment – or both. These approaches will support Continuous Descent Operations, which enable aircraft to fly at higher altitudes and are generally quieter compared to procedures that require aircraft to employ low altitude level segments as they approach the airport.

TIMES OF USE

The new RNAV nighttime approaches are used between the hours of 12:30 a.m. and 6:30 a.m. local time. These procedures require relatively low traffic levels to be operationally feasible; spikes in traffic increase complexity and may result in vectors to final or other approach types to be used. If possible, usage would start earlier, but use is limited to very low traffic periods overnight.

USAGE SUMMARY

New procedures were published in the Canada Air Pilot. To support awareness of the new nighttime procedures, an Aeronautical Information Circular (AIC) was published in October 2018 and the new procedures were further communicated through the Quieter Operations Guide.

Between January and December 2019, these new nighttime approaches accounted for 53 per cent of operations during Toronto Pearson's restricted hours.

Table 1 shows monthly usage counts of the new nighttime procedures. The variation in procedure usage is predominantly driven by arrival volumes during Toronto Pearson's overnight hours as well as the type of flight management system available on individual aircraft.

Between November 2018 and January 2020, the optimized nighttime procedures were flown a total of 5,748 times. For the 2019 calendar year, the procedures were flown a total of 4,674 times.

USAGE COUNTS	DATE *(for nighttime procedures)*
5,748	November 2018 - January 2020
4,674	January 2019 - December 2019

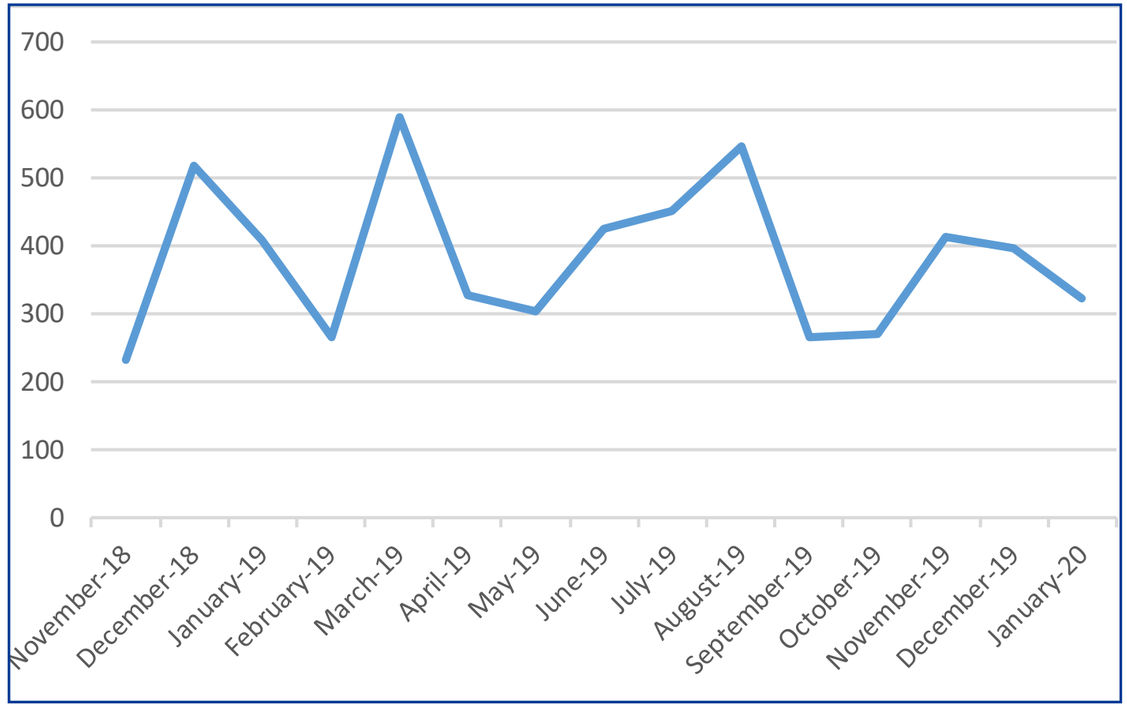


Table 1: New Nighttime Procedures - Total Counts (by month)

USAGE SUMMARY (CONTINUES)

Nighttime Procedure Use (Runways 23, 24L/R)
As the prevailing winds in the area are from the west, the most common runway configuration at Toronto Pearson supports a westerly flow, resulting in arrivals to Runways 23, 24 Left, and 24 Right. Greater Toronto Area residents living east of the airport will be interested in these new nighttime procedures.

The map below shows a 12-hour sample of traffic as flown during nighttime restricted hours subsequent to implementation when Runways 23, 24 Left or 24 Right were in use. The yellow tracks show arrivals using the night procedures and the white tracks show those that did not. The variation in the latter depict how aircraft are vectored, sorted and separated for safe arrival at the airport.

For Runway 23, a total of 2,130 RNAV approaches were flown over the post-implementation report period, accounting for 37 per cent of total RNAV usage. Runway 24 Left procedures accounted for 557 RNAV flights (0.09 per cent) and Runway 24 Right accounted for 550 RNAV flights (0.05 per cent).

As expected, RNAV usage for Runways 24 Left, 24 Right, 06 Left and 06 Right were low as the airport's nighttime preferential runways for east-west traffic are Runways 05 and 23.

Noise modelling conducted prior to the consultation phase indicates as many 112,000 fewer people would be exposed to noise greater than 60 decibels from overnight flights when Runway 23 is in use, representing a reduction as much as 44 per cent depending on the transition flown. This same analysis suggested that as many as 130,000 fewer people (up to 24 per cent) would be exposed to noise greater than 60 decibels from overnight flights when Runways 24 Left and Right are in use depending on the transition flown.

With limited opportunities to avoid residential areas east of the airport, due to population density, the main changes observed include aircraft overflying the Don Valley Parkway from the south and taking advantage of industrial areas, such as trainyards, from the north.

USAGE SUMMARY (CONTINUES)

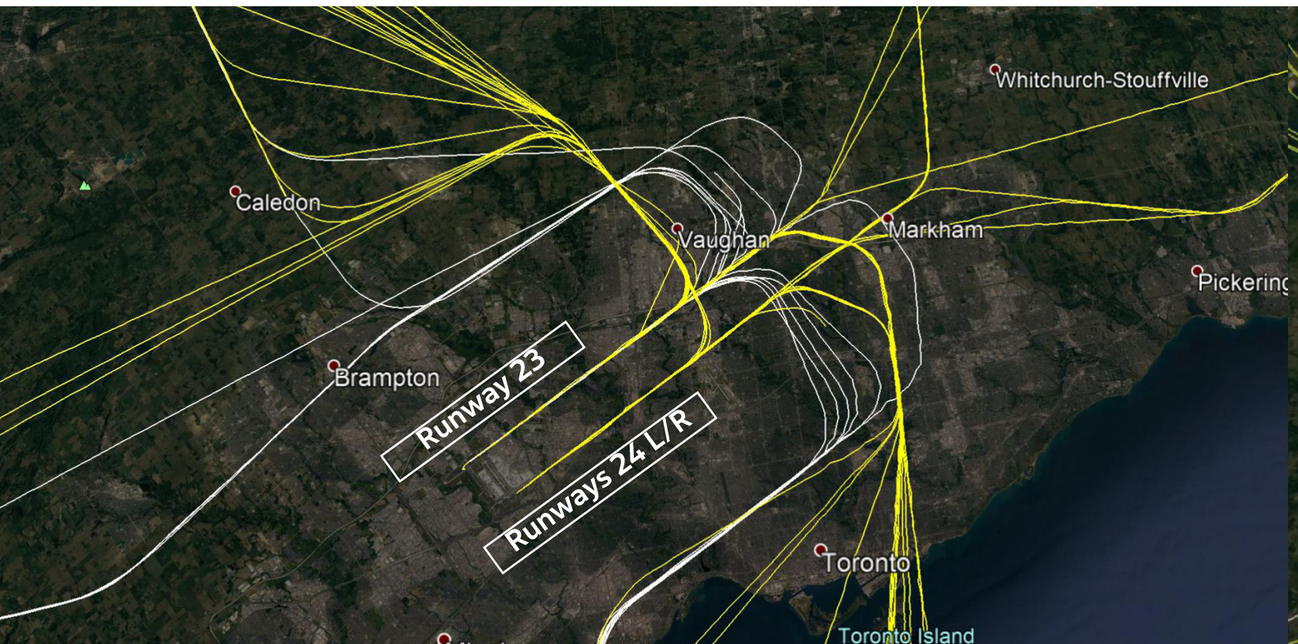
Nighttime Procedure Use (Runways 05, 06L/R)
Greater Toronto Area residents living west of the airport will be interested in the new nighttime procedures off Runways 05, 06 Right and 06 Left.

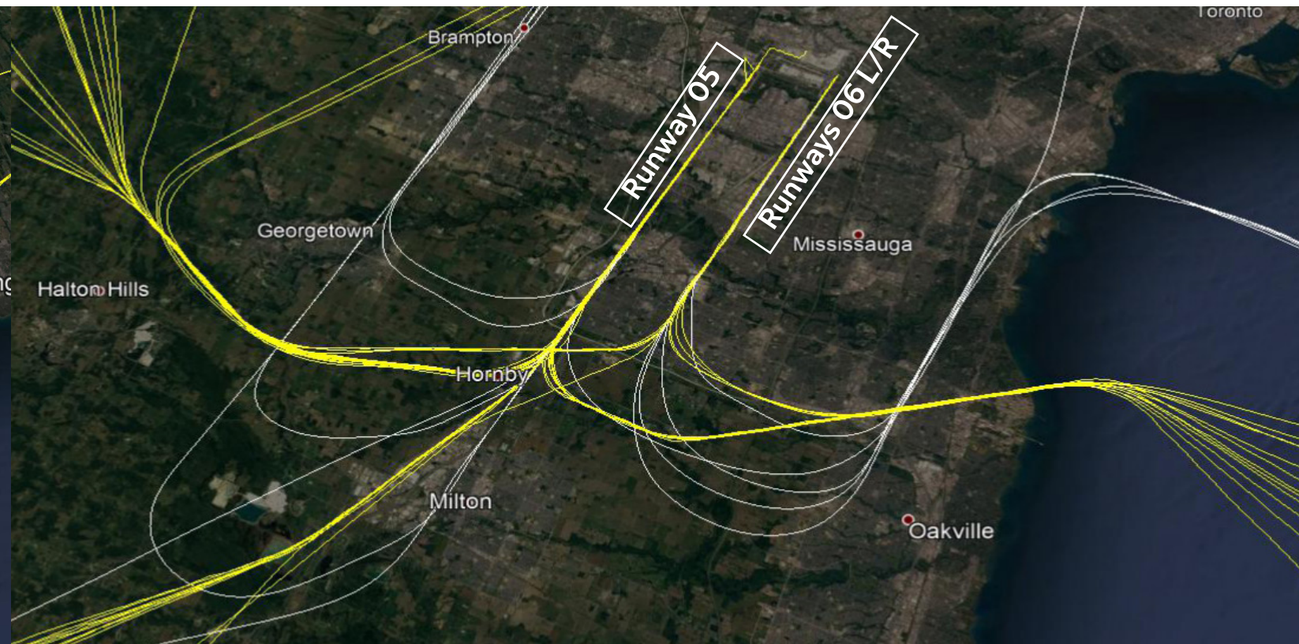
The map below shows a 12-hour sample of traffic as flown during nighttime restricted hours subsequent to implementation when Runways 05, 06 Left or 06 Right were in use. The yellow tracks show arrivals using the night procedures and the white tracks show those that did not. The variation in the latter depict how aircraft are vectored, sorted and separated for safe arrival at the airport.

For Runway 05, a total of 1,794 nighttime procedures were flown over the post-implementation report period, accounting for 30 per cent of total nighttime procedure usage. The procedures for Runway 06 Left were flown 421 times (0.07 per cent) and 296 times (0.05 times) for Runway 06 Right. As expected, RNAV usage for Runways 24 Left, 24 Right, 06 Left and 06 Right were low as the airport's nighttime preferential runways for east-west operations are Runways 05 and 23.

Noise modelling conducted prior to the consultation phase indicates as many 29,000 fewer people would be exposed to noise greater than 60 decibels from overnight flights when Runway 05 is in use, representing a reduction as much as 22 per cent depending on the transition flown. This same analysis suggested that as many as 34,000 fewer people (up to 30 per cent) would be exposed to noise greater than 60 decibels from overnight flights when Runways 06 Left and Right are in use.

While the new approaches are located among existing traffic patterns, the main benefits include aircraft flying higher compared to the typical approach and avoidance of residentially populated areas where possible. The flight path from the north was placed west of Georgetown, the procedure from the northwest towards Milton leveraged an industrial area to the north of Milton and arrivals from the south shifted over an automobile assembly plant.





Idea

02

NEW NIGHTTIME DEPARTURES

BACKGROUND

NAV CANADA's new nighttime departures have been optimized to avoid more households than a typical departure that is flown today. Lower capacity demands during night at Toronto Pearson enable increased overflight in non-residential areas.

NAV CANADA's new nighttime departure procedures, implemented November 2018, provide flexibility to delay when an aircraft turns when traffic permits. When operationally feasible and depending on the specific runway, air traffic controllers tactically instruct aircraft to reach a higher altitude prior to turning (when departing to the east) or delay their turn until aircraft have reached a point indicated on their radar screens (when departing to the west). These instructions are in accordance with existing safety and procedural requirements.

TIMES OF USE

Night-time departure procedures are used between the hours of 12:30 a.m and 6:30 a.m. Limited to low traffic periods, use of the new procedures may start earlier, when possible.

USAGE SUMMARY

On average, there are four to six departures overnight. While departure volumes are low, departures may be more noticeable because of the higher thrust settings.

These procedures leverage tactical instructions to support quieter operations for aircraft operators. As a result, there can be a greater variance in flight tracks and associated benefits due to rate of climb, wind drift, manner of aircraft operation and the route structure to be used.

To better understand utilization, the busiest months – in terms of the number of departures respectively – for runways 05 and 23 were analysed.

Departures off Runway 23 depart at a 10-degree heading and climb until they pass a marker on the controller's radar screen (aligned with the residential boundaries to the east of the airport and targeting the non-residential space between Mississauga and Milton) before turning towards their destination.

A total of 221 departures used Runway 23 between 12:30 a.m. and 6:30 a.m. in January 2020. This was the month with the highest number of overnight departures over the measured period. Of the 221 departures included in this sample, 35 per cent used the new nighttime departure procedure.

Departures off Runway 05 depart at a 10-degree heading and climb to 5,000 feet before turning towards their destination (as opposed to the standard 3,600 feet) to mitigate the impact of aircraft noise on surrounding communities.

A total of 136 departures used Runway 05 between 12:30 and 6:30 local time in June 2019. This was the month with the highest number of overnight departures over the measured period.

Of the 136 departures included in this sample, 48 per cent climbed higher than 5,000 ft. before making their turn.

Noise modelling conducted prior to the consultation phase indicates as many as 115,000 fewer people would be exposed to noise greater than 60 decibels from overnight flights to the west when Runway 23 is in use, representing a reduction of 54 per cent. When departing to the east from Runway 05, up to 14,000 fewer people (-6%) would be exposed to noise levels greater than 60 decibels (28,000 fewer at 65 dBA).

Idea

04

CONTINUOUS DESCENT APPROACHES (CDO)

BACKGROUND

In busy airspace such as that surrounding Toronto Pearson, keeping flights flying at a specific altitude can be necessary to safely manage traffic flows. In order to keep aircraft at a level altitude, pilots must increase thrust and drag, which can create more engine and airframe noise.

Improvements to the Standard Terminal Arrival (STAR) were implemented in February 2019 with the aim of reducing low altitude level segments for aircraft operating on the downwind phase of flight through the increased use of Continuous Descent Operations (CDO). Air traffic controllers can provide more flexible altitude guidance in anticipation of the base leg turn, enabling arriving aircraft to fly on a continuous descending path.

While noise from aircraft operations cannot be entirely eliminated, Continuous Descent Operations have been shown to reduce aircraft noise by up to 5 decibels compared to aircraft on a level segment. Additionally, a reduced noise footprint from continuous descent results in fewer households flown over at noise levels above 60 dBA.

TIMES OF USE

Continuous Descent Operations can be used during daytime and evening periods when traffic is relatively light. Usage is dependent on capacity demands and tactical sequencing requirements – not all traffic will be able to use a continuous descent. Achieving continuous descent requires an early clearance by the controller, and effective use of the flight management system by the pilot. In some scenarios, it may not be possible for the pilot to achieve a CDO or the traffic scenario may limit a controller's ability to anticipate the necessary base leg turn early. In all scenarios, ensuring a safe operation is always the priority.

USAGE SUMMARY

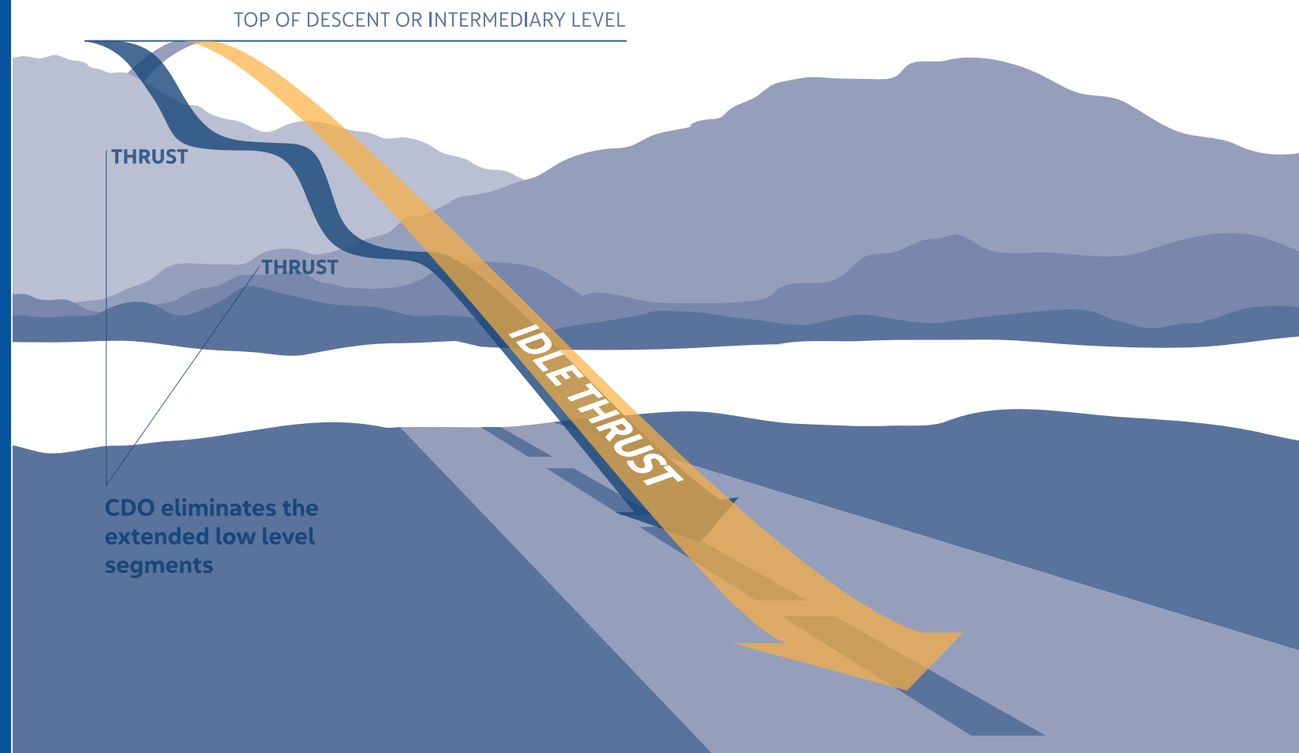
Achieving CDO is a multifaceted effort that requires a mix of navigation procedures, aircraft operating procedures and front-line awareness to help move the performance yardstick. During the consultation phase, it was anticipated that an increase of approximately 10 per cent in CDO achievement would be realized.

In December 2018, NAV CANADA published the Quieter Operations Guide, a document providing controllers and pilots with information on how they can maximize use of aircraft noise mitigating procedures including tie-ins to new night procedures, continuous descent operations and other opportunities to reduce airframe noise. The Guide complements guidance provided in official aeronautical information products and is intended to increase awareness of good practices among pilots and air traffic controllers.

Analysis considerations
In order to analyze CDO operations, NAV CANADA developed a custom tool to process large volumes of flight data. Performance was monitored on the downwind portion of final descent to the east-west runways (05/23, 06 Left/24 Right, 06 Right/24 Left).

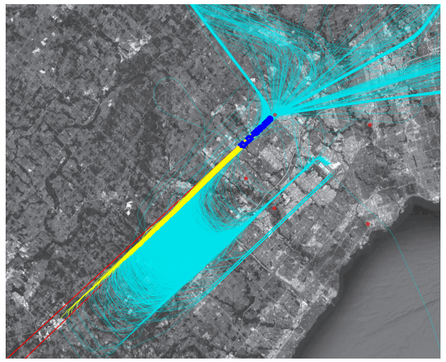
A continuous descent approach is achieved when the aircraft descends with no segment of level flight greater than 2.0 nautical miles (NM). Level flight is interpreted as any segment of flight having a height change of no more than 100 ft over the 2.0 nautical mile track distance.

Our analysis begins at the downwind entry points defined in the RNAV arrival routes in the Canada Air Pilot (CAP) aeronautical publication and extend approximately 25 nautical miles. (Aircraft on the final approach, when they are lined up with the runway, already achieve CDO due to ILS guidance).

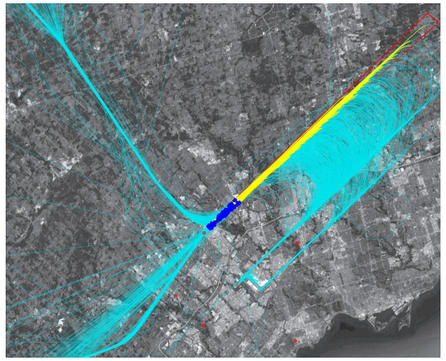


DOWNWIND FLIGHT PROFILE

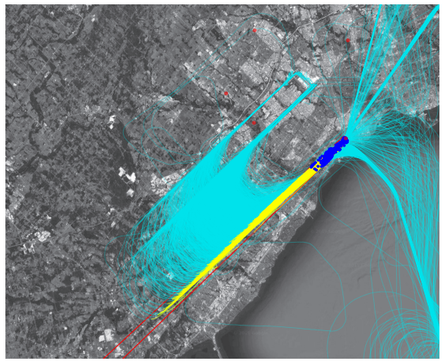
On the maps to the right, the teal lines represent radar tracks, the red box indicates the downwind capture area, the yellow lines represent the capture area for radar tracks and the blue dots are the capture area entry points for each respective downwind.



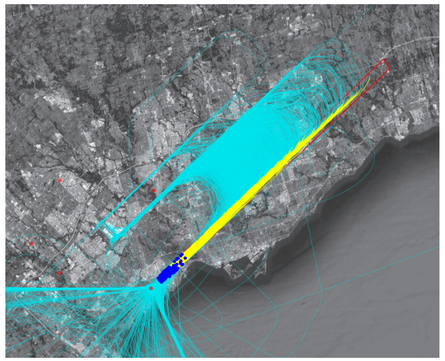
Aircraft employing CDO towards the **North-West downwind** are mainly approaching Runway 05 (with some distribution to Runways 06 Left/Right).



Aircraft employing CDO towards the **North-East downwind** are mainly approaching Runway 23 (with some distribution to Runways 24 Left/Right).



Aircraft employing CDO towards the **South-West downwind** are mainly approaching Runways 06 Left and Right (with some distribution to Runway 05).



Aircraft employing CDO towards the **South-East downwind** is mainly directed towards Runways 24 Left and Right (with some distribution to Runway 23).

USAGE SUMMARY (CONTINUES)

Table 2 shows potential in aircraft utilizing the procedure improvements as intended and keeping aircraft at a higher altitude. Current traffic levels tend to influence procedure usage. The grey columns represent pre-implementation and the blue columns represent usage of CDO post-implementation.

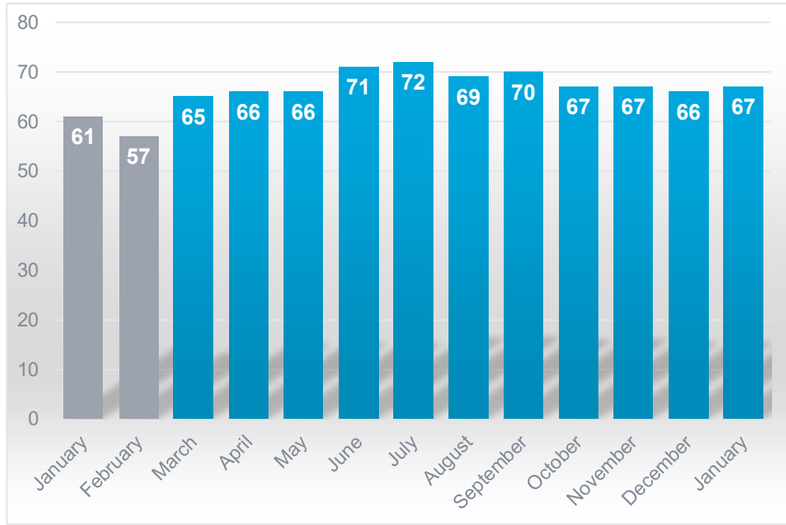


Table 2: Total % CDO utilization (by month)

Table 3 represents the average length in nautical miles of level segments by downwind segment (when aircraft are not employing CDO).

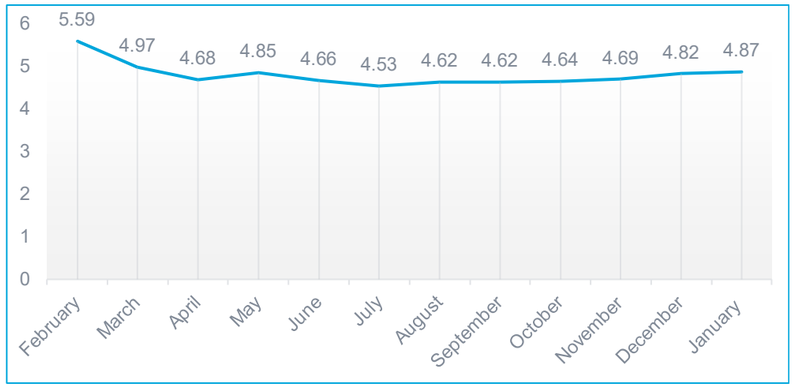
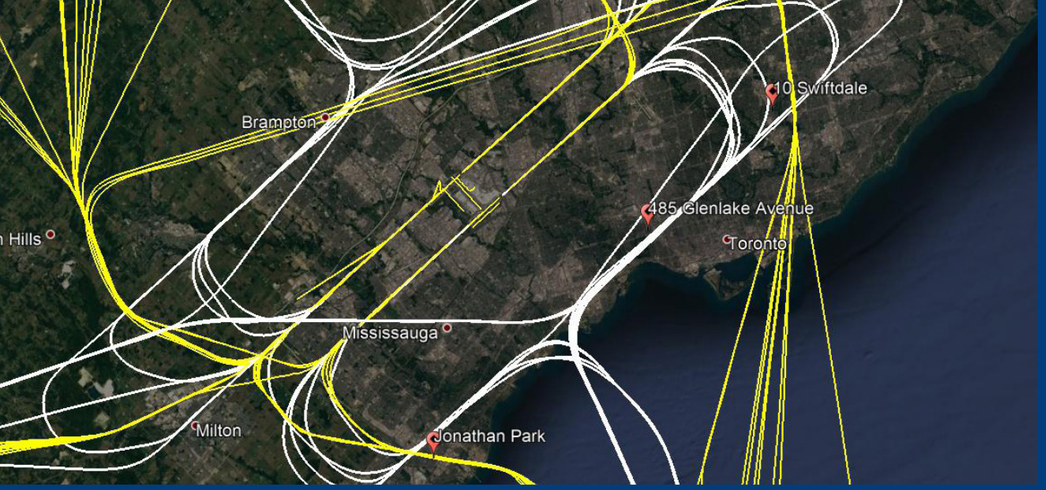


Table 3: Total average level segment distance (nautical miles) by month



ENVIRONMENTAL IMPACTS &NOISE MONITORING

MONITOR AT 10 SWIFTDALE

MONITOR AT JONATHAN PARK

MONITOR AT 485 GLENLAKE AVE

IMPACT ANALYSIS

As part of the post-implementation review process, NAV CANADA undertook some sample-level noise monitoring to further validate noise modeling and, where possible, provide insight into impacts and benefits. Noise monitoring was contracted to a GTA-based environmental services company named Akoustik Engineering Limited. The data was collected between the dates of January 3rd and January 24th, 2020.

To capture the noise information related to nighttime procedures and Continuous Descent Operations, two monitoring locations were chosen which were in the vicinity of Highway 401 and Don Mills Road (10 Swiftdale Place) and the High Park area (485 Glenlake Avenue). A third location in the vicinity of the QEW and Winston Churchill Blvd. (Jonathan Park) was chosen for monitoring the noise impacts from the alternative nighttime arrival procedure. Noise monitoring locations are shown on page 18.

Each noise monitoring installation included a DC powered Class 1 Type 2250 Bruel & Kjaer analyzer housed in a weather tight enclosure. The analyzer was connected to a Type 4952 Bruel & Kjaer outdoor microphone which was mounted at least 1.5 meters above the ground. The noise monitoring equipment was field calibrated at the beginning and end of each measurement period. Photos of the equipment installations are shown on page 18.

The noise data collection procedure involved the continuous logging of the environmental noise at the three locations in one-minute intervals. Sound recordings were also collected with the acquired noise levels to facilitate the listening of any segments during the post-processing of the data, where necessary. The flight details for the aircraft over the monitoring positions, relevant to Toronto Pearson operations, was provided by NAV CANADA for correlation to the measured noise data.

Noise Measurement Data

The LAmax metric is the most common supplementary aircraft noise parameter used around the world, and was used in the consultation period to assist in communicating the anticipated impacts to airspace enhancement. Only data which aligned with overflight times and which was collected under favourable weather conditions (e.g. wind speed, humidity and precipitation conditions) were considered. Other factors that may impact specific results can include wind dispersion, buildings and atmospheric conditions.

An initial, four-day measurement period was planned, but extended to 14 days due to significant winds and precipitation over the month of January. Despite the extended period, winds and weather limited the available data set. While more data would have been desirable, adequate data was acquired in several areas for the intended sample-level purposes and validation of noise modeling. Noise modeling developed to estimate post-implementation single event noise levels utilized a common narrow body aircraft, the Boeing 737-800 type. Noise modeling was completed by a third party, utilizing the Aviation Environmental Design Tool (AEDT).

The arithmetic average has been used to provide a numerical indication of the average measurement, which is different from using a logarithmic average intended to provide the average sound energy level.

Jonathan Park Location

This location was selected to identify if noise measurement of the new nighttime procedure to runways 05 and 06R/L would be within the expected range that was modelled. Noise modeling showed that the anticipated single event LAmax level would be in the 55-60 dBA range for the nighttime procedure at this location, depending on the runway in use.

AVERAGE SOUND LEVEL	MEASUREMENT TYPE
54 dBA	Average Night Procedure Measurement
57 dBA	Average Level Segment
54 dBA	Average CDO

Additional Insights

In addition to being placed directly under the new nighttime procedure, this monitor was located approximately one kilometre from the downwind leg, allowing for some measurement of the associated operation. Given the proximity to where aircraft would turn on to the base leg, the impact of Continuous Descent Operations was anticipated to be minimal at this point.

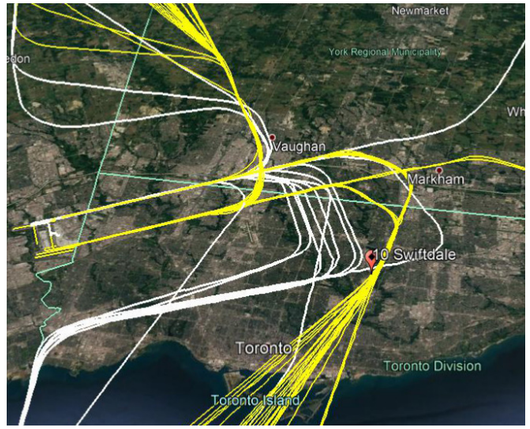
Glen Lake Ave Location

This location was identified to provide insight into the use of Continuous Descent Operations. While its location – at the approximate halfway point on the downwind – means that most aircraft at this specific point will be descending, a comparison of both level and descending segments was considered. The estimated LAmax for aircraft on a CDO at this point is in the 55 to 60 dBA range.

AVERAGE SOUND LEVEL	MEASUREMENT TYPE
63 dBA	Average Level Segment
60 dBA	Average CDO

Swiftdale Location

This location was identified due to its proximity to the night procedure serving runways 05 and 06L/R. Noise modeling indicates that aircraft would typically have an LAmax in the 60-65 dBA range. For comparison purposes, the average noise level for aircraft initiating a base leg turn is also provided.



AVERAGE SOUND LEVEL	MEASUREMENT TYPE
60 dBA	Average Night Procedure Measurement
64 dBA	Base Leg

Noise Measurement Summary

While sample level measurements may not provide insight into the full range of aircraft noise events across the region, the noise measurements show that aircraft noise events are in line and within range of noise modeling used to communicate potential impacts to communities.

Examples of Non-Aviation Noise Events

AVERAGE SOUND LEVEL	ACTIVITY TYPE
120 dBA	Chainsaw
90 dBA	Motorcycle (at 25 feet)
76 dBA	Freeway (at 50 feet from pavement edge at 10am)
60 dBA	Conversation in restaurant
50 dBA	Quiet suburb

COMMUNITY **FEEDBACK**

COMMUNITY FEEDBACK

The Greater Toronto Airports Authority (GTAA) confirms receiving noise complaints from nine Greater Toronto Area residents (representing Nobleton, King, Toronto Don Valley and Oakville communities) specifically associated with the implementation of the new nighttime approach procedure (RNAV). All but one of these complaints can be attributed to Runway 23, 24 Left or Right operations.

No further complaints can be attributed to the new nighttime departures or for the Continuous Descent Operations. NAV CANADA did not receive any complaints subsequent to implementation from Greater Toronto Area residents.

To learn more about the Six Ideas, please visit ***torontopearson.com/conversations***

CONCLUSION

The implementation of the three initiatives detailed in this post-implementation report represent a significant collaborative effort between NAV CANADA, the Greater Toronto Airports Authorty (GTAA), the broader industry and communities.

Overall, utilization rates and measured noise levels are in line with those communicated during consultation, with both operational and environmental benefits being realized. Analysis of the procedures show that many aircraft are flying procedures that better avoid populated areas where feasible, while the quantity of complaints attributable to the changes have been exceptionally low.

The consultation process was deemed to provide a consistent description of the location and noise impacts associated with airspace enhancement surrounding Toronto Pearson prior to implementation.

Nonetheless, the performance metrics and feedback received by a small number of residents show that there is still room for improvement looking ahead, both in terms of continued increases in utilization of existing noise-mitigating procedures and through ongoing work that considers new opportunities, working collaboratively with our stakeholders via the GTAA Noise Forums and the Industry Noise Management Board.

NAV CANADA and the Greater Toronto Airports Authority will continue to monitor and respond to questions related to changes. Future changes to the airspace will be subject to the appropriate engagement processes based on the Airspace Change Communications and Consultation Protocol.

To learn more about the Six Ideas, please visit
torontopearson.com/conversations

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