The Cadillac Fairview Corporation Limited and Shindico Realty Inc.

Polo Park Airport Vicinity Protection Area Study

Airport Noise and Adjacent Development Report

REP 001

Rev A | January 31, 2020

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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I hereby certify that the attached document has been prepared accurately to the best of my knowledge. The assumptions and analysis contained herein have been formulated using standard planning methods.

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Executive summary

Objective and structure

The Cadillac Fairview Corporation Limited and Shindico Realty Inc. have commissioned Arup to review the relevant noise studies with relation to the Polo Park site in Winnipeg, Manitoba, leading to a potential redevelopment of portions of the site that will include residential uses. The review identifies aviation noise metrics used in Canada and the United States and how they are applied at Winnipeg James Armstrong Richardson International Airport (YWG). Research was also conducted to examine the airport-adjacent residential land use planning policy framework and to identify the prevalence and quantity of residential development at comparable North American airports.

Aviation noise metrics

Noise exposure maps are often the primary tool in establishing guidelines for land-use planning around airports. While both noise exposure forecast (NEF) and day-night average sound level (DNL) contours are commonly used and referenced in planning documents, they are built based on historical and forward-looking information. It is important that the contour predictions are updated to reflect revised airport operations, traffic patterns, changes to infrastructure and current aircraft technology.

The NEF metric is normally forecast for a period between five to ten years into the future and include current and future runway geometry forecast to be completed prior to the end of the forecast period.

The Winnipeg Airports Authority noise contours have not been publicly updated since 2005, well outside the maximum 10-year period defined by Transport Canada. Furthermore, they do not align with the WAA airport master plan which states that a third runway is not required within the master plan period of 2033, well beyond the period of the NEF contour map. At minimum, without an updated contour study it would be expected that the Polo Park site has a NEF less than 30 (the Transport Canada threshold for limiting residential development) and would comply with Transport Canada guidelines for residential development near aerodromes.

Airport-adjacent residential land use planning and development

Having reviewed the planning framework and airport-adjacent development in other cities, it appears that the development of residential uses should be appropriate at the Polo Park site.

- Transport Canada notes that, in areas with a NEF less than 30, residential use may be acceptable. The 1995 NEF contours show that a sizeable portion of the site has a NEF less than 30, and the 2000 contours show that the entire site has a NEF less than 30. (Transport Canada goes on to recommend that developers be made aware of this fact and that they undertake to so inform all prospective tenants or purchasers of residential units, and suggests that acoustic insulation features, if required, be considered in the building design.)
- The City of Winnipeg has reviewed the proposal to re-designate the Polo Park site from policy Area I to Area II, with the latter being a less restrictive designation under the *Airport Vicinity Protection Area Secondary Plan By-law* that permits new residential development, and has found that the proposed redesignation is consistent with the policies of *OurWinnipeg*, the City's official plan, and the *Complete Communities Direction Strategy*[1].
- Based on a review of four major North American airports (Toronto, Vancouver, Los Angeles, and Seattle)[2], there are existing areas of airport-adjacent residential development in areas with a NEF greater than or equal to 30 or DNL greater than or equal to 65.
- Focusing on Mississauga, Ontario (adjacent to Toronto Pearson International Airport) and Richmond, British Columbia (adjacent to Vancouver International Airport), there has been significant residential growth in the last few decades.
    - In the Meadowvale Village area of Mississauga, which has a NEF greater than or equal to 30, 462 new single-detached, semi-detached, row house, and apartment units were built between 2009 and 2019.
    - In Richmond Centre, nearly 8 000 new apartment units were built within an area with a NEF greater than or equal to 30, with a sizeable proportion having a NEF between 35 and 40 and a small number in areas with a NEF greater than or equal to 40.

Mitigation

Although the Polo Park site has a NEF less than 30 (going by the 2000 NEF contours), a range of potential airport noise mitigation and noise complaint prevention methods may be examined for residential development at the Polo Park site. Of note, buildings should be designed and constructed to meet minimum

[1] City of Winnipeg. *By-Law No. 48/2019 – Amendment to the Airport Vicinity Protection Area Secondary Plan By-Law No. 6378/94 for Polo Park/Former Stadium Site*. Administrative report to City of Winnipeg Standing Policy Committee on Property and Development, Heritage and Downtown Development. 4 September 2019.

[2] These airports were selected based on the location of airport within the urban area (airports located within their respective city's built-up area, like YWG's context, were preferred), and noise contour study and data availability (studies tend to be publicly available only for large airports with ongoing expansion programs).

acoustic insulation and mechanical ventilation requirements, as detailed in the City's *Airport Vicinity Acoustic Insulation By-law No. 6419/94*.

Conclusions

Having reviewed the methods underlying aviation noise metrics, the airport-adjacent residential land use planning policy framework in Canada (including the local Winnipeg context) and the United States, and current airport-adjacent residential development in select North American cities, Arup concludes that a redesignation of the Polo Park site from Area I to Area II, with the intent of permitting residential development at Polo Park in the longer term, is appropriate and consistent with overall Winnipeg planning policy directions.

1 Introduction

1.1 The Polo Park site

As shown in Figure 1, the Polo Park site is in the west end of Winnipeg, Manitoba, and is generally bounded by:

- St. Matthews Avenue to the north;
- Empress Street to the east;
- Portage Avenue to the south; and
- St. James Street to the west.

As shown in Figure 2 and measured as-the-crow-flies from the centroid of the Polo Park site, the site is located approximately 2.77 km southeast of Winnipeg James Armstrong Richardson International Airport (YWG) terminal and 2.35 km southeast of the end of Runway 13/31 (which is oriented northwest-southeast).

1.2 Modern history of the Polo Park site

The Polo Park name can be traced back to the Polo Park Racetrack, a horse racing facility that opened on 12 June 1925. In its 31-year history, Polo Park was the home of the Canadian Derby and the Manitoba Jockey Club. Increasing land values and new neighbouring sports facilities, including Winnipeg Stadium (opened 14 August 1953) and Winnipeg Arena (opened 18 October 1955), led to the racetrack's closure on 4 July 1956 and its redevelopment.

On 20 August 1959, Polo Park Mall, an open-air shopping centre on the former racetrack grounds, opened. Since then, Polo Park Mall was enclosed and expanded in 1963, 1968, 1986, 2007, and 2014, creating Manitoba's largest shopping centre.

Both sports facilities were eventually closed and demolished: Winnipeg Arena closed in November 2004 (replaced by a new arena in downtown Winnipeg), and Winnipeg Stadium in January 2013 (replaced by a new stadium on the University of Manitoba lands).

Today, the site is currently comprised of three centres:

- CF Polo Park (formerly Polo Park Mall), a regional-scale, two-storey mall owned and operated by The Cadillac Fairview Corporation Limited (CF);
- The Plaza at Polo Park, an emerging retail development on the grounds of the former Winnipeg Stadium; and
- Polo North, a retail and office building on the former Winnipeg Arena grounds.



Figure 1: Polo Park site in Winnipeg, Manitoba



Figure 2: The Polo Park site in relation to Winnipeg James Armstrong Richardson International Airport and Downtown Winnipeg (rotated counterclockwise for legibility)

1.3 Objective and structure of this report

CF and Shindico Realty Inc. (Shindico) have commissioned Arup to review the relevant noise studies with relation to the Polo Park site in Winnipeg, Manitoba, leading to a potential redevelopment of portions of the site that will include residential uses. The review identifies aviation noise metrics used in Canada and the United States and how they are applied at YWG. Research was also conducted to examine the airport-adjacent residential land use planning policy framework and to identify the prevalence and quantity of residential development at comparable North American airports.

1.4 Winnipeg Richardson International Airport Master Plan 2033

On 15 June 2015, *Winnipeg Richardson International Airport Master Plan 2033* was released, providing a vision and recommendations for terminal area planning and land use strategies to meet growth in air travel to 2033. The conceptual land use plan was approved by the Federal Minister of Transport on 25 September 2015.

Overall, the number of air passengers is expected to nearly double between 2015 and 2033. However, the quantity of aircraft movements will only increase modestly due to the use of larger aircraft. The terminal building was last renovated in 2011.

The master plan notes that airfield capacity analyses have been undertaken which show that runway capacity is sufficient, and a third runway will not be required within the 20-year planning period despite anticipated passenger growth. As such, there has been no detailed analysis conducted on the thresholds that would be required for the construction of a third runway and no detailed planning has been done in anticipation of a third runway. However, the master plan's land use plan recommends reserving a portion of the airfield for future runway. Of note, the runway reserve is recommended to the far north of the existing airfield and would require a portion of land in the Regional Municipality of Rosser.

The only runway-related change recommended in the master plan is for a parallel taxiway expansion to the existing Runway 13 for improved capacity, which should be examined once there are 190 000 annual aircraft movements. (Arup notes that the taxiway expansion would not affect the noise contours.) This number of aircraft movements is not anticipated until beyond the 2033 planning horizon (167 500 aircraft movements are forecast be 2033).

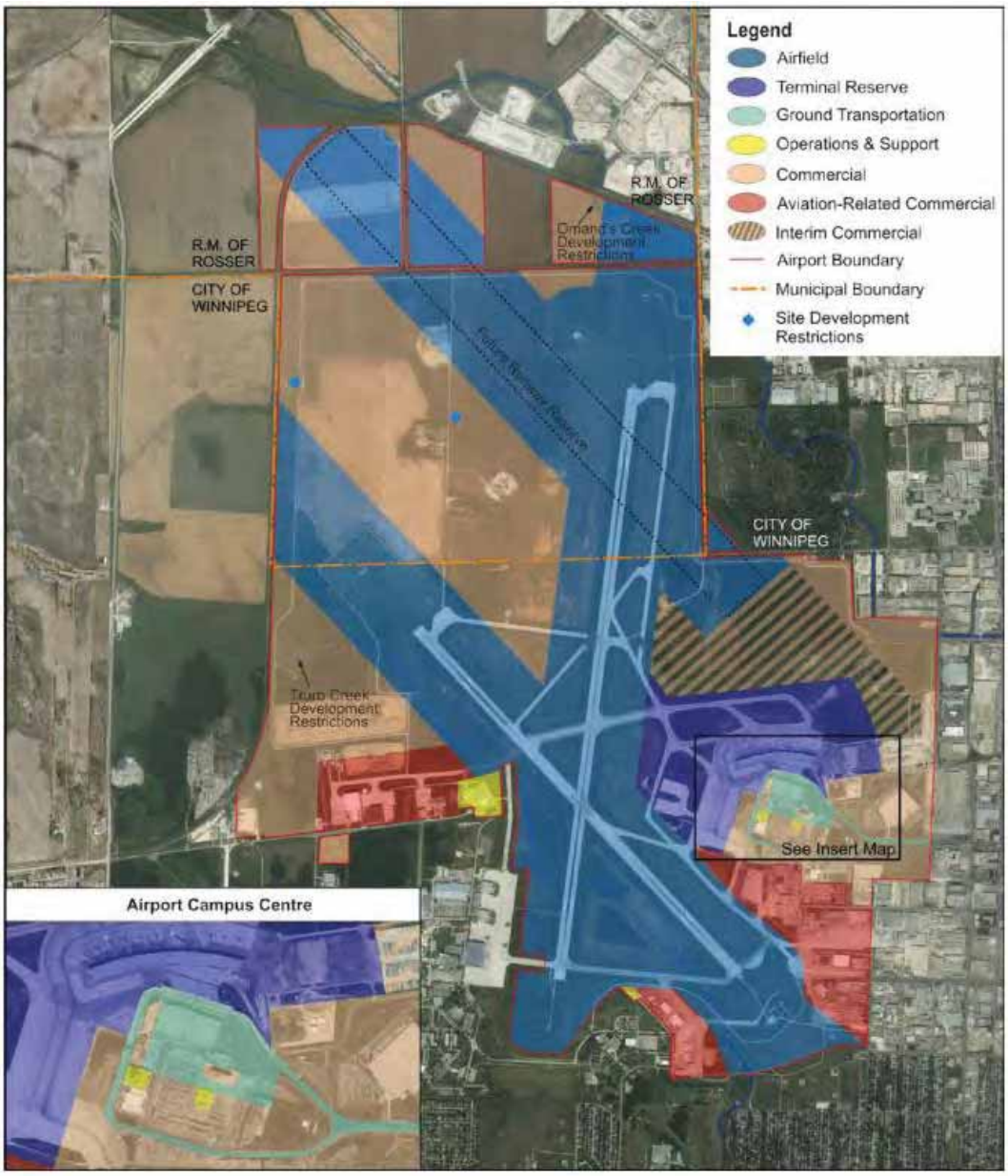


Figure 3: Winnipeg International Airport 2033 airport land use plan



Figure 4: Winnipeg International Airport long-term (+20 years) layout

2 Aviation noise metrics

Airports provide positive benefits to the community, including global accessibility and direct and indirect employment. Noise from aircraft movements has the potential to affect development and community growth. The impact of noise will depend on the noise level of the flyovers and the number of times they occur during the day and night. Therefore, the airport and adjacent community stakeholders should strive to strike a balance between the benefits to the community and the noise impacts near the airport.

Noise impacts are usually higher near airports, and a common method to communicate these impacts are noise contours. The contours are typically developed based on a yearly average day of aircraft movements. This provides an indication of the extent of the noise impact and helps people understand what the potential noise impact may be if they are buying (or developing) residential property near the airport.

Most planning rules do not exclude sensitive receivers (such as residential uses) in areas of high exposure. Local or national planning rules for building development often refer to the aircraft noise contours to guide the acceptability of areas close to airports for differing types of building development. However, noise from aircraft can be mitigated by building design, particularly using a sound insulating building envelope, to reduce aircraft noise ingress into the building. Locations exposed to higher levels of aircraft noise are required to have higher levels of building sound isolation.

2.1 Noise terminology and evaluation

Aircraft noise can be quantified by measurement or predictive methods to develop a sound pressure level. For mathematical convenience, the logarithmic parameter called sound pressure level (SPL) is used. The unit of sound (noise) measurement is the decibel (dB). Noise is also dependent on the frequency spectrum of the source and time variance.

Four classes of metrics for aircraft noise have evolved from these fundamentals of noise measurement/prediction:

- Single event maximum sound levels – Represent a maximum sound level from a single aircraft movement and are typically measured as an A-weighted noise level to represent the human response to loudness. The perceived noise level (PNL) and A-weighting are often used in aircraft noise assessment.
- Single event energy dose – Represent both the maximum sound level and the duration of the event. Effective perceived noise level (EPNL) and the sound exposure level (SEL) are typically used for aircraft noise assessment and derived from the single event sound level metrics.

- Cumulative energy average metrics – Derived from single event energy dose metrics and can be predicted or derived from continuous noise measurement data. Generally, they correlate well with aggregate community annoyance response. They do not relate to speech interference, sleep disturbance, or other phenomena requiring analysis of single event energy dose metrics. They are not used to determine source standards or certification of aircraft noise. Common metrics used in aircraft noise studies include noise exposure forecast (NEF) and day-night average level (DNL) and are usually based on 'yearly average day' of flight movements.
- Cumulative time metrics – Represent a period in minutes that an A-weighted level is exceeded. It can be related to "threshold activated" physiological or annoyance effects.

Canadian aircraft noise exposure studies utilize cumulative energy average metrics for aircraft noise exposure assessments. In Canada, NEF is approved by Transport Canada for land use planning.

Noise exposure forecast

The NEF metric, expressed in dB, uses the EPNL metric as its basis. It is defined as follows and is summed over all aircraft types and flight paths:

$$\text{NEF} = EPNL + 10\log(N_D + 16.7 * N_N) - 88$$

Where:

- N_D is the number of daytime operations (7:00 AM-10:00 PM)
- N_N is the number of nighttime operations (10:00 PM-7:00 AM)
- The multiplier on nighttime operations results in a +12.2 dB penalty

The data required for determining the NEF consists of EPNL versus distance information for various aircraft types and their generalized performance data (e.g. takeoff, landing).

To calculate the NEF at a specific location, the EPNL contribution from each aircraft operating from each runway is assessed by considering the distance from the point in question to the aircraft, and then obtaining EPNL values from the appropriate EPNL versus distance curve. The noise contributions from all aircraft types operating on all runways are summed on an anti-logarithmic basis to obtain the total noise exposure at that one location.

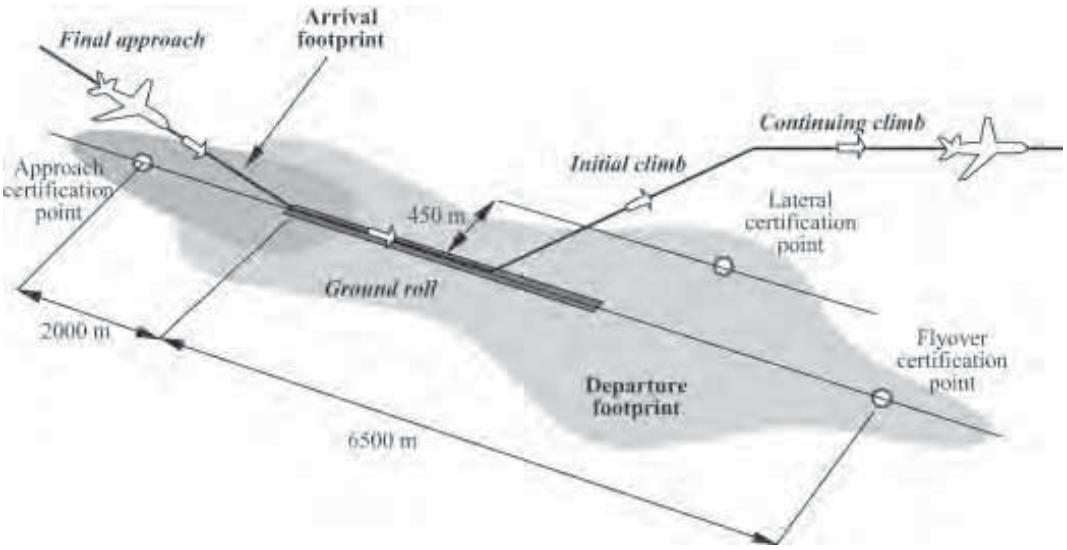


Figure 5: Illustration of how an aircraft noise footprint is determined with the different approach and departure stages at certification stages. The single event energy summation of different aircraft noise footprint over a period result in the forecasted noise contours.

2.2 Contour prediction methods

Software

Transport Canada provides a NEF contour prediction software package (NEF-Calc v.2.0.6.1). Though it is still actively used for NEF contour studies, this software is not actively supported by Transport Canada at the time of this review.

Typical inputs

Table 1 summarizes typical inputs into the commonly used contour software prediction packages.

Table 1: Typical input parameters into NEF-Calc and AEDT for noise contour prediction

Input parameter	NEF-Calc	AEDT
Physical description of airport layout (e.g. runway orientations, lengths, etc.)	Yes	Yes
Number and mix of aircraft operations	Yes	Yes
Day-night split of operations (by aircraft type)	Yes	Yes
Runway utilization rates	Yes	Yes
Representative flight track descriptions and flight utilization rates	Yes	Yes
Meteorological conditions	No	Yes
Terrain	No	Yes

Outputs

NEF contours

There are three types of NEF predictions typically conducted to generate the contours:

- Noise exposure forecast (NEF) – Traffic volume and aircraft type and mix to create the NEFs are normally forecast for a period between five to ten years into the future. Runway geometry should be the current layout plus any changes forecast to be completed prior to the end of the forecast period.
- Noise exposure projection (NEP) – Similar to NEFs but are contours for projections more than 10 years into the future.
- Planning contour – These contours are produced to investigate planning alternatives.

All produced contours are the property of the sponsoring aerodrome operation or airport authority and are made available to the provincial and local governments at their discretion to support land-use planning and/or public access to them.

Transport Canada calculates NEF values for the number of operations occurring on a peak planning day that is approximately a 95th percentile day[3]. The 95th percentile day represents a near- to worst-case 24-hour period where, for only 5% of the time, there more aircraft operations than on this 95th percentile day.

The following procedure is used to determine the number of aircraft operations for a peak planning day.

[3] Bradley, JS. *NEF Validation Study: (3) Final Report*. National Research Council Canada. December 1996. <https://nrc-publications.canada.ca/eng/view/fulltext/?id=f07ea19e-e398-46cc-93a5-a6ce700bd143>

- During the year, the three busiest months are isolated (usually the summer months) and the seven busiest days in each of the three months, for a total of 21 days, are identified.
- The peak planning day is then calculated as the average number of movements over these 21 days.

2.3 Contour maps and changes over time

Aircraft technology, airport operations, traffic volume, and field improvements are some of the factors that can change over time and affect predicted noise contours. As airports and airlines are always changing, it would be expected that contours must change as well.

In a recent benchmarking study, six Canadian and 48 American airports responded to a survey which included queries on the frequency they update their noise exposure maps. 55% of the respondents update their noise contour maps with a frequency of five years or less. Within that group, 17% update them annually or quarterly.[4]

In the United Kingdom, all airports are required to update their noise contour studies every five years under the Environmental Noise Directive. Select airports are required to update them annually.

Other local regulations and planning changes, both for the local city and airport, could warrant an update to a noise exposure map.

2.4 Winnipeg noise contour maps and the Polo Park site

NEF contours for YWG are prepared by the Winnipeg Airports Authority and form the basis of the City of Winnipeg's (City's) airport-adjacent land use planning framework (which is reviewed further in section 3.2 of this report). Through research and data supplied to Arup, two sets of noise contours have been mapped:

- The 1995 noise contours, as shown in Figure 6, were directly sourced from the City's *Airport Vicinity Protection Area Secondary Plan By-law*; and
- The 2000 noise contours, as shown in Figure 7, were indirectly sourced from the City's Planning, Property, and Development Department through CF and Shindico.

[4] Airport Noise Management Benchmarking Study, HMMH, September 1, 2018 (https://www.macnoise.com/sites/www.macenvironment.org/files/pdf/Benchmarking_Final_Report_9.4.18.pdf)

Arup notes that a 2005 set of noise contours is shown in a 2000 WAA report[5]. However, the map shown in this report is presented as a small, low-definition image that cannot be used for mapping and spatial analysis. Arup was unable to obtain a higher resolution map and has not considered this set of contours in this analysis.

With reference to the Polo Park site, the two sets of noise contours generally show that most of the site has a NEF of less than or equal to 30, which is the threshold for residential development:

- The 1995 contours, as shown in Figure 8, show that the CF Polo Park portion of the site has a NEF of less than or equal to 30, with only the southwest corner of CF Polo Park and the northern portion (The Plaza at Polo Park and Polo North) having a NEF between 30 and 35. (The northeast corner has a NEF between 35 and 40.)
- The 2000 contours (Figure 9) show that the entire site has a NEF less than 30.

2.5 Summary

Noise exposure maps are often the primary tool in establishing guidelines for land-use planning around airports. NEF contours are commonly used and referenced in planning documents and are built based on historical and forward-looking information. It is important that the contour predictions are updated to reflect revised airport operations, traffic patterns, changes to infrastructure and current aircraft technology.

The NEF metric is normally forecast for a period between five to ten years into the future and include current and future runway geometry forecast to be completed prior to the end of the forecast period.

The WAA noise contours have not been publicly updated since 2005, well outside the maximum 10-year period defined by Transport Canada. Furthermore, they do not align with the WAA airport master plan which states that a third runway is not required within the master plan period of 2033 – well beyond the period of the NEF contour map. At minimum, without an updated contour study it would be expected that the Polo Park site has a NEF less than 30 and would comply with Transport Canada guidelines for residential development near aerodromes (see Section 3.1).

[5] Winnipeg Airports Authority. *Bringing 2020 Into Focus: Airport Development Plan Summary*. December 2000. <https://www.waa.ca/uploads/ck/files/Reports/AirportDevelopmentPlan_Summary.pdf>

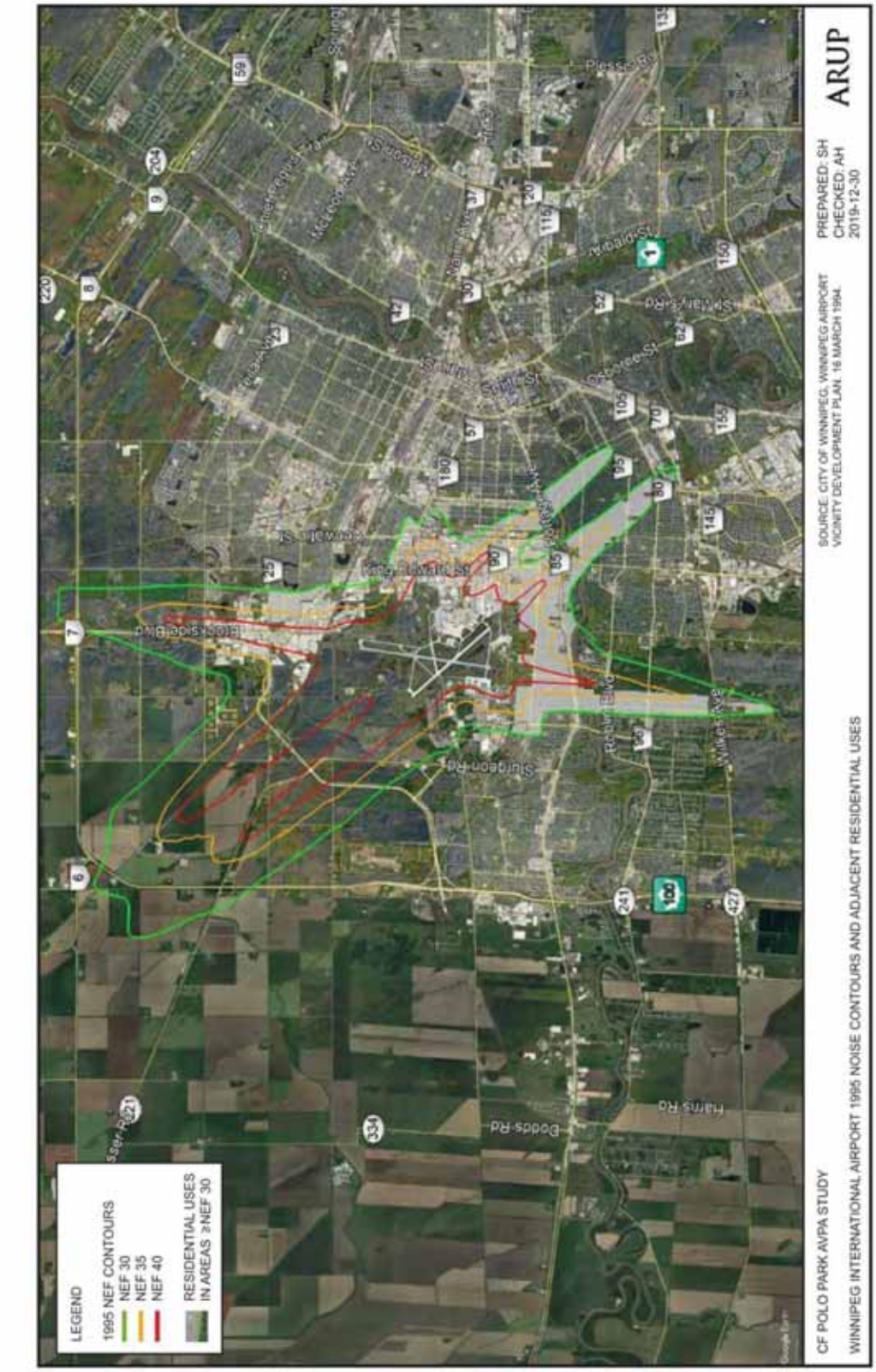


Figure 6: Winnipeg James Armstrong Richardson International Airport noise contours (1995) and adjacent residential uses (rotated counterclockwise for legibility)



Figure 7: Winnipeg James Armstrong Richardson International Airport noise contours (2000) and adjacent residential uses (rotated counterclockwise for legibility)



Figure 8: Detail of the 1995 NEF contours with reference to the Polo Park site



Figure 9: Detail of the 2000 NEF contours with reference to the Polo Park site

3 Airport-adjacent residential land use planning and development

3.1 Civil aviation authority policy guidance

Transport Canada

Although land use planning for non-airport property is generally under the purview of provincial and municipal governments, Transport Canada provides guidance on how non-airport lands should be developed, as expressed in its *Land Use in the Vicinity of Aerodromes* (TP 1247E, Ninth Edition) manual.

Section 4 of the manual focuses on aircraft noise: its measurement, the NEF system, the production of noise exposure contours, and community responses to noise. Based on case histories of noise complaints, a relationship has been established between the NEF contour levels, community response, and land use recommendations. Table 2 and Table 3 summarize these recommendations from Transport Canada related to residential development.

The Transport Canada guidelines note that the location of the contour lines between noise zones cannot be fixed exactly. It will therefore be necessary for the responsible public authority to make an appropriate interpretation of what regulations are to apply at a specific location.

Table 2: Community response prediction[6]

Response area	Response prediction (see note)
1 (over 40 NEF)	Repeated and vigorous individual complaints are likely. Concerted group and legal action might be expected.
2 (35-40 NEF)	Individual complaints may be vigorous. Possible group action and appeals to authorities.
3 (30-35 NEF)	Sporadic to repeated individual complaints. Group action is possible.
4 (below 30 NEF)	Sporadic complaints may occur. Noise may interfere occasionally with certain activities of the resident.
It should be noted that the above community response predictions are generalizations based upon experience resulting from the evolutionary development of various noise exposure units used by other countries. For specific locations, the above response areas may vary somewhat in accordance with existing ambient or background noise levels and prevailing social, economic, and political conditions.	

[6] Transport Canada. *Land Use in the Vicinity of Aerodromes*. Manual TP 1247E. 2013/14.

Note that, in Table 3, Transport Canada makes a broad recommendation that new construction should not be undertaken in areas with a NEF greater than or equal to 30. However, Transport Canada also notes that municipal planning authorities may choose to approve developments with NEF greater than or equal to 30, and makes several additional notes aimed at mitigating the effects of noise and reducing noise-related complaints.

Table 3: Land use table - aircraft noise considerations only (for residential uses)[7]

Noise exposure forecast values	>40	40-35	35-30	**<30**
Response areas	1	2	3	4
Detached, semi-detached	No	No	No	A
Town houses, garden homes	No	No	No	A
Apartments	No	No	No	A
No: indicates that new construction or development of this nature should not be undertaken. This note applies to NEF 30 to 35 only. New residential construction or development should not be undertaken. If the responsible authority chooses to proceed contrary to Transport Canada's recommendation, residential construction or development between NEF 30 and 35 should not be permitted to proceed until the responsible authority is satisfied that: (1) appropriate acoustic insulation features have been considered in the building and (2) a noise impact assessment study has been completed and shows that this construction or development is not incompatible with aircraft noise. Notwithstanding point 2, the developer should still be required to inform all prospective tenants or purchasers of residential units that speech interference and annoyance caused by aircraft noise are, on average, established and growing at NEF 30 and are very significant by NEF 35.				
A: this particular land use may be acceptable in accordance with the appropriate note and subject to the limitations indicated therein. Annoyance caused by aircraft noise may begin as low as NEF 25. It is recommended that developers be made aware of this fact and that they undertake to so inform all prospective tenants or purchasers of residential units. In addition, it is suggested that development should not proceed until the responsible authority is satisfied that acoustic insulation features, if required, have been considered in the building design.				

[7] Same.

3.2 City of Winnipeg planning policies

Section 269(1) of *The City of Winnipeg Charter Act*, the City's enabling legislation as enacted by the Government of Manitoba, requires that regulations be made to protect the airport vicinity:

> The Lieutenant Governor in Council may make regulations
>
> (a) requiring the establishment by council in Plan Winnipeg of an area of the city adjacent to Winnipeg International Airport as an airport vicinity protection area;
>
> (b) establishing policies for use of real property, and for development, in the airport vicinity protection area to ensure that the use of real property and development in the area are compatible with the operation of Winnipeg International Airport, and requiring any Plan Winnipeg by-law to be consistent with those policies
>
> (c) requiring a zoning by-law to be passed by council to control or prohibit any use of real property or development in the airport vicinity protection area, or in a part of it, to ensure that the use of real property and development are compatible with the policies established under clause (b).

To meet the Charter requirement, on 25 May 1994, the City adopted the *Winnipeg Airport Vicinity Development Plan* No. 6378/94 to protect the 24-hour air operations of YWG by limiting residential noise complaints. (The *Winnipeg Airport Vicinity Development Plan* was renamed to the *Airport Vicinity Protection Area Secondary Plan By-law* (henceforth referred to as the Plan) in December 2002.)

To protect the operations, the Plan limits new residential development by delineating two airport vicinity protection areas (AVPAs), prohibiting new residential uses in Area I. It does allow for new residential development, including multi-family, in Area II.

The boundaries of Areas I and II directly relate to the NEF contours. The NEF 25 contour approximates the outer limit of the Plan area. The Plan indicates that the NEF contours reflect "the ultimate traffic volume at Winnipeg International Airport, and includes the potential for an additional runway to the northeast of the existing runway".

The Plan also states that its boundaries will be reviewed and revised as necessary to reflect changes to the NEF contours. However, it appears that the AVPA boundaries have not been revised since the implementation of the Charter in 1994 despite revisions to the Airport Master Plan and other City planning initiatives.

For residential dwellings constructed in Area II, the City has established acoustic performance guidelines for sound insulation within sleeping areas. Though these are intended for Area II constructions (NEF less than 25), the guidelines provide parameters for sleeping areas within higher NEF contour locations.

In August 2019, the City prepared *By-Law No. 48/2019 – Amendment to the Airport Vicinity Protection Area Secondary Plan By-Law No. 6378/94 for Polo Park/Former Stadium Site*, an administrative report to the City's Standing Policy Committee on Property and Development, Heritage and Downtown Development dealing with a proposed redesignation of the Polo Park site from Area I to Area II, with the aim of facilitating residential development on the Polo Park site. Figure 10 shows the Polo Park site with reference to Areas I and II of the Plan and the 1995 airport NEF contours.

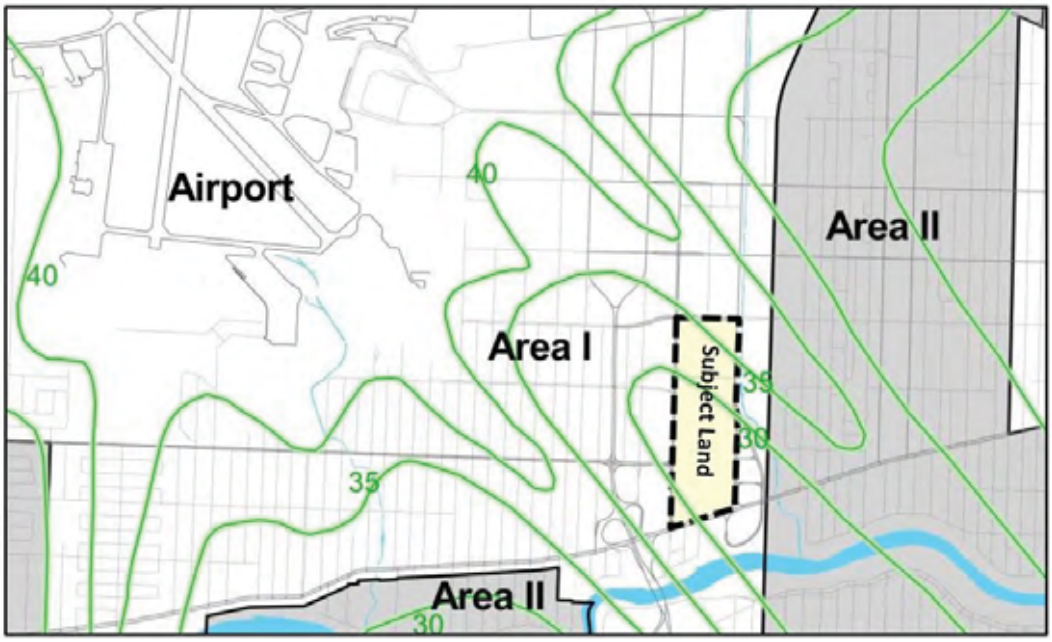


Figure 10: The Polo Park site (subject lands) is in Plan Area I, with the 1995 NEF contours superimposed[8]

Of note, the administrative report notes that:

> The proposal to re-designate the subject lands from policy Area I to Area II in order to consider future residential development is consistent with the policies of *OurWinnipeg* [the City's official plan] and *Complete Communities* [Direction Strategy].

The City has released an updated map showing the Plan boundaries with 2000 NEF contours, as shown in Figure 11. Of note, the Polo Park site has a NEF less then 30 using the 2000 NEF contours.

[8] City of Winnipeg. *By-Law No. 48/2019 – Amendment to the Airport Vicinity Protection Area Secondary Plan By-Law No. 6378/94 for Polo Park/Former Stadium Site*. Administrative report to City of Winnipeg Standing Policy Committee on Property and Development, Heritage and Downtown Development. 4 September 2019.

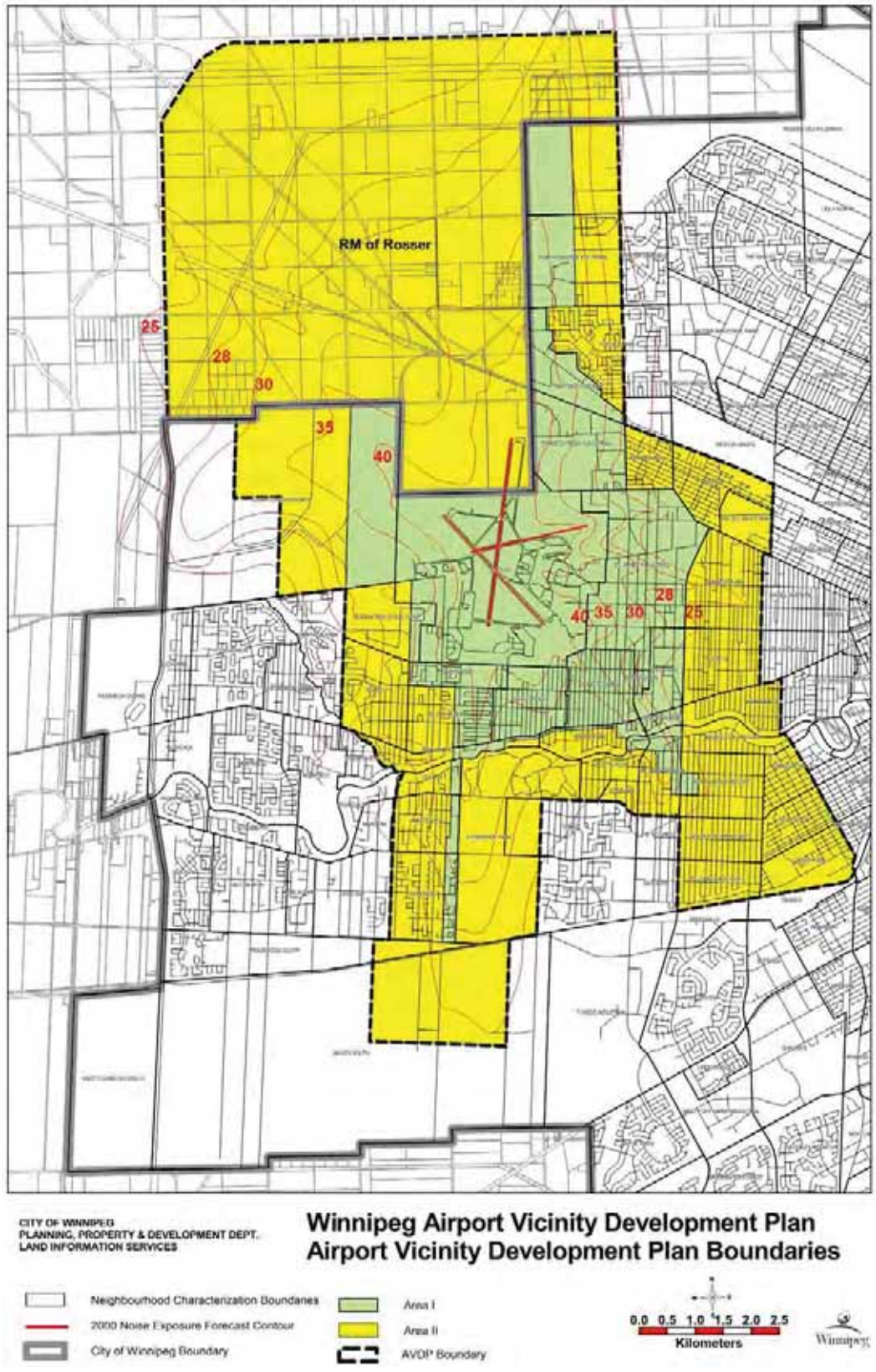


Figure 11: Airport Vicinity Development Plan boundaries with 2000 NEF contours[9]

3.3 Airport-adjacent residential land uses in Winnipeg

Referring back to Figure 7, which shows the 2000 YWG noise contours and adjacent residential uses, a significant proportion of Winnipeg's residential areas have a NEF greater than or equal to 30 (and, in many cases, greater than NEF 35 and 40). These residential neighbourhoods include:

- The western half of Tyndall Park, northeast of YWG;
- The entirety of Deer Lodge and Jameswood, nearly the entirety of King Edward and Silver Heights, and the eastern half of Booth, all located between YWG and the Assiniboine River (shown in Figure 12 with the Polo Park site highlighted in blue); and
- The eastern half of Varsity View and Vialoux, south of the Assiniboine River and west of Assiniboine Park.

These neighbourhoods contain a varied mix of single-detached housing, low-, mid-, and high-rise apartments, and other noise sensitive land uses such as schools and the Deer Lodge Centre, a long-term care and rehabilitation facility.

3.4 Mitigation

Although the Polo Park site has a NEF less than 30 (going by the 2000 NEF contours), a range of potential airport noise mitigation and noise complaint prevention methods may be examined for residential development at the Polo Park site, such as:

- Designing and constructing buildings to meet minimum acoustic insulation and mechanical ventilation requirements, as detailed in the City's *Airport Vicinity Acoustic Insulation By-law No. 6419/94*;
- Informing all prospective tenants or purchasers of residential units of potential annoyance caused by aircraft noise, as recommended by Transport Canada;
- Including appropriate cautionary language in the registration of land titles for new residential units; and
- Providing public notice of airport-related noise using signage, where appropriate.



Figure 12: Winnipeg International Airport 2000 NEF contours overlaid on the Booth, Deer Lodge, Jameswood, King Edward, and Silver Heights neighbourhoods to the south

3.5 Airport-adjacent residential land uses in other cities

As a comparative analysis, Arup selected four airports and reviewed the relevant noise contour studies for these airports. The aim of this comparative analysis is to provide an understanding of how airport noise contours correlate with residential land uses in other cities, and whether Winnipeg is unique in its residential development restrictions with Areas I and II of the Plan.

For comparison with Figure 6, the four airports were mapped to show the noise contours associated with each airport, and the adjacent residential areas within these contours were highlighted:

- Toronto Pearson International Airport, in Toronto, Ontario (as shown in Figure 13);
- Vancouver International Airport, in Vancouver, British Columbia (Figure 14);
- Los Angeles International Airport, in Los Angeles, California (Figure 15); and
- Seattle-Tacoma International Airport, Seattle, Washington (Figure 16).

These airports were selected based on the location of airport within the urban area (airports located within their respective city's built-up area, like YWG's context, were preferred), and noise contour study and data availability (studies tend to be publicly available only for large airports with ongoing expansion programs).

Table 4: Comparison of Winnipeg International Airport and selected airports

Airport	Number of passengers	Aircraft movements per annum	Date of last contour mapping	Noise abatement procedures
Winnipeg (YWG)	4,484,343 (2018, Winnipeg Airports Authority)	121,305 (2017, Nav Canada)	2005[10]	Nighttime operating restrictions, 23:00 to 07:00 Attenuation wall constructed on Apron 4
Toronto Pearson (YYZ)	41,968,572 (2018, Greater Toronto Airports Authority)	467,103 (2017, Nav Canada)	2000	Engine run-up prohibitions for all noisier Chapter 2 aircraft, 02:00 to 05:00 "Night flight budget" restricting number of movements between 00:30 and 06:29 Standard Instrument Departure procedures and Standard Terminal Arrival Route procedures
Vancouver (YVR)	25,936,907 (2018, Vancouver Airport Authority)	333,861 (2017, Nav Canada)	2000	Nighttime operating restrictions, including north runway closure, 22:00 to 07:00 Preferential runway system over non-populated areas, weather permitting
Los Angeles (LAX)	87,534,384 (2018, Los Angeles World Airports)	707,833 (2018, FAA)	2019	Preferential runway use policy
Seattle-Tacoma (SEA)	49,849,520 (2018, Port of Seattle)	438,391 (2018, Port of Seattle)	2013	Voluntary late-night noise limitation program, 00:00 to 05:00 North flow arrivals and departures corridor and altitude restriction procedures, 22:00 to 06:00

[10]Arup notes that a 2005 set of noise contours is shown in a 2000 WAA report. However, the map shown in this report is presented as a small, low-definition image that cannot be used for mapping and spatial analysis.



Figure 13: Toronto Pearson International Airport noise contours and adjacent residential uses (rotated counterclockwise for legibility)



Figure 14: Vancouver International Airport noise contours and adjacent residential uses (rotated counterclockwise for legibility)



Figure 15: Los Angeles International Airport noise contours and adjacent residential uses (rotated counterclockwise for legibility)



Figure 16: Seattle-Tacoma International Airport noise contours and adjacent residential uses (rotated counterclockwise for legibility)

3.6 Recent airport-adjacent residential development

Focusing on the Toronto and Vancouver airports, airport-adjacent residential development was tracked using aerial photos. The aim of this tracking was to quantify the degree of development within the NEF contours of each respective airport over the last 15 to 20 years, which would provide an understanding of how prevalent residential development is in a similar airport noise context.

Toronto Pearson International Airport and Mississauga, Ontario

Land use planning policy framework

Per the Government of Canada Standing Committee on Transport, Infrastructure and Communities, Toronto Pearson International Airport last prepared a noise contour map in 1996. The latest publicly available noise contour map is a composite image of the 1996 NEP and 2000 NEF contours.

According to the Ontario Environmental Noise Guideline - Stationary and Transportation Sources – Approval and Planning (NPC-300), the following is required when constructing a new residential development with a NEF between 25 and 30:

- C7.4 Aircraft Noise Control Measures: “If a new residential unit is within the NEF/NEP contours of 25 and 30, the dwelling should be designed with central air conditioning. In addition, building components including windows, doors, walls, and ceiling/roof should be designed so living and dining rooms do not exceed 5 NEF and sleeping areas do not exceed 0 NEF. Warning clause Type C is also recommended.”
- Warning clause Type C: “This dwelling unit has been designed with the provision for adding central air conditioning at the occupant’s discretion. Installation of central air conditioning by the occupant in low and medium density developments will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment.”
- Air conditioning is not a noise control measure. The use of air conditioning allows windows and doors to remain closed, and therefore reduce the indoor sound levels.
- C7.9 Verification of Noise Control Measures: “It is recommended that the implementation of noise control measures be verified by qualified individuals with experience in environmental acoustics.”[11]

The 2007 City of Mississauga Official Plan states that no residential development will be permitted in lands with a NEF greater than or equal to 35. As part of this

[11] Ontario Environmental Noise Guideline - Stationary and Transportation Sources - Approval and Planning (NPC-300)

plan some land uses were designated for business/employment use rather than the previous residential uses.

The City of Mississauga passed an Official Plan amendment on 7 February 2019 to replace Aircraft Noise Policies in the Mississauga Official Plan, to add a portion of lands in the Malton Community Node and Neighbourhood Character Areas as an "Exception Area" and to amend the boundary of the Meadowvale Village Neighbourhood Exception Area. Amendments include new restrictions on residential development in airport adjacent areas and the requirement that tenants and purchasers to be notified if a proposed development has a NEP/NEF greater than or equal to 25.

Current residential development within the noise contours

The Meadowvale Village Neighbourhood Exception Area, focused at the intersection of Derry Road West and McLaughlin Road and having a NEF between 30 and 35, has experienced a fair amount of growth in the last ten years, primarily in ground-related single-detached, semi-detached, row, and low-rise apartment dwelling units, although this is slowing as the Village approaches build-out of developable lands.

Table 5: New residential development in Meadowvale Village with a NEF greater than or equal to 30, 2009-2019

Dwelling unit type	New residential units
Single-detached	150
Semi-detached	194
Row	83
Apartment	36
Total	462

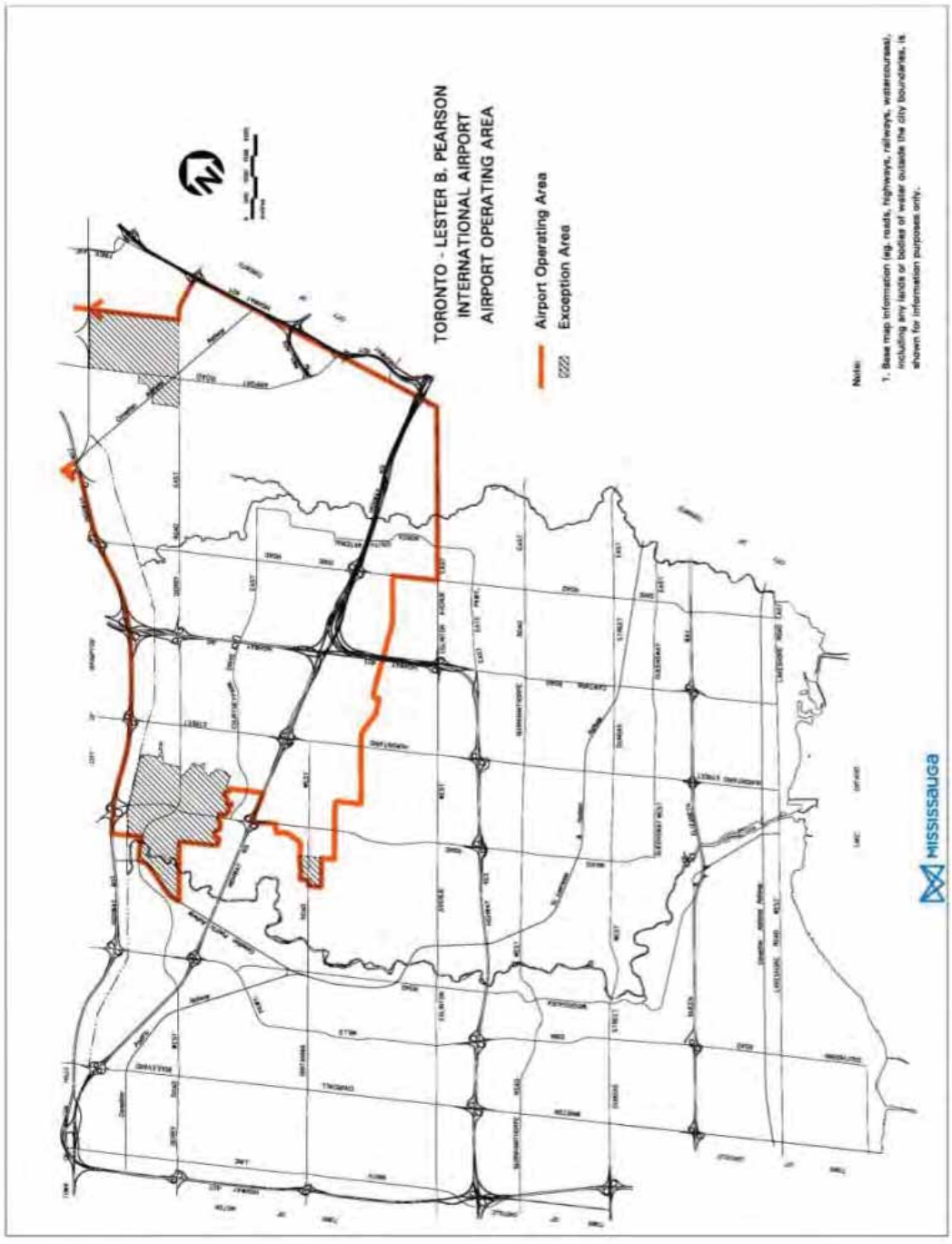


Figure 17: Toronto Pearson International Airport (YYZ) Operating Area (Source: City of Mississauga, rotated counterclockwise for legibility)



Figure 18: Aerial photo of Meadowvale Village showing future residential developments highlighted in orange, 29 September 2009



Figure 19: Aerial photo of Meadowvale Village showing build-out of residential developments highlighted in orange, 9 June 2018

Vancouver International Airport and Richmond, British Columbia

Land use planning policy framework

The Vancouver Airport Authority publishes annual aeronautical noise management reports but does not undertake noise contour mapping as part of these exercises. The latest publicly available noise contour maps were developed in 1994 as a projection of 2015 noise contours.

In the City of Richmond, some pockets of residential use have a NEF greater than or equal to 30. These are mainly single detached dwellings which were constructed prior to the enactment of the most recent sensitive development policies.

The City of Richmond Official Community Plan has aircraft noise sensitive land use and development policies which limit the development, including prohibiting new residential development in areas with a NEF greater than or equal to 35 under Bylaw 9121, 2015-06-15.

The Aircraft Noise Sensitive Development Management in the City of Richmond Community Plan – Bylaw 900 outlines the development requirements for new residential development adjacent to the Vancouver International Airport. The following criteria are listed:

- Where aircraft noise sensitive land uses are permitted in an area or on a site, they are to achieve a high level of livability and maximize aircraft noise mitigation requirements; the livability and aircraft noise mitigation considerations include:
    - Varying the development mix;
    - Mixing aircraft noise sensitive development such as residential with other non-aircraft noise sensitive land uses like parks, commercial, and office spaces;
    - Mixing various aircraft noise sensitive developments residential land uses (e.g., single family, mid-rise, high-rise, live/work, work/live);
    - Varying the density of aircraft noise sensitive land uses;
    - Varying the degree of aircraft noise sensitive land use site coverage;
    - Orienting and facing land uses and buildings to minimize aircraft noise;
    - Ensuring land use compatibility; and
    - Encouraging high quality, innovative urban design and landscaping.
- In a high aircraft noise area, the following requirements must be met:
    - Provide an Acoustic Report;
    - Noise mitigation incorporated in construction;
    - Mechanical ventilation incorporated in construction; and
    - Central air conditioning system incorporated in construction.

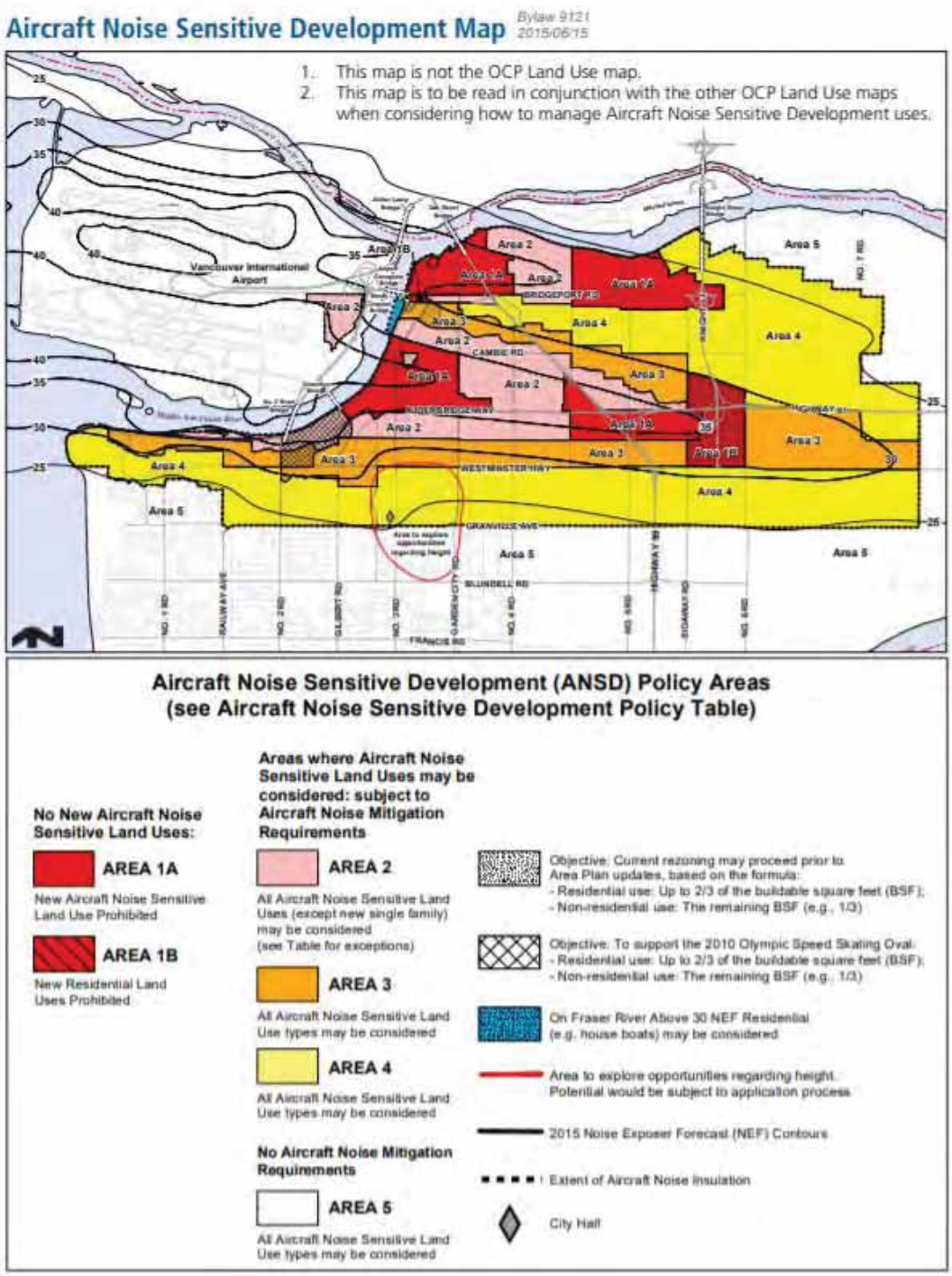


Figure 20: Aircraft Noise Sensitive Development map (Source: City of Richmond)

Current residential development within the noise contours

Residential development with a NEF between 30 and 40 contours was focused primarily in Richmond Centre (as shown in Figure 21).

- This area had the highest level of residential intensification based on historic and current aerial photographs;
- Most of the development was high-rise residential apartments with at-grade retail; and
- A community centre was constructed with a NEF greater than or equal to 35.

Other areas within the NEF contours had minor growth in residential uses, but mainly ground-related residential units.

Additional development is anticipated based on rezoning applications submitted to the City of Richmond.

Table 6: New residential development in Richmond Centre with NEF greater than or equal to 30, by year

Year	New residential units
1997	69
1998	77
2003	534
2006	289
2007	721
2008	887
2009	111
2010	624
2013	1 187
2015	1 392
2016	221
2017	732
2018	413
2019	266
2020 (anticipated)	438



Figure 21: Vancouver International Airport airport-adjacent residential development, 1997-today, rotated counterclockwise for legibility)

3.7 Summary

Having reviewed the planning framework and airport-adjacent development in other cities, it appears that the development of residential uses should be appropriate at the Polo Park site.

- Transport Canada notes that, in areas with a NEF less than 30, residential use may be acceptable. The 1995 NEF contours show that a sizeable portion of the site is has a NEF less than or equal to 30, and the 2000 contours show that the entire site is has a NEF less than 30. (Transport Canada goes on to recommend that developers be made aware of this fact and that they undertake to so inform all prospective tenants or purchasers of residential units, and suggests that acoustic insulation features, if required, be considered in the building design.)
- The City has reviewed the proposal to re-designate the Polo Park site from policy Area I to Area II, with the latter being a less restrictive designation under the *Airport Vicinity Protection Area Secondary Plan By-law* that permits new residential development, and has found that the proposed redesignation is consistent with the policies of *OurWinnipeg*, the City's official plan, and the *Complete Communities Direction Strategy*.
- Based on a review of four major North American airports (Toronto, Vancouver, Los Angeles, and Seattle), there are existing areas of airport-adjacent residential development with a NEF greater than or equal to 30 or DNL greater than or equal to 65.
- Focusing on Mississauga, Ontario (adjacent to Toronto Pearson International Airport) and Richmond, British Columbia (adjacent to Vancouver International Airport), there has been significant residential growth in the last few decades.
    - In the Meadowvale Village area of Mississauga, 462 new single-detached, semi-detached, row house, and apartment units were built with a NEF greater than or equal to 30 between 2009 and 2019.
    - In Richmond Centre, nearly 8 000 new apartment units were built with a NEF greater than or equal to 30, with a sizeable proportion having a NEF between 35 and 40 and a small number with a NEF greater than 40.

Appendix A

List of abbreviations used

A1 List of abbreviations used

Abbreviation	Term
AEDT	Aviation Environmental Design Tool
CF	The Cadillac Fairview Corporation Limited
City	City of Winnipeg
dB	Decibel
dBA	A-weighted decibel
DNL	Day-night average sound level
EPNL	Effective perceived noise level
FAA	(United States) Federal Aviation Administration
NEF	Noise exposure forecast
NEP	Noise exposure projection
NLR	Noise level reduction
Plan	(City of Winnipeg) Airport Vicinity Protection Area Secondary Plan By-law
PNL	Perceived noise level
SEL	Sound exposure level
SPL	Sound pressure level
YWG	(IATA airport code for) Winnipeg James Armstrong Richardson International Airport

Appendix B

United States aviation noise metric and policy guidance

B1 United States aviation noise metric and policy guidance

For comparison with the Canadian civil aviation authority policy guidance (as established by Transport Canada), this appendix provides an overview of the United States civil aviation authority policy guidance pertaining to development in airport-adjacent areas in the United States.

B1.1 Day-night average sound level metric

Whereas in Canada, NEF is approved by Transport Canada for land use planning, the day-night average sound level (DNL) is used for land use planning in the United States and is approved by the Federal Aviation Administration (FAA).

The DNL metric describes the total noise exposure during a defined period. It is an enhancement of the A-weighted equivalent sound level (L_{Aeq}) because a correction for nighttime noise intrusions was added. The 24-hour DNL is defined as follows:

$$L_{DN} = 10 \log\left(\frac{1}{24}\left(15\left(10^{\frac{L_D}{10}}\right) + 9\left(10^{\frac{L_N+10}{10}}\right)\right)\right)$$

Where:

- L_D is the daytime (7:00 AM-10:00 PM) L_{Aeq} sound level
- L_N is the nighttime (10:00 PM-7:00 AM) L_{Aeq} sound level
- There is an extra weighting of 10 dB for any sound levels occurring during nighttime

This nighttime penalty is intended to account for the greater annoyance that nighttime noise is presumed to cause for most people. This extra weight treats one nighttime noise event as the equivalent to ten daytime events of the same magnitude.

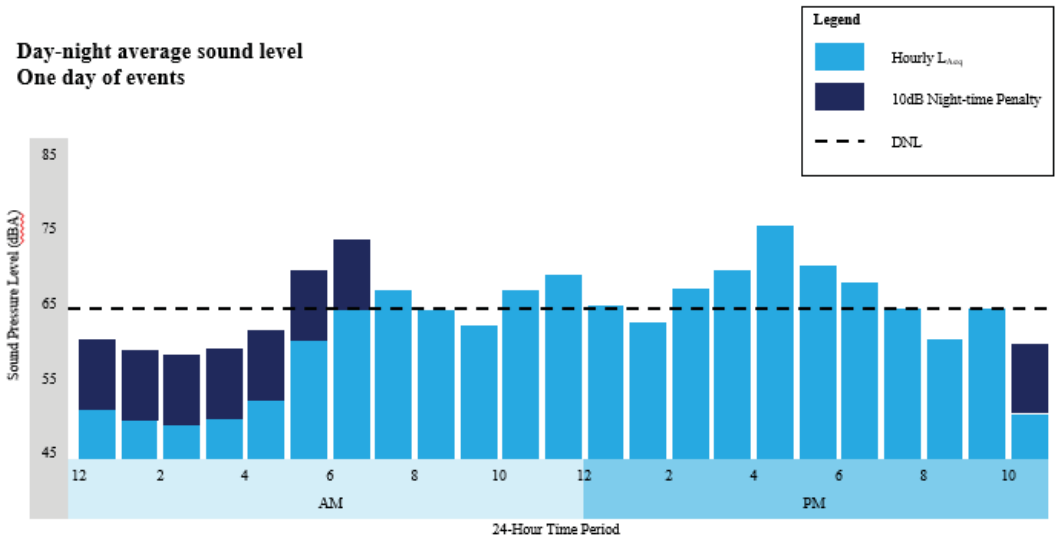


Figure 22: Graphical illustration of the DNL metric. A 10 dB nighttime penalty is added.

Conversion and comparison of metrics

The NEF metric correlates with the DNL metric. The two are commonly compared using the following conversion formula:

$$DNL = NEF + 35$$

B1.2 Contour prediction methods

Software

DNL contours are most commonly generated by the FAA's Aviation Environmental Design Tool (AEDT) software package (an FAA approved prediction program). AEDT can also generate NEF contours.

Outputs

DNL contours

The FAA does not require airports to participate in the Airport Noise Compatibility Planning or Part 150 program (it is completely voluntary and so named because the Aviation Safety and Noise Abatement Act of 1979 created the program under 14 CFR Part 150). However, participating airports that produce noise contour maps for submission to the FAA must adhere to the following:

- Five-year outlook – Noise contour maps shall be based on a forecast of aircraft operations at least five years into the future beginning after the date of submission to the FAA. The contours need to account for reasonable assumptions concerning future type and frequency of aircraft operations,

number of nighttime operations, flight patterns, airport layout (including planned development), planned land use changes, and demographic changes in the surrounding areas.

- Update contours – If after submission of a noise exposure map a new operation significantly reduces or increases the forecasted contours by 1.5 dB DNL, a revised map shall be submitted.

Contour maps and changes over time

The FAA requires updates to noise exposure maps to be updated every five years or sooner if changes warrant. The updated noise exposure maps shall be submitted when any change in the operation of the airport would significantly reduce noise over existing noncompatible uses that is not reflected in either the existing condition or forecast noise exposure map. The FAA defines a significant reduction as a decrease in the yearly DNL average of 1.5 dB or greater in land areas that were formally non-compatible.[12]

B1.3 Federal Aviation Administration policy guidance

The FAA adopted land use compatibility guidelines relating to types of land use to airport sound levels. They are outlined in the Part 150 regulations. Compatibility parameters for residential dwellings are summarized in Table 7.

The designations contained in the table do not constitute a Federal determination that any use of land covered by the program is acceptable under Federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

Many airports have established noise compatibility programs and gained federal funding to improve the sound insulation of residential structures within the DNL 65 and 70 contours. An accepted interior noise level is <45 dB for residential structures.

[12] Code of Federal Regulations, Title 14 Chapter I Subchapter I, *Part 150 – Airport Noise Compatibility Planning*. Docket No. 18691, 49 FR 49269, Dec. 18, 1984.

Table 7: Land use compatibility guidelines – 14 CFR Part 150 (for residential uses)[13]

Land use	Yearly day-night average sound level (DNL) in decibels					
	Below 65	65-70	70-75	75-80	80-85	Over 85
Residential, other than mobile homes and transient lodgings	Yes	No (see note)	No	No	No	No
Mobile home parks	Yes	No	No	No	No	No
Transient lodgings	Yes	No (see note)	No (see note)	No (see note)	No	No

Yes: land use and related structures compatible without restrictions.

No: land use and related structures are not compatible and should be prohibited.

Note: where the community determines that residential or school uses must be allowed, measure to achieve outdoor-to-indoor noise level reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10 or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year-round. However, the use of NLR criteria will not eliminate outdoor noise problems.

B1.4 Summary

As with NEF contours, DNL contours are commonly used and referenced in planning documents. They are built based on historical and forward-looking information. It is important that the contour predictions are updated to reflect revised airport operations, traffic patterns, changes to infrastructure and current aircraft technology.

The FAA and other international regulatory agencies require that the noise contour maps are updated with a minimum frequency of five years.

As a reference, the FAA states that residential uses and related structures are compatible without restrictions with areas with a DNL less than 65 (equal to a NEF of less than 30).

[13] Code of Federal Regulations, Title 14 Chapter I Subchapter I, *Part 150 – Airport Noise Compatibility Planning*. Docket No. 18691, 49 FR 49269, Dec. 18, 1984.

Regine Weston, P.Eng.



Profession
Airport Planner

Current Position
Arup Fellow
Principal Consultant
Aviation Planning

Joined Arup
2000

Years of Experience
30+

Qualifications
B.A.Sc (Hons.) Industrial Engineering, University of Toronto, 1986
P.Eng., Province of Ontario

Professional Associations
Professional Engineers of Ontario
Consulting Engineers of Ontario

Publications
“Guidance for Estimating Occupancy in Airport Terminals”, FAA (Publication Pending)
"Terminal Systems Analysis by Microcomputer Model", Airport Forum
“Developing a Space Program for Airport Passenger Terminals”, FAA (Publication Pending)
“Passenger Flow Dynamics and Level of Service in Airport Terminal Buildings”, FAA (Publication Pending)
“More passengers, more queues, more delays?”, Ingenia

Lectures
“Airport Systems Planning, Design & Management”, International Association of Airport Executives, 2010, 2012
“Airside and Landside Computer Models”, Airport Systems, MIT, 1998-2006

Regine Weston is a registered Professional Consulting Engineer and an internationally recognized expert in Airport Planning and Systems Analysis.

With over 25 years of experience specializing in terminal and apron capacity/demand analyses, forecasting and facilities programming, and strategic airport development, Regine has been responsible for the planning of airport projects on all habitable continents. Recently, many of Regine’s projects have focused on the special requirements of airline hub facilities and optimising facilities to balance passenger experience with capital expenditure.

Regine is experienced at scenario assessment and rapidly models the impact of alternative traffic assignment, forecast scheduling, development phasing options and physical planning scenarios.

Aviation:

Delta Airlines T2/T3 Redevelopment, Los Angeles International Airport, Los Angeles, CA

Programming Lead for renovation and expansion of T2/T3 to enable Delta to double their operation at LAX by 2022. Responsibilities include determination of short, medium and long term requirements for Delta and other impacted airlines, project phasing to minimize impact on operations and balancing project costs with operational objectives.

International Arrivals Facility, Seattle Tacoma International Airport, Seattle, USA

Lead Planner and Strategic Advisor to SOM/Clark for the redevelopment of the South Satellite and Concourse A to provide 19 International gates and related FIS facilities. Working closely with SeaTac and CBP to develop the “Automated Primary” pilot project. Responsibilities include management of airside planning and simulation modelling as well as meetings with key stakeholders

Long Term Capacity Plan, Copenhagen Airport, Katsrup, Denmark

Project Director and Principal Aviation Planner responsible for the development of a strategic framework for the delivery of incremental capacity. Includes generation of different terminal area options and their impact on airfield and support facilities.

Dubai World Centre (DWC) International Airport, UAE

"Terminal Planning and Design", FAA Annual Airport Conference, 2002

"Simulation Modeling in Airport Design and Development",

IATA Fundamentals of Airport Development

Strategic advisor on “Airport of the Future” study to develop new planning concepts to handle up to 200mppa in an efficient manner with a high level of passenger service. Led the detailed assessment of proposed designs and prepared options for traffic allocations between the two airports. Subject Matter Expert for Concept of Operations

2025 Master Plan Second Opinion, Schiphol Amsterdam Airport, Amsterdam, Netherlands

Project Director for Arup’s team providing overview, comment and challenge on the Schiphol Group (SG) and KLM jointly developed long term master plan options. Role involved reviewing assumptions and approach, and commenting on a series of development options in terms of airline assignment, capacity, phasing, etc. Regine led discussions between the airline and operator, and the team providing demand analysis and gating analysis, as well as phasing strategy, airline/alliance assignment and operational improvement and flexibility advice. The project also included high level Capex review.

OR Tambo International Airport, Johannesburg, South Africa

Advising the design team on airline allocation between the existing facilities and new midfield terminal, including various phasing and investment options. Lead technical advisor on the development of FAST (Facility Allocation and Strategy Testing) software used to evaluate long term development options from an operational, physical and financial perspective.

Dubai International Airport, UAE

Lead Planner and Analyst in the development of a series of airside and terminal strategic briefs to assist Dubai Airport (DA) in maintaining a good level of service during a period of rapid growth and constrained capacity. Technical services included the development of a variety of interactive software tools for continued use by DA’s Strategy Department.

Abu Dhabi International Airport, UAE

Primary client contact for Arup standing services contract including strategic, analytical and physical planning options. Spreadsheet Modelling, Gate Analysis, and Simulation of the existing Terminals 1, 2, and Terminal 3 to assess physical and operational alternatives to meet demand up to the opening of the planned MTC (Midfield Terminal). Demand generation and planning reviews of the MTC.

New Doha International Airport, Doha, Qatar

Under Arup’s standing service contract, providing strategic advice on terminal sizing, phasing and level of service for NDIA Passenger Terminal and Airside. Responsible for forecasting and long-term options through 2044 as part of the Airport City team.

Project Director for simulation modeling using Arena and Simio software.

Airport Strategic Study, Aéroports de Montréal (AdM), Canada

Project Director for a Long Term Strategic Study examining options for accommodating traffic at Montreal-Trudeau, Montreal-Mirabel and a potential new airport site. Project included traffic forecasting, capacity demand analysis (airside, terminal, landside, support facilities- MACAD, DELAYS, Excel), options development, evaluation, capex estimation and risk assessment.

London Heathrow International Airport, London, UK

Provided future forecast demand analysis and Master Plan expansion concepts, including new runways, terminals and ancillary facilities, to the year 2030 – for London area airports, including Heathrow and a new site as part of the Southeast Regional Airports Study (SERAS).

jetBlue Terminal, Logan International Airport, Boston, MA

Responsible for apron and terminal planning for jetBlue's 11 gate facility at Boston Logan in 2005. Continuing assistance as jetBlue expands to an 18 gate operation.

Strategic Planning, Lester B. Pearson International Airport, Toronto, ON

Through a series of on-call tasks, currently undertaking short (1-3 years) and long (30-40 years) studies. Detailed generation of requirement and facility options for the "next concourse", including terminal, airside and landside planning.

LaGuardia International Airport, New York, NY

Working on behalf of the PANYNJ, gate utilization analysis and proposals for optimization under a variety of operational and leasing scenarios.

JFK International Airport, Jamaica, NY

Provided forecast demand analysis, gate modelling and terminal simulation services to assist in the development of planning alternatives and to test the robustness of selected options in the redevelopment of this major US airport.

Newark International Airport, Newark, NJ

Provided future demand forecasts and analyses to the Port Authority of New York and New Jersey to validate strategic planning initiatives in the ongoing redevelopment of the broader airport terminal facilities and Continental's Global Gateway plan for Terminal C. Analysis includes impact of traffic forecasts on gate capacity and the examination of terminal layout alternatives

to reduce potential passenger congestion while optimizing airline assignments and gating capacity.

Seattle-Tacoma International Airport, Seattle, WA

Analysis of physical and operational configurations to comply with TSA requirements for screening. Groundside advice, passenger flow simulations and gating demand analysis to assist in the provision of an operational gate, terminal and groundside expansion plan. Determination of "ultimate capacity" for the various processing components.

Paris-Charles de Gaulle Airport, Paris, France

Developed for Aeroports de Paris a detailed People Mover ridership forecasting model of Charles de Gaulle through the year 2030, including airline and sector assignment scenarios and future planning day schedules.

Program Definition, Ottawa Macdonald-Cartier International Airport, Ottawa, ON

Led the airport planning team in the development of a 20-year terminal development plan including preparation of comprehensive Program Definition Document. Subsequently completed a Long Term Capacity Study to match the ultimate landside, terminal, and runway capacities.

Calgary International Airport, Calgary, AB

Using future forecasts and passenger scheduling development, provided Calgary Airport Authority with airfield capacity analysis and confirmation of 10 year Capital Development Plan including traffic forecasts, programming, strategic expansion concepts, construction staging, and cost estimates.

Vancouver International Airport, Vancouver, BC

Provided an analysis of capacity/demand for the current and planning years, and of proposed alternatives, using in-house computer models.

Winnipeg International Airport, Winnipeg, MB

Served as facilitators during Value Planning session to generate ideas for cost effective modifications to the WAA AIRPlan, to ensure financial viability. The session examined all aspects of the plan to identify potential savings, without adversely impacting the passenger experience.

Project Director for a comprehensive Program Definition Document which included the evaluation of up to twenty different expansion and new build options. Included forecasting, demand assessment, program of requirements, site plans, terminal layouts, cost estimation and financial analysis.

*experience prior to joining Arup

Ryan Biziorek, LEED AP, CTS



Profession
Acoustics & Audiovisual Consultant

Current Position
Associate

Joined Arup
2005

Years of Experience
12

Qualifications
MSc Sound & Vibration Studies University of Southampton, Hampshire, United Kingdom, 2004

BA Physics & Economics, Kalamazoo College, Kalamazoo, Michigan, 2003

LEED AP, 2006

Certified Technology Specialist (CTS), InfoComm 2012

Professional Associations
Member, Acoustical Society of America

Member, US Green Building Council (USGBC)

LEED Indoor Environmental Quality Technical Advisory Group, 2013 – Present

Chicago Architecture Foundation Auxiliary Board, Chair of Development (2011-2014), President (2014 – Present)

Guest Lecturer
Chicago Architecture Biennial 'The Architecture of Sound' 2015

Washington University, Sam Fox School of Design + Visual Arts, St. Louis, MO, 2013 – 2016

Columbia College, Chicago, IL 2015

Ryan is an Associate consultant in the Arup Acoustics, Audiovisual, and Theatre consulting team. He provides acoustics and audiovisual technical expertise and project management skills for various building types. He serves as the regional acoustics aviation business champion and is involved with many of the regional and global aviation projects.

Ryan is an active proponent of performance based design, constantly evaluating the prescribed acoustic criteria for different facilities whose user's needs and requirements are incorporated into the project. He strives to implement integrated acoustic solutions into the design using innovative tools and techniques.

He contributes to the operation and development of the Arup SoundLab, a virtual reality room where clients can experience in 3-D the acoustics of existing or modelled buildings. The SoundLab is used for a wide array of applications from acoustically optimizing a room shape to design for acoustic privacy.

Ryan is a specialist in acoustic, electro-acoustic and audiovisual systems design for transportation environments.

Toronto Pearson Pier H Processor, Toronto, ON

Acoustic and AV consultant for expansion of T1 at Toronto's Pearson Airport. The new T1 concourse will be configured to accommodate 10 Narrow Body and 10 Regional Aircraft stands with provision for conversion to wide body stands; be connected with a link to the Terminal 1 liner; and provide for passenger hold room areas at the gates; retail spaces and common area spaces; and ground floor ramp support, baggage room and bus station areas.

Portland Airport Terminal Core Redevelopment and Concourse B, Portland, OR

Acoustic and AV consultant for renovation and expansion of the terminal central core and new Concourse B. With extensive focus on the passenger experience, the Terminal Core project will provide an enhanced aural journey for passengers going through the central terminal core.

Mickey Leland International Terminal, George Bush Intercontinental Airport, Houston, TX

Lead acoustic and AV consultant for new terminal to accommodate up to 15 wide-body aircraft at Terminal C and D. Acoustic consulting tasks include site noise surveys, façade and

Illinois Institute of Technology School of Design, Chicago, IL 2014, 2016

Parsons New School of Design, 2010

Cooper Union School of Architecture, 2009

Awards

2007 Emerging Green Builders Design Competition- NY region, 1st place, National level, 1st place

envelope sound isolation design, room acoustic, and control of MEP and people mover systems noise. AV consulting includes public address and visual paging systems design to optimize speech intelligibility and integration with architecture.

Kansas City Airport Single Terminal, Kansas City, MO

Acoustic and AV consultant for new single 750,000 ft^2 terminal at Kansas City Airport. The new terminal consists of a head house, with a single pier containing a single-loaded landside concourse and one double-loaded airside concourse reached via an above ground concourse connector. Work included development of combined fire alarm / public address system strategy, review with local authorities for a mass notification system, and development of the interior acoustic environment for speech intelligibility, passenger comfort and external noise mitigation.

Delta T2 & T3 Modernization, Los Angeles World Airport, Los Angeles, CA

Acoustic consultant and AV consultant for $1.9B phased terminal redevelopment. Acoustic and AV design focuses on enhancing the passenger experience. Work included acoustic and PA site survey, public address system modeling, and control of people mover systems noise. Recommendations were also provided to enhance spaces during their short-term occupancy before full phased construction.

Delta Public Address System Audit, Various Locations

Review of the public address system performance at 13 airports where Delta operates across the USA. Acoustic measurements were conducted at a selection of gates with varying archetypes to determine the quality of the PA system. Recommendations were made to improve uniformity of coverage, level, and intelligibility in a dynamic electronic document.

O'Hare International Airport, Chicago, IL

Project Manager and Lead Systems designer for the upgrade of the public address head end equipment and expansion of public address systems in Terminals 1, 2, 3, 5, bus terminal, airport transit system stations, parking structures and pedestrian walkways. The PA systems upgrade will result in a unified system within all public areas of the airport that is connected via the airport's ICT network, simplifying day to day and emergency operations and systems maintenance. Visual paging system design services were also provided throughout public areas to achieve ADA requirements.

Annika Hui, RPP, MCIP



Profession
Land use planning and development; transportation planning; project management

Current Position
Senior Planner

Joined Arup
2013

Years of Experience
10

Qualifications
Master's Module (Cities: Navigating Urban Power and Influence), Boston University (Questrom School of Business), 2017

Master of Urban and Regional Planning (Land Use Planning and Development), Queen's University at Kingston, 2006

Bachelor of Arts (Political Science and Economics), University of Alberta, 2001

Professional Associations
Registered Professional Planner (RPP), Ontario Professional Planners Institute

Member (MCIP), Canadian Institute of Planners

Annika Hui is a senior planner in Arup's Toronto office with ten years of experience as a municipal planner and a consultant, providing her with a holistic understanding of the planning framework.

Annika specializes in the integration of land use planning and development with transportation infrastructure improvements. Her work includes statutory plan research and writing, neighbourhood and station area plans, site plan preparation and design, and transit infrastructure feasibility and design studies. Annika has recently managed multiple projects focusing on improving the arrivals experience at key destinations like train stations and retail centres, with the aim of positioning properties to be ready for the emergence of new mobility trends including ridesharing, microtransit, and autonomous vehicles.

As a Registered Professional Planner, Annika aims to provide practical advice that maximizes the financial, environmental, and social returns on land development and infrastructure improvements and upholds the public interest.

Annika brings together a unique mix of strategic research and policy writing, site development planning, transportation planning, and project management experience.

CF Fairview Mall Redevelopment (Toronto, Ontario) and CF Masonville Place Redevelopment (London, Ontario)

As part of its ongoing program to evolve its suburban shopping centre portfolio to a more urban form that is better integrated with its neighbouring communities, Cadillac Fairview (CF) commissioned Arup to provide services for site development and design, along with transportation planning and engineering, in support of a zoning by-law amendment application. Our services included contributing to the site design for the intensification of surface parking lots into high-rise residential, office, and hotel towers, designing improvements for pedestrian and cycling access and connectivity, and completing transportation impact and origin-destination studies in support of the planning application.

Annika served as project manager and contributed to the site plan in both leadership and technical roles. Annika also represented CF before municipal staff on transportation-related matters.

Period of individual participation in assignment: 2018-ongoing

Buttonville Airport Redevelopment (Markham, Ontario)

Cadillac Fairview (CF) plans to redevelop Buttonville Municipal Airport into an employment and high-density mixed-use district containing prestige employment, office, hotel, convention centre, retail, and residential uses that are pedestrian, cycling, and transit-oriented. To this end, CF commissioned Arup to provide services for site development and design, along with transportation planning and engineering, in support of an official plan amendment application.

Annika served as project manager and contributed to the site plan and transit infrastructure conceptual designs in both leadership and technical design roles. Annika also represented CF on transportation-related matters at meetings with municipal staff, and at mediation hearings before the Ontario Municipal Board.

Period of individual participation in assignment: 2015-17

Planning Response to Metrolinx Regional Transportation Plan Review (Toronto, Ontario)

Recognizing that Toronto Pearson International Airport and the Airport Megazone employment area around it is the single biggest generator of car trips in the Toronto region, the Greater Toronto Airports Authority (GTAA) commissioned Arup to provide strategic transportation planning advice in the preparation of the GTAA's response to the Metrolinx Regional Transportation Plan Review. Examining the opportunities and challenges from a groundside planning and operations standpoint, Arup identified the gaps in the review work and generated strategic directions for engagement with Metrolinx.

Annika served as the project manager and technical lead by conducting the policy review, preparing the strategic transportation planning advice, and coordinating with GTAA staff in the preparation of their response to Metrolinx.

Period of individual participation in assignment: 2016

Downsview Airport Operational Needs Review (Toronto, Ontario)

In support of the City of Toronto's Keele and Finch Planning Study, which aims to develop a planning framework that best leverages the new Finch West Station on the Toronto-York Spadina Subway Extension, Annika worked with Arup's airports planning group to translate the operational needs and flight path limitations associated with Downsview Airport into land use planning recommendations. The work included three-dimensional modelling of flight paths and visualizations of how these flight paths affected existing and potential development around the rapid transit station area and its adjacent community areas.

Period of individual participation in assignment: 2016

**experience gained prior to joining Arup*