November 2013

HEALTH IMPACT ASSESSMENT

Proposed Expansion to Billy Bishop Toronto City Airport

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REPORT

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Executive Summary

The City of Toronto (the City) is reviewing a request to permit commercial jet aircraft (jets) at Billy Bishop Toronto City Airport (BBTCA). The proposed BBTCA expansion (hereinafter referred to as the "Proposal") includes:

- a 200-metre (m) runway extension at each end of the runway, extending beyond the existing eastern and western shorelines and into the water;
- an increase in number of flight passengers per annum; and
- the addition of commercial jets at the BBTCA.

Construction potentially needed to accommodate any expansion to BBTCA has not been considered in the Proposal.

The current lease agreement between the City, Government of Canada and the Toronto Port Authority (TPA) does not permit commercial jet aircraft to operate at BBTCA. The City is investigating the potential benefits, challenges, issues and opportunities that may result from the Proposal. Part of this investigation includes a Health Impact Assessment (HIA) by Toronto Public Health. On behalf of the City, Golder Associates Ltd. (Golder) carried out a rapid HIA for the Proposal. The purpose of the HIA is to provide Toronto's Medical Officer of Health with the evidence necessary to advise on potential health impacts and risk reduction measures associated with the Proposal by:

- identifying potential impacts of the Proposal on environmental, economic, social and cultural factors of health and well-being;
- characterizing the magnitude of these health impacts; and
- assessing cumulative health impacts.

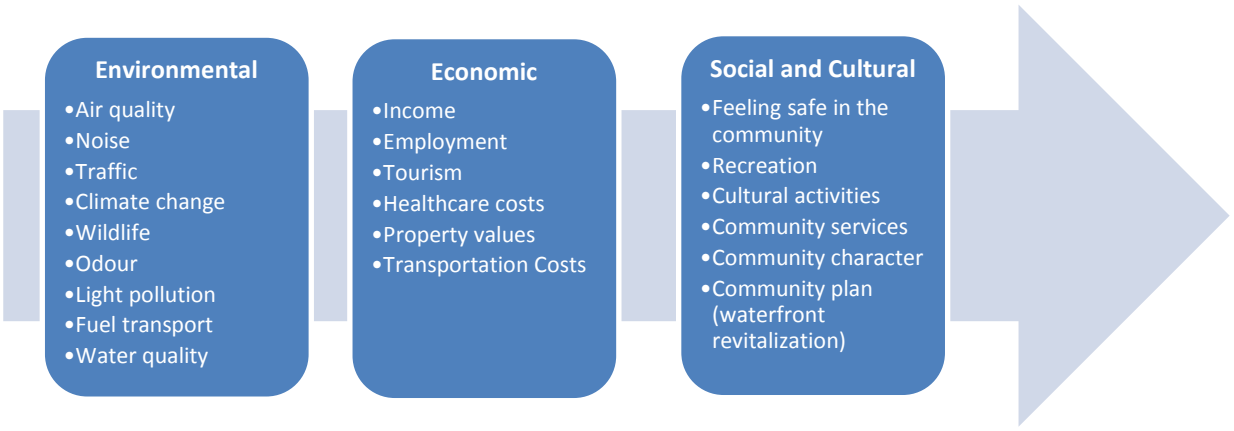
Research shows that airports can have impacts on the health of people who live, work and play nearby from exposure to noise and air pollution associated with aircraft, ground-side operations and traffic. However, the available research examines airports where operations and settings are distinct from those at BBTCA. The extent to which health impacts are associated with a specific airport depends on many factors including the type and frequency of operations, which affect the levels of noise and air pollution at various locations around the airport. Impacts also depend on the number, proximity and vulnerability of people nearby. This HIA Report reflects local circumstances and therefore, focuses on the health and related environmental, social, cultural and economic impacts of the Proposal.

HIA is a well-defined process to assess the health impact of a policy or decision on a population. An HIA typically looks at who is most likely to be affected, explore whether the positive or negative impacts unfairly affect certain groups of people more than others, and consider all aspects of health, including physical, cultural and social well-being.

To ensure that health concerns were addressed in the HIA, a focused key stakeholder workshop was held on October 9, 2013 to receive feedback on the HIA scope and gain an understanding of health concerns arising from the Proposal. Overall key stakeholder feedback indicated that the current conditions in the area around the

airport are already unacceptable and would be expected to worsen with the expansion of airport operations. Health impacts were linked to vulnerable populations in the area, namely children, low income individuals, people with disabilities, pregnant mothers and seniors. Vulnerable places were identified including, Harbourfront residences, the Toronto Islands, public spaces (e.g., Little Norway Park, Toronto Music Garden, and Hanlan's Point Beach), and the waterfront school/pre-school/child care facility.

The results of the focused workshop were used to refine the scope of the HIA to include an assessment of the following issues:



The potential human health impacts of the Proposal on the above issues, or indicators, were assessed using the following information sources:

- observations of BBTCA operations;
- discussions with TPA and Porter personnel related to current and proposed operations;
- review of documentation provided by Porter Airlines and Bombardier;
- published literature from credible regulatory agencies; and
- technical reports from the City and TPH's website.

Where available, risk reduction measures were identified based on existing management practice at the BBTCA, recommendations by consultants' reports and/or professional judgement. Risk reduction measures were provided to explore whether engineering controls and/or management measures can be implemented to reduce/prevent health impacts associated with the Proposal.

A qualitative assessment of potential health impacts was carried out for all factors except for air quality and noise. To evaluate the health effects associated with noise and air impacts related to the Proposal, the HIA included a quantitative assessment for the following three scenarios:

- Background conditions without BBTCA operations;
- Existing operations based on 3.8 million passengers per annum (ppa) and 202 commercial movements per day with Bombardier Q400 (turboprop aircraft); and

- Proposed future scenario based on 4.3 million ppa and 202 commercial movements per day with Bombardier Q400 (75%) and CS100 or similar jets (25%).

City staff specified 202 commercial movements per day as the total maximum slot capacity for all commercial aircraft operations for the purposes of this HIA. It is noted that the existing scenario is not much different than the 'maximum existing' scenario as BBTCA is operating above 85% utilization.

A consistent study area was evaluated for the air quality and noise assessments and included Wards 19, 20, 27, 28, 30 and 32. The study area for other health factors other than noise and air varied from the immediate vicinity of BBTCA (e.g., Bathurst Quay neighbourhood) to a larger area (e.g., Lake Ontario). The geographical extent of potential health impacts were discussed in relevant sections of the report. Vulnerable populations and locations were also considered in the HIA.

The comprehensive noise assessment indicated that the background noise pollution in the study area is already elevated even without contribution from the BBTCA. The HIA evaluated the following health effects associated with noise exposure: children's learning performance, annoyance, sleep disturbance and cardiovascular disease. The following summarizes the key findings:

- **Children's learning performance** - Predicted noise levels (L_{day}) at the Waterfront School / City School are above the WHO guideline for school playgrounds for background (without BBTCA), existing (with BBTCA) and future scenarios. The existing BBTCA operations result in an increase of 2 dBA (L_{day}) at the Waterfront School / City School and 11.7 dBA (L_{day}) at the Island Public School, compared to the background scenario (without BBTCA). While predicted L_{day} values at the Island Public School are below the WHO guideline for all scenarios, the predicted increase in exposure to aircraft noise suggests a linear decrease in reading comprehension based on the results of the European RANCH study (Clark *et al*., 2006). The Proposal was predicted to reduce the L_{day} by 1 dBA at the Waterfront School / City School and by 3 dBA at the Island Public School, compared to existing conditions.

- **Annoyance** – Predicted L_{day} values at Ward's Island at 2 m, 15 m and 70 m elevation above ground level were below the WHO guideline of 55 dBA for serious annoyance. For all other receptor locations, the predicted noise levels are already above the WHO guideline of 55 dBA (L_{day}) for serious annoyance for the background scenario (without BBTCA). Therefore, including BBTCA under the existing scenario only worsens an already noisy environment for the following receptor locations: Little Norway Park, Windward Co-op Homes, Harbour Side Co-op Homes, Harbour Square, Toronto Music Garden. Predicted noise level increase an additional 1 to 7 dBA (L_{day}) depending on the location when contribution from BBTCA is considered.

  Also, predicted noise levels (without BBTCA) increases approximately 1 to 7 dBA (L_{day}) for most receptor locations with elevation (i.e., 2 m, 15 m, and 70 m above ground level); which indicates a potentially higher health impact for people who live in multi-storey condominium buildings.

  Between existing and future scenarios at these locations, the predicted L_{day} values at 2 m, 15 m and 70 m elevations either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

  For the change between background and existing conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at: Stadium Road (2 m, 15 m and 70 m elevations); Windward Co-op

Homes (2 m and 70 m elevations); Little Norway Park (2 m and 15 m elevations); and Harbour Side Co-op Homes (15 m elevation).

For the change between background and future conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at: Stadium Road (2 m, 15 m and 70 m elevations); Windward Co-op Homes (2 m elevation); Little Norway Park (2 m and 15 m elevations); and Harbour Side Co-op Homes (15m elevation).

Overall, the change in %HA is less between the background and future scenarios than between the background and existing scenarios. This means that the proposed use of jets would result in a lower percentage of the population that would be considered highly annoyed in comparison to existing conditions. The average change in %HA from background to existing at these locations across all elevations is 5.6%, while the average change from background to future is 4.8%. This indicates that the Proposal would result in lower percentage of population that would be considered highly annoyed compared to the existing scenario.

- **Sleep Disturbance** – Except for background at Ward's Island, all the predicted L_{night} levels are above the WHO guideline of 40 dBA outside for sleep disturbance. The WHO has an interim target of 55 dBA (L_{night}) for situations where 40 dBA cannot be achieved in the short run. However, it is expected that above 55 dBA (L_{night}), a higher proportion of the population would be sleep-disturbed (WHO, 2009).

  Except for the Toronto Music Garden, all other receptor locations were below 55 dBA (L_{night}) for all scenarios at 2 m elevation. However, at a higher elevation of 70 m, predicted L_{night} values are above 55 dBA for all scenarios for Harbour Square, Harbour Side Co-Op Homes, Windward Co-Op Homes and Little Norway Park in addition to the Toronto Music Garden which indicates a potentially higher health impact for people who live in multi-storey condominium buildings. It is noted that the elevated predicted L_{night} values appear to be unrelated to BBTCA. While the construction of older condominiums may not be consistent with current regulations, it is noted that newer condominiums should ensure that appropriate indoor noise level is in accordance with MOE publication LU-131, now replaced by NPC 300.

  The change in L_{night} from background (without BBTCA) to existing (with BBTCA) ranges from <1 - 5 dBA at 2 m elevation, 0 – 4 dBA at 15 m elevation, and 0 to <1 dBA at 70 m elevation.

  Between existing and future scenarios at these locations, the predicted L_{night} values at 2 m, 15 m and 70 m either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

- **Cardiovascular –** The Health Council of the Netherlands (1999) identified an increased risk of hypertension and ischemic heart disease at a threshold of 70 dBA (L_{day}). The only location with L_{day} values above 70 dBA was the Toronto Music Garden for all scenarios at 70 m elevation. This is not a residential location, however there are condos located directly north across Queen's Quay West that may experience similar noise levels at 70 m. As discussed above for sleep disturbance, the exposure of condo residents at higher elevations to noise depends on window-opening behaviour and the insulation properties of the building. As discussed previously for annoyance, L_{day} values increase by up to 7 dBA from the background to existing scenario and decrease by up to 1 dBA from existing to future scenario. While the construction of older condominiums may not be consistent with current regulations, it is noted that newer condominiums

should ensure that appropriate indoor noise level is in accordance with MOE publication LU-131, now replaced by NPC 300.

In addition, this report has identified specific operations that result in noise effects that require further consideration. Specifically, engine maintenance run-ups, ferry operation and taxiing have been identified by local residents as concerns and predicted levels support this view in the community. What should be acknowledged is that noise effects from the CS100 are significantly lower for both engine run-ups and taxiing compared to the Q400. However, during nighttime hours, taxiing with the CS100 can result in slightly higher noise levels compared to Q400. Therefore, moving towards the incorporation of CS100 jets would be preferable compared with current from a noise perspective. With respect to the ferry operation, additional detailed investigations may be warranted to help identify whether or not noise effects in the early morning hours (i.e., after 4 am) when background noise levels are lower, are resulting in noise impacts to the nearby residents.

The comprehensive air assessment indicated that the baseline air pollution in the study area is already elevated without the contribution of the BBTCA. The following summarizes key findings:

- The results of the health assessment are dependent on the successful achievement of the modal shift assumed in the transportation assessment for existing and future scenarios.
- Boeing 737-700 increases cancer risk by up to 4×10^{-7} primarily a result of chromium VI emissions; whereas, Bombardier CS100 results in a decrease in cancer risk.
- Non-cancer exposures are not expected to pose a health hazard under any scenarios.
- For background (without BBTCA), the added risk for premature deaths based on maximum conditions associated with the five criteria air contaminants are 0.06, 0.5, 7, 4 and 4 per 100 for carbon monoxide, sulphur dioxide, $PM_{2.5}$, ozone and NO_x, respectively. The change in added risk of premature deaths per 100 people is less than 0.005 across all scenarios for carbon monoxide and sulphur dioxide. Between background and current airport scenario, the change in added risk is 0.24 per 100 people for $PM_{2.5}$ and 0.12 per 100 people for NO_x. Between the current airport and future airport scenarios, there are additional minimal changes in risk of premature deaths for $PM_{2.5}$ (i.e., <0.02 increase per 100) and an increase of 0.22 per 100 (Boeing 737-700) and 0.18 per 100 (Bombardier CS100) for NO_x.

The following table provides a high level overview of the assessment findings of the Proposal impact on health.

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Environmental Factors				
Climate change	▪ Change in contribution to greenhouse gases	▪ **Increase** in greenhouse gas contribution and potentially to climate change	Negative	Global
Water Quality	▪ Change in water quality	▪ **Increase** in potential for release to Lake Ontario from runoff and/or failure in containment and drainage system at BBTCA	Negative	Lake Ontario

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Fuel Transport	▪ Risk of fuel tanker truck accidents ▪ Exhaust emissions from fuel tanker trucks	▪ **Increase** in demand for fuel supply which increases the potential risk of fuel tanker truck accidents leading to spills or explosions. ▪ **Increase** in fuel supply requirements, increasing the number of fuel tanker trucks and exhaust emissions, and potentially causing a negative impact on air quality	Negative	Throughout transport route from fuel source (refinery) to airport
Traffic	▪ Risk of injury or fatality resulting from vehicular accidents	▪ **Increase** in traffic volumes as result of the Proposal may result in increased potential risk of vehicular accidents causing injury or fatality in an otherwise already high traffic volume area; pedestrians especially children, those with disabilities and seniors are considered particularly vulnerable	Negative	Bathurst Quay neighbourhood
Noise	▪ Change in children's learning performance, annoyance, sleep disturbance and cardiovascular disease for future scenario with jets	▪ Background noise pollution (without BBTCA) in the study area is already elevated ▪ In the absence of BBTCA, noise levels would already exceed health guidelines which have been established to prevent annoyance, sleep disturbance and impaired learning performance in most locations considered, mainly a result of traffic in the area ▪ The Proposal was predicted to decrease L_{day} by up to 1 dBA at school locations near BBTCA, indicating potential improvement in conditions for children's learning compared to existing conditions	Positive and Negative	Primarily southern part of Wards 20 and 28

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Noise (cont)		▪ The change in the percentage of the population highly annoyed (%HA) from background (without BBTCA) to existing (with BBTCA) scenarios is greater than the Health Canada guideline of 6.5% at Stadium Road (2 m, 15 m and 70 m elevations); Windward Co-op Homes (2 m and 70 m elevations); Little Norway Park (2 m and 15 m elevations); and Harbour Side Co-op Homes (15 m elevation) ▪ Both the existing conditions and future scenario with jets were predicted to cause an increase in %HA above the Health Canada guideline at several locations, compared to background. However, the future scenario with jets had lower %HAs, indicating a smaller number of individuals would be highly annoyed compared to existing conditions ▪ The Proposal was predicted to cause a small decrease in L_{day} (e.g., 1 dBA) and levels across the study area are generally below the threshold for cardiovascular disease ▪ Noise levels from aircraft activities due to the Proposal including take-off, landing and flyovers do not result in meaningful change to the cumulative noise levels including background ▪ The Proposal was predicted to cause a decrease in night noise at some locations and a slight increase (e.g., 1 dBA) at other locations ▪ Noise levels from run-ups and taxiing are predicted to be lower for the Proposal		

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Air Quality	▪ Change in cancer risk, non-cancer risk and risk of premature mortality	▪ The results of the health assessment are dependent on the successful achievement of the modal shift assumed in the transportation assessment for existing and future scenarios ▪ Background air pollution (without BBTCA) in the study area is already elevated ▪ Boeing 737-700 increases cancer risk by up to 4 x 10-7 primarily a result of chromium VI emissions; whereas, Bombardier CS100 results in a decrease in cancer risk ▪ Non-cancer exposures are not expected to pose a health hazard under any scenarios ▪ For background (without BBTCA), the added risk for premature deaths based on maximum conditions associated with the five criteria air contaminants are 0.06, 0.5, 7, 4 and 4 per 100 for carbon monoxide, sulphur dioxide, $PM_{2.5}$, ozone and NO_x, respectively. The change in added risk of premature deaths per 100 people is less than 0.005 across all scenarios for carbon monoxide and sulphur dioxide. Between background and current airport scenario, the change in added risk is 0.24 per 100 people for $PM_{2.5}$ and 0.12 per 100 people for NO_x. Between the current airport and future airport scenarios, there are additional minimal changes in risk of premature deaths for $PM_{2.5}$ (i.e., <0.02 per 100 increase) and an increase of 0.22 per 100 (Boeing 737-700) and 0.18 per 100 (Bombardier CS100) for NOx.	Positive and Negative	Primarily southern part of Wards 20 and 28

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Economic Factors				
Employment	▪ Number of jobs created	▪ **Increase** in employment but benefit not specific to local residents	Positive and Negative	Primarily Quebec and Ontario
Income	▪ Change in labour income	▪ **Increase** in income but benefit not specific to local residents	Positive and Negative	Primarily Quebec and Ontario
Transportation Costs	▪ Cost of transit upgrades	▪ **Increase** in costs of transportation upgrades which were not considered in the economic assessment	Negative	Ontario (tax base)
Healthcare Costs	▪ Direction of change in healthcare costs	▪ **Increased** healthcare costs are anticipated as a result of exposures to elevated levels of noise and air pollution for background scenario even without consideration of BBTCA ▪ For background scenario (without BBTCA), the added risk of premature deaths as a result of exposures to $PM_{2.5}$, ozone and NO_x is 7, 4 and 4 per 100 people, respectively. ▪ The Proposal is not expected to increase healthcare costs related to noise and air impacts as predicted noise and air levels from aircraft activities due to the Proposal including take-off, landing and flyovers do not result in meaningful change to the cumulative noise levels including background. ▪ **Increased** healthcare costs are anticipated related to increased risk of vehicular accidents potentially causing injury or fatality; pedestrians, especially children, those with disabilities, and seniors are considered particularly vulnerable	Positive or Negative	Ontario (tax base)

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Tourism	▪ Direction of change in tourism spending	▪ Some stakeholders feel the tourism experience will be **diminished** by the air quality, noise and traffic issues related to the Proposal ▪ The HLT Advisory Group reported significant spending by tourists as a result of jet service, although the extent that this is displaced from Pearson is not known ▪ Net economic effect on the City in consideration of the costs associated with infrastructure upgrades including transportation, health care and community services	Positive or Negative	Ontario (tax base)
Property Value	▪ Direction of change in property value	▪ Some stakeholders feel that the Proposal may **decrease** property values, result in relocations and even cause closure of co-op buildings ▪ Condo developers seem to be favourable to the presence of the airport ▪ Stable demand in condominium market with unit pricing consistent with overall Toronto condominium market	Positive or Negative	Primarily southern part of wards 20 and 28
Social and Cultural Factors				
Recreation	▪ Access to and enjoyment of recreational space	▪ **Decrease** in opportunities for access of recreational space due to longer travel times resulting from traffic congestion and delays ▪ **Diminished** enjoyment of recreational space due to the ongoing impact of the BBTCA on air quality, traffic, odour and noise at nearby recreational space	Negative	the City of Toronto as a whole

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Recreation (cont)		▪ **Increase** in light pollution in the area which may interfere with the enjoyment of recreational space ▪ The addition of jets to the BBTCA may **increase** the risk of wildlife strikes		
Cultural Activities	▪ Access to and enjoyment of cultural activities	▪ **Decrease** in opportunities for access due to longer travel times resulting from traffic congestion and delays ▪ **Diminished** enjoyment of cultural activities due to the ongoing impact of the BBTCA on air quality and noise at nearby cultural sites	Negative	the City of Toronto as a whole
Community Services	▪ Access to community services	▪ **Decrease** in opportunities for access due to longer travel times resulting from traffic congestion and delays	Negative	Waterfront communities
Community Character	▪ Satisfaction with Neighbourhood	▪ Some stakeholders feel that the Proposal would **decrease** their satisfaction of the neighbourhood due to the perception that the air quality, noise, and traffic related to the BBTCA are already **impairing** the enjoyment of their homes and community	Negative	Waterfront communities
Community Plan	▪ Satisfaction with Neighbourhood	▪ **Decrease** in satisfaction because the Proposal does not seem to align with the Toronto Official Plan	Negative	City of Toronto
Feeling Safe in the Community	▪ Accidents from vehicular traffic or aircraft crashes	▪ **Decrease** in the feelings of safety for pedestrians, particularly seniors and children due to increase in traffic volume ▪ The increase in the number of fuel tanker trucks required to support the fueling requirements of jets will likely **decrease** the feelings of safety for individuals concerned about spills and explosions	Negative	Waterfront communities and the Islands

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent
Feeling Safe in the Community (cont)		▪ **Decrease** in the feeling of safety due to presence of jets, which are larger than turboprop aircraft and carry more passengers, and may raise concerns about the impacts of a crash because they are more likely to be affected by a bird strike		

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1.0 INTRODUCTION

The City of Toronto (the City) retained Golder Associates Ltd. (Golder) to carry out a rapid Health Impact Assessment (HIA) for the proposed expansion of the Billy Bishop Toronto City Airport (BBTCA). The proposed BBTCA expansion includes a 200-metre (m) runway extension at each end of the runway, extending beyond the existing eastern and western shorelines and into the water, an increase in number of flight passengers per annum, and the addition of commercial jet aircraft (jets) at the BBTCA (hereinafter referred to as the "Proposal"). The impact of the construction phase needed to accommodate any expansion to BBTCA has not been considered in the Proposal.

The City is reviewing a request to permit commercial jets at BBTCA. The current lease agreement between the City, Government of Canada and the Toronto Port Authority (TPA) does not permit jets to operate at BBTCA. The City is investigating the potential benefits, challenges, issues and opportunities that may result from allowing jets or further expansion of the BBTCA.

1.1 Purpose and Scope

The HIA has been completed in collaboration with Toronto Public Health and is focused on the BBTCA to understand the potential impacts of the Proposal on environmental, economic, social and cultural factors of health and well-being. The purpose of the rapid HIA is to provide Toronto's Medical Officer of Health with the evidence necessary to advise on potential health impacts and risk reduction measures associated with the operation and potential expansion to the BBTCA.

Research shows that airports can have impacts on the health of people who live, work and play nearby. Evidence suggests that airports have impacts on human health arising from exposure to air pollution and noise associated with aircraft, ground-side operations, and traffic generated by passengers and employees accessing the facility. However, not all airports are alike and BBTCA is unique given its location on the Toronto Islands. Therefore, this report focuses on the health and related environmental, social, cultural and economic impacts of the Proposal.

The objectives of the HIA for the BBTCA are:

- To identify potential health impacts associated with the Proposal;
- To characterize the magnitude of these health impacts; and
- To assess cumulative health impacts.

For noise and air impacts related to the Proposal, the HIA quantitatively assessed the following three scenarios:

- Background conditions without BBTCA operations;
- Existing operations based on 3.8 million passengers per annum (ppa) and 202 commercial movements per day with Bombardier Q400 (turboprop aircraft); and
- Proposed future scenario based on 4.3 million ppa and 202 commercial movements per day with Bombardier Q400 (75%) and CS100 or similar jets (25%).

City staff specified 202 commercial movements per day as the total maximum slot capacity for all commercial aircraft operations for the purposes of this HIA. It is noted that the existing scenario is not much different than the 'maximum existing' scenario as BBTCA is operating above 85% utilization.

The predicted noise and air emissions based on the above noted operating scenarios were then quantitatively evaluated to determine if the Proposal impacts human health.

For the other environmental (i.e., climate change, water quality, fuel transport, traffic), economic, social and cultural factors, a qualitative assessment of the potential health impacts associated with the Proposal was carried out. The HIA relied on information provided by the City, Toronto Public Health (TPH), TPA and their consultants. Additional information from other sources such as published literature from credible regulatory agencies, and technical reports from the City and TPH's website, were also used to assess the potential health impacts associated with the Proposal.

1.2 Limitations

Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with the level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied, is made.

This HIA was prepared for the exclusive use of the City of Toronto and Toronto Public Health. The report is based on observations of BBTCA operations, discussions with Toronto Port Authority and Porter Airlines personnel related to current and proposed operations, and review of documentation provided by Porter Airlines and Bombardier. This report cannot account for changes in BBTCA's current and proposed operational practices completed after the report has been finalised and submitted to the City of Toronto and Toronto Public Health.

The information, recommendations and opinions expressed in this report are for the sole benefit of the City of Toronto and Toronto Public Health, subject to the limitations and purposes described herein. No other party may use or rely on this report or any portion thereof without Golder's express written consent. Any other use of this report by others is prohibited and is without responsibility to Golder.

When evaluating BBTCA and developing this report, Golder has relied on information provided by the City of Toronto and Toronto Public Health, Porter Airlines and Bombardier, and others. Golder has acted in good faith and accepts no responsibility for any deficiencies, misstatements, or inaccuracies contained in this report resulting from omissions, misinterpretations or falsifications by those who provided Golder with information.

2.0 DESCRIPTION OF THE HIA PROCESS

2.1 Framework

In its constitution, the World Health Organization (WHO) defines health as: "*A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" (WHO, 1946). Health impacts are defined by the WHO as "*the overall effects, direct or indirect, of a policy, strategy, programme or project on the health of a population*" (WHO, 1999a). Toronto Public Health adopted the WHO's definition of health and developed an HIA framework that is designed to effectively integrate community health-related concerns into the evaluation of major infrastructure projects, such as the Proposal. Toronto Public Health uses the HIA framework as a tool to collect, analyze and summarize necessary information to inform the Medical Officer of Health's assessment of the Proposal.

An HIA is defined as "*a combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population*" (WHO, 1999a). This means that the assessment of equity impacts of a proposal is fundamental to an HIA. The TPH HIA framework provides two options for the assessment of potential health impacts: a Limited Scope HIA or an In-Depth HIA process. To be useful for decision making, an HIA needed to be done in a timely fashion. Given the time available, it was decided that a Limited Scope HIA was appropriate. To ensure that the HIA was completed in a timely fashion, in consultation with TPH, it was agreed that a rapid Limited Scope HIA would be completed for the Proposal.

2.2 Approach

The general approach taken for this HIA is outlined in Figure 1. The first step in the HIA was to compile and review background information including HIAs completed for other airports, literature studies on health effects of airports, and data on the operations at the BBTCA including information from the City, Toronto Port Authority, Transport Canada, aviation consultants, aircraft manufacturers and Porter Airlines Inc. (Porter). Adequate scoping of the HIA was a critical second step and included identifying the study areas, constraints and operational scenarios. Any assessment of potential health effects must have a starting point, and as such, it was critical to describe the existing conditions for the health determinants and indicators. Therefore, the third step described the existing conditions, including the current health status of the population in the study area and the existing operations at BBTCA. The fourth step identified the health determinants, indicators and measures based on HIAs for other airports, available literature studies, and the findings of the public consultations and stakeholder workshop. A quantitative or qualitative approach to evaluating each health indicator was used based on the available site-specific data. For each indicator, the method, results, health impacts and possible risk reduction measures were discussed. Finally, the conclusions of the HIA were presented summarizing the key results.

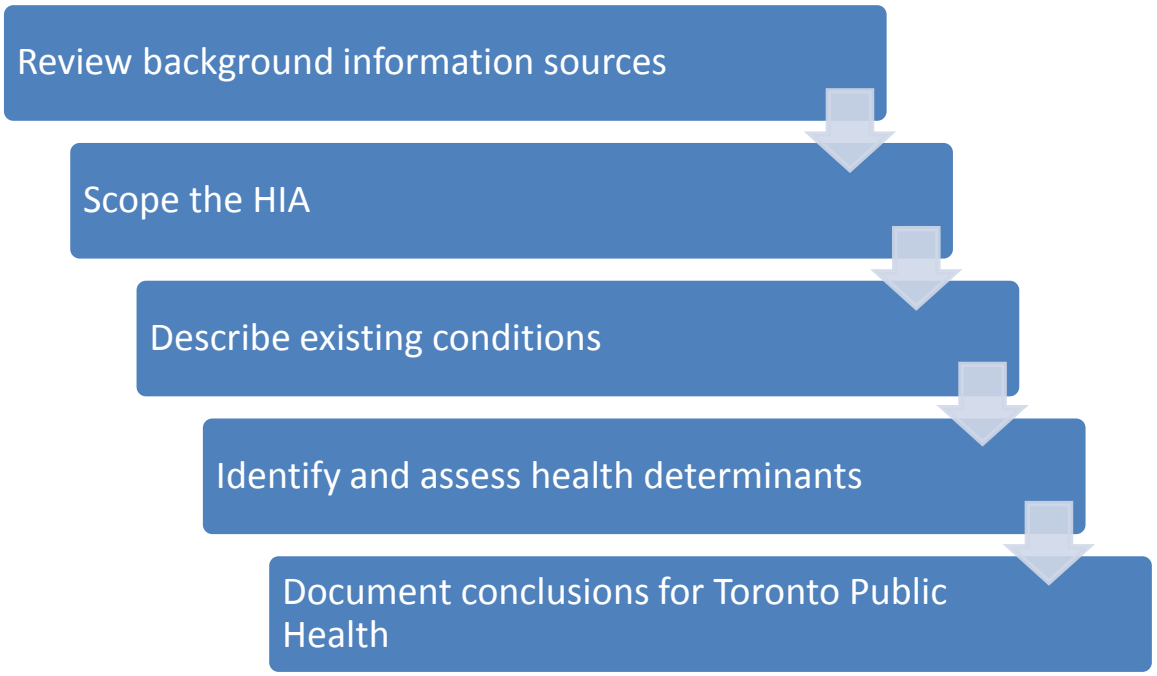


Figure 1: HIA Approach

2.3 Determinants of Health

Many factors combine to affect the health of individuals and communities. Health determinants are "*the personal, social, cultural, economic and environmental factors that influence the health status of individuals or populations*" (WHO, 1999a). One of the key steps in an HIA is to select which determinants of health are likely to be affected by the proposal or project and should be carried forward for assessment. Categories of health determinants provided by TPH (2008) include social and cultural factors, economic factors, environmental factors, population-based services, individual and behavioural factors, biological factors and equity factors. Determinants are evaluated by specific indicators and measures; for example, environmental factors could be evaluated by air quality (the indicator) and comparison of predicted concentrations to health-based benchmarks (the measure). To select relevant indicators for the Proposal, information was reviewed from literature studies on health effects from airports, public consultation, a stakeholder workshop and HIAs carried out for other airports, as shown in Figure 2 and discussed further in Section 5.

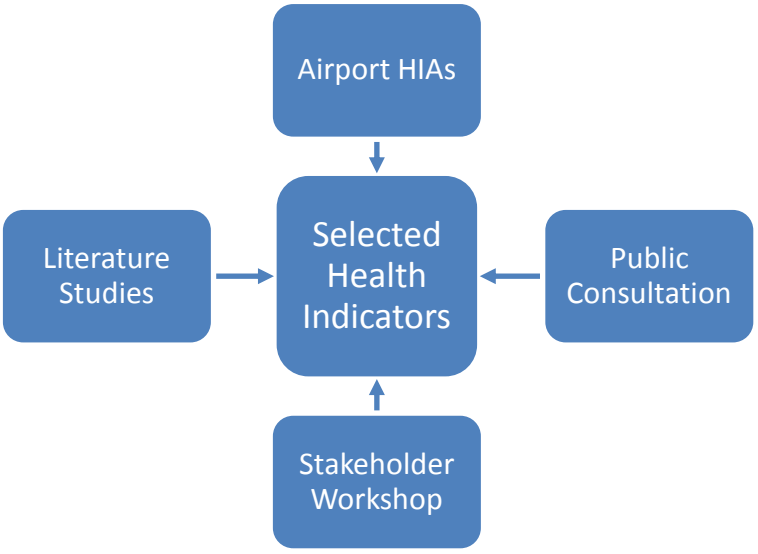


Figure 2: Information used to Select Health Indicators

3.0 BACKGROUND

3.1 Airport Location

The BBTCA is located at the north-western tip of the Toronto Islands (the "Islands") within the City of Toronto (Figure 3). The Islands are located south of the City of Toronto mainland. The Islands are accessible from the mainland via ferry. A pedestrian tunnel between the mainland and the BBTCA is currently under construction and is expected to be completed in the second half of 2014.

3.2 History

The BBTCA opened in 1939. In 1983, the City, Toronto Harbour Commission (now the Toronto Port Authority) and the Government of Canada (Minister of Transport) entered into a "Tripartite Agreement" for the lease of the airport lands for a term of 50 years. The Tripartite Agreement governs the operation of the airport through the Toronto Port Authority and includes a ban on jets, a night curfew (11 pm – 6:45 am) and a ban on expansion of existing runways and construction of new runways. Porter began commercial operations at BBTCA in 2006, relying exclusively on Bombardier Dash8-Q400 aircraft to fly to regional ports generally within 925 kilometres of Toronto. Air Canada resumed operations at the BBTCA in 2011 following the award of 30 slots. Air Canada affiliate Air Canada Jazz had previously offered regional airline service out of the BBTCA up until 2006.

3.3 Current Airport Operations

The BBTCA handled over 2.3 million commercial passengers in 2012, in addition to general aviation operations (Airbiz, 2013). Currently, both Porter and Air Canada operate out of BBTCA. Per the Tripartite Agreement, flights are restricted to hours between 6:45 am and 11 pm. Jets are not permitted at BBTCA except for Medevac (medical evacuation) flights. In addition to turboprop aircraft, piston aircraft and helicopters operate out of BBTCA (Airbiz, 2013).

In 2010, the Toronto Port Authority completed a capacity study to assess the number of aircraft movements that could be handled within the noise limits set in the Tripartite Agreement. Based on a scenario which included general aviation operations and consideration of night movements, it was determined that the airport could accommodate 202 daily slots for scheduled commercial aircraft arrivals and departures based on a specific operational scenario (Airbiz, 2013).

3.4 Surrounding Lands

On the mainland, in the broader waterfront area, the mix of land uses includes: parks and recreation trails; boating and water-based recreational facilities; cultural and event spaces; housing; schools; shops, restaurants, and offices; public transit lines; local streets and major roads; a highway; and former industrial lands that are the subject of revitalization and redevelopment plans (Urban Strategies Inc., 2013). The Toronto Islands likewise contain a mix of land uses, including: the Airport; beaches; parks; houses; an amusement park; restaurants; a fire hall; and others (Urban Strategies Inc., 2013).

There are 44 wards (Figure 3) and 140 neighbourhoods in the City (Figure 4). Neighbourhood #77, which encompasses the Islands and adjacent waterfront communities, had a population of 43,295 in 2011, and neighbourhood #82, which is adjacent to the Islands, had a population of 20,990 in 2011 (City of Toronto, 2013a). Ward 28, which encompasses the Islands, had a population density of 7.21 thousand people per km^2 in 2011, and Ward 20, which is adjacent to the Islands, had a population density of 10.27 thousand people per km^2 in 2011 (City of Toronto, 2013b).

3.5 Study Area Evaluated in the HIA and Vulnerable People

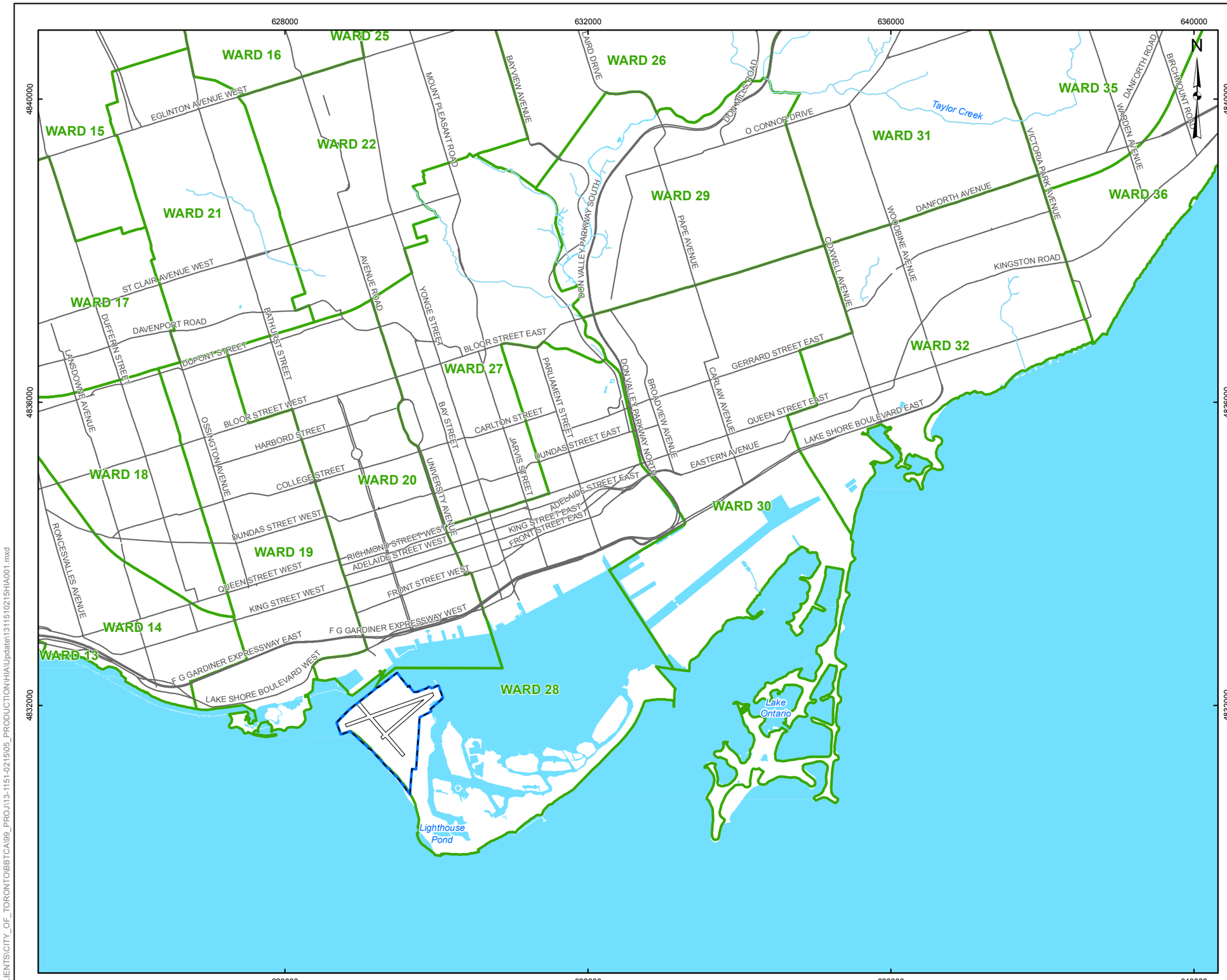
The HIA evaluated a consistent study area for the key environmental health factors, specifically noise and air.

The study area for the air quality assessment included Wards 19, 20, 27, 28, 30 and 32. A grid of receptor points at 200 m interval on land was used in the air quality model (Figure 5) for the study area. The same study area was used for the noise assessment with a grid density of 50 m x 50 m at elevations of 2 m, 15 m and 70 m above ground level to account for potential differences in noise exposure at different elevations.

For health factors other than noise and air, the study area varies from the immediate vicinity of BBTCA (e.g., Bathurst Quay neighbourhood) to a larger area (e.g., Lake Ontario) depending on the potential geographic extent of the impact of the specific factor. The geographic extent of potential health impacts are discussed in relevant sections of this report.

The HIA also relied on the transportation assessment provided in the preliminary draft report entitled: “Transportation Assessment of the Proposed Jet Activity – Billy Bishop Toronto City Airport”, dated October 2013, and completed by BA Consulting Group Ltd. for the City of Toronto. Two study areas were considered for the traffic assessment. A broader study area was considered for the purposes of reviewing the order of magnitude of traffic impacts at significant intersections. The broader study area was bounded by Jameson Avenue to the west, York Street to the east, Lake Ontario to the south and Front Street to the north. A second smaller study area was also analysed for the purposes of undertaking a more detailed assessment of the impacts. The smaller study area was bounded by Stadium Road to the west, Dan Leckie Way to the east, Lake Ontario to the south, and Lake Shore Boulevard to the north.

A number of sub-populations that may be more vulnerable to health impacts have been identified in the vicinity of the BBTCA, including children, toddlers and infants, the elderly, individuals with existing health conditions and low income groups. Further details about people living in Wards 14, 18, 19, 20, 27, 28, 30 and 32, including vulnerable populations, are presented in Section 3.6.



LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- City of Toronto Wards

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

500 250 0 500 1,000 1,500
SCALE 1:50,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
City of Toronto Wards

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008	FIGURE: 3	
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

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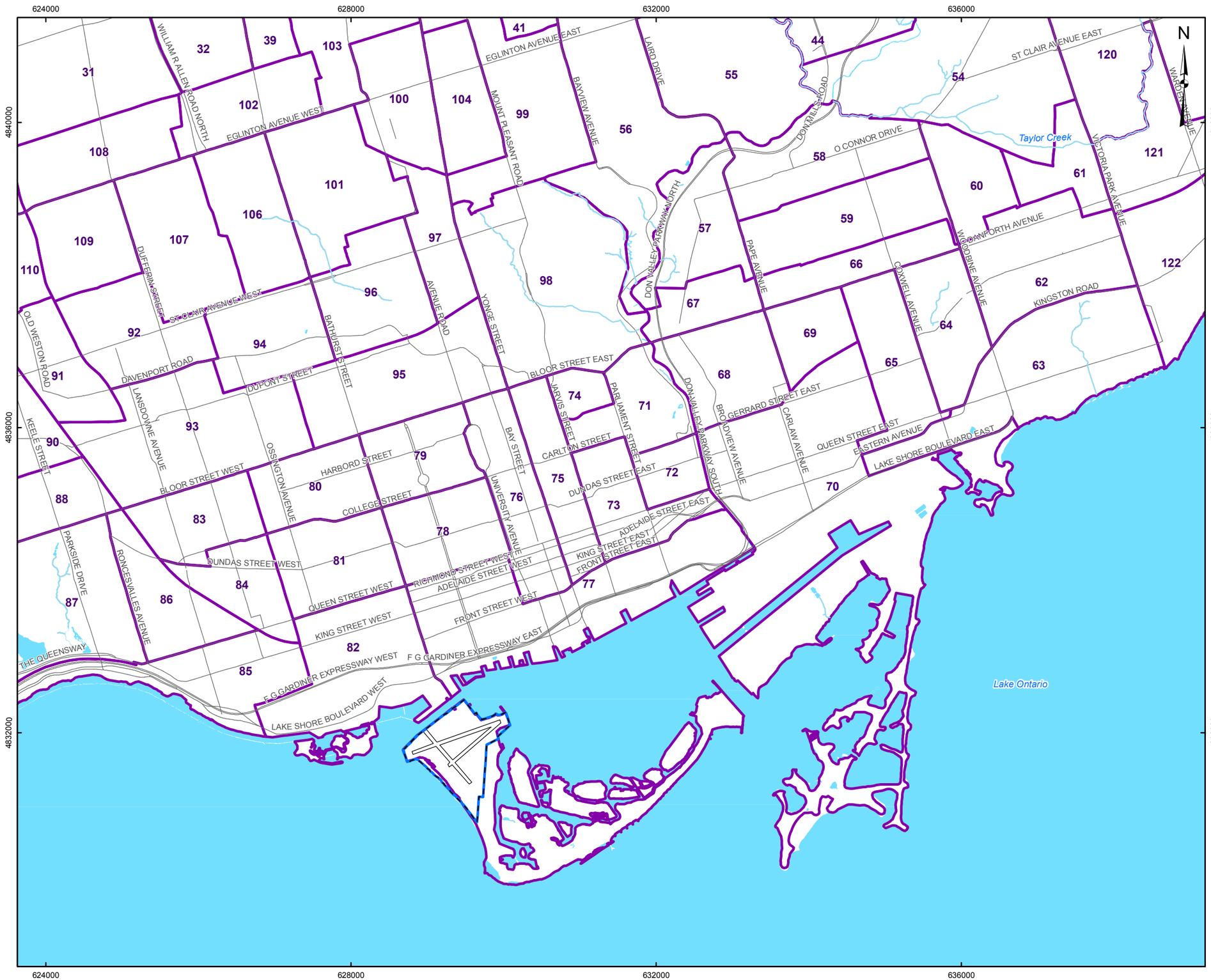

LEGEND

- Major Roads
- Watercourse
- Waterbody
- City of Toronto Neighbourhoods
- Billy Bishop Toronto City Airport

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

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SCALE 1:50,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
City of Toronto Neighbourhoods

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008		
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

FIGURE: 4

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628000 632000 636000 640000

4840000 4836000 4832000

WARD 15 WARD 16 WARD 17 WARD 18 WARD 19 WARD 20 WARD 21 WARD 22 WARD 25 WARD 26 WARD 27 WARD 28 WARD 29 WARD 30 WARD 31 WARD 32 WARD 35 WARD 36

EGLINTON AVENUE WEST
ST CLAIR AVENUE WEST
DAVENPORT ROAD
LANSDOWNE AVENUE
DUFFERIN STREET
BATHURST STREET
AVENUE ROAD
MOUNT PLEASANT ROAD
BAYVIEW AVENUE
LEASIDE DRIVE
DON VALLEY PARKWAY SOUTH
DONMILLS ROAD
O'CONNOR DRIVE
RAPE AVENUE
COXWELL AVENUE
WOODBINE AVENUE
VICTORIA PARK AVENUE
DANFORTH AVENUE
WARDEN AVENUE
DANFORTH ROAD
BIRCHMOUNT ROAD
KINGSTON ROAD
Taylor Creek
DUPONT STREET
BLOOR STREET WEST
BLOOR STREET EAST
OSSINGTON AVENUE
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
RONCESVALLES AVENUE
YONGE STREET
BAY STREET
CARLTON STREET
JARVIS STREET
UNIVERSITY AVENUE
PARLIAMENT STREET
DUNDAS STREET EAST
DONCASTER PARKWAY NORTH
BROADVIEW AVENUE
EASTERN AVENUE
GERRARD STREET EAST
CARLAW AVENUE
QUEEN STREET EAST
LAKE SHORE BOULEVARD EAST
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
F G GARDINER EXPRESSWAY WEST
F G GARDINER EXPRESSWAY EAST
LAKE SHORE BOULEVARD WEST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
Lake Ontario

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Wards

- Beaches-East York (32)
- Toronto Centre-Rosedale (27)
- Toronto Centre-Rosedale (28)
- Toronto-Danforth (30)
- Trinity-Spadina (19)
- Trinity-Spadina (20)
- Other

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

500 250 0 500 1,000 1,500
SCALE 1:50,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Receptor Grid for Air Quality

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008		
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

FIGURE: 5

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3.6 Community Profile

Many socio-economic and environmental factors affect health. These include air and water quality, culture education, employment, housing, income and social support. These factors are also important for creating vibrant and thriving cities that attract business and foster economic development.

The conditions in which people live, work, learn and play shape health and thus inequity in these conditions is largely responsible for producing health inequities (WHO, 2008). Urban health inequities are not just harmful to those who are most vulnerable (WHO, & UN-Habitat, 2010; Woodward, A., & Kawachi, I., 2000) - there are also substantial social and economic costs associated with them (Health Officers Council of BC, 2008). This means that the way cities are built and how well they perform on these factors[1] are critical not only for the health of residents but also for the social and economic well-being of cities (Health Officers Council of BC, 2008).

The City has compiled community profile information by wards (Figure 3) and by neighbourhoods (Figure 4), which provide demographic and health status information (City of Toronto, 2013b). To assess and interpret potential health impacts, a description of the population that currently exists in the community and their health status is required. . Demographic and health status information for each of the wards included in the study area for the air quality and noise assessment (i.e., Wards 19, 20, 27, 28, 30 and 32), as well as nearby Wards 14 and 18, are summarized below, along with a comparison to data for the City of Toronto as a whole. The health indicators that were summarized for each ward are provided in Table 1.

Table 1: Health Indicators included in Community Profile

Factors	Measures
Socio-demographic characteristics	Age distribution, percentage of low income households, median household income, unemployment rate, and percentage of people with less than high school education
Reproductive and child health indicators	Low birth weight rate, percentage of kindergarten students who are vulnerable in terms of readiness to learn
Injury	Hospital Emergency Department visits for injuries among children/youth and seniors
Hospitalization and mortality	Hospitalization and mortality rates for respiratory disease, cancer and cardiovascular disease
Infectious disease	Incidence rates for tuberculosis, influenza, enteric diseases and sexually transmitted infections

3.6.1 Socio-Demographic Characteristics

Age distribution information (Table 2) is useful for identifying the proportion of individuals who may be particularly sensitive to health impacts (e.g., children and seniors).

In comparison to the age distribution for the City as a whole:

- Wards 14, 18, 19, 20, 27, and 28 have a lower percent of children/youth aged 0 to 19;

1 the socio-economic and environmental factors that affect health such as Natural Environment / Built Environment / Transportation / Housing / Neighbourhoods / Income and Employment / Education / Food Security / Health Services

- All wards have an equal or lower percent of seniors (age 60 and above); and
- Ward 32 is the only ward that has a higher percent of children aged 0 to 9.

Table 2: Age Distribution (Approximate %)

Age Group (years)	Ward 14	Ward 18	Ward 19	Ward 20	Ward 27	Ward 28	Ward 30	Ward 32	Toronto
0 to 9	9.5	8	6	4.5	4.5	8	10	**12**	10
10 to 19	8	8	5	5	5.5	7.5	9	10	**11**
20 to 29	16	19	24	**31**	25.5	20	13.5	11	15.5
30 to 39	21	20	**25**	23	19	20	18.5	17	15.5
40 to 49	17	15	15	12	15	16	18	**19**	15.75
50 to 59	13	12.5	10	10	12.5	13.5	14	**15.5**	13
60 to 69	8	8.5	7	7	**9**	**9**	**8.5**	**9**	**9**
70 to 79	4.5	**6**	5	4.5	5	4	5	4	**6**
80+	3	3	3	3	4	2	3.5	2.5	**4.25**

Source: City of Toronto, 2013b
Note:
(a) Age distribution data are from 2011.
(b) Percentages were estimated based on the figures provided in the ward profiles.
(c) Bolded values represent the highest percentages for each age group.

The socio-demographic characteristics presented in Table 3 are based on the 2006 Census data, as the 2011 National Household Survey results were not available at the time of publication of the Ward Health Profiles. Low income is defined as "*the percentage of people in private households below the before-tax low income cut-offs (LICO), created by Statistics Canada*" (City of Toronto, 2013b). LICO refers to an income level at which people spend 20% more than average on basic necessities, including food, shelter and clothing.

In comparison to the City as a whole:

- Wards 14, 20 and 28 have a higher proportion of low income residents (more than 20% higher);
- Wards 14 and 28 have a lower median household income (lower by more than 20%); and
- Wards 18, 19 and 30 have a higher percentage of residents with less than high school education (more than 20% higher).

Table 3: Socio-Demographic Characteristics

Characteristic	Ward 14	Ward 18	Ward 19	Ward 20	Ward 27	Ward 28	Ward 30	Ward 32	Toronto
Low Income (%)	**33.0 (H)**	28.9	23.2	**30.0 (H)**	25.4	**40.9 (H)**	27.9	**18.3 (L)**	24.5
Median Household Income	**$38,352 (L)**	$44,096	$55,704	$49,732	$50,763	**$38,479 (L)**	$53,100	$61,098	$52,833
Unemployment Rate (%)	7.5	7.7	**5.8 (L)**	7.0	7.1	8.6	7.2	6.5	7.6
Less than high school education (%)	17.8	**33.2 (H)**	**25.1 (H)**	**12.6 (L)**	**6.7 (L)**	**15.7 (L)**	**25.2 (H)**	16.6	20.4

Source: City of Toronto, 2013b
Note:
(a) Socio-demographic conditions are based on the 2006 Census data.
(b) Less than high school education includes people aged 15 and older.
(H) Indicates the estimate is at least 20% higher than in Toronto as a whole
(L) Indicates the estimate is at least 20% lower than in Toronto as a whole

Based on data provided by Toronto Public Health, the following enumerates the number of sensitive receptor locations in each ward within the study area for the noise and air assessments. The sensitive receptor locations included nursing homes, retirement homes, community housing and child care facilities.

	Nursing Home / Home for the Aged	Retirement Home	Toronto Community Housing	Child Care
Ward 19	1	0	0	23
Ward 20	5	0	6	45
Ward 27	0	0	5	19
Ward 28	2	1	51	25
Ward 30	1	1	1	25
Ward 32	1	0	3	28

Research indicates that some groups of people are more vulnerable to health risks than others, including groups with lower incomes, lower education, children and seniors and those with underlying medical conditions such as pre-existing respiratory illness. An examination of the TPH Ward Profiles for the study area showed that compared to the Toronto average, their residents are more likely to be living on low income. The HIA focused on specific disease outcomes to assess whether the Proposal may impact the incidences of these health outcomes within the study area.

3.6.2 Reproductive and Child Health Indicators

Reproductive and child health indicators provide a measure of the health of babies and children in the area. Low birth weight is defined as the percentage of singleton babies born weighing less than 2,500 grams. A “singleton”

birth is a baby born alone (i.e., does not include twins, triplets, etc.). Low birth weight is associated with higher risk for short-term and long-term health effects. Vulnerable in terms of readiness to learn is defined as the percentage of kindergarten children who are considered vulnerable according to the Early Development Instrument (EDI). The EDI evaluates readiness to learn by looking at five major areas: physical health and well-being, social knowledge and competence, emotional health and maturity, language and cognitive development, and communication skills and general knowledge. "Vulnerable" children are in the bottom 10th percentile in one or more of these areas. The available data from the Ward Health Profiles on reproductive and child health are summarized in Table 4. In comparison to the City as a whole, Ward 28, which encompasses the BBTCA, has a higher proportion of vulnerable students in terms of readiness to learn.

Table 4: Reproductive and Child Health Indicators

Indicator	Ward 14	Ward 18	Ward 19	Ward 20	Ward 27	Ward 28	Ward 30	Ward 32	Toronto
Low Birth Weight (% of newborn babies)	5.4	6.0	5.1	5.2	5.8	6.3	**4.6 (L)**	4.9	5.8
Vulnerable in Terms of Readiness to Learn (% of kindergarten students)	28.4	27.7	32	28	**16.4 (L)**	**35.8 (H)**	25.0	**16.6 (L)**	26.9

Source: City of Toronto, 2013b

Note:

(a) Low Birth Weight rate are for 2009, 2010 and 2011, combined. Readiness to Learn is for the 2007/2008 school year.

(H) Indicates the estimate is considered significantly higher than Toronto based on comparison of the 95% confidence intervals.

(L) Indicates the estimate is considered significantly lower than Toronto based on comparison of the 95% confidence intervals.

3.6.3 Injury

Injury is defined as the number of emergency department hospital visits due to external events or circumstances that result in injury, poisoning or other adverse effect. The Ontario Ministry of Health and Long-term Care states that the term 'injury' shall include all the ways people can be physically hurt, impaired or killed, involving unintentional or intentional damage to the body. Unintentional injuries include motor vehicle crashes, falls, sport injuries and unintentional poisoning; whereas intentional injuries include those resulting from violence, self-harm and suicide. While this information may not be specific to traffic-related injuries, this data is considered useful in the HIA for identifying whether there may be more pressure on hospital emergency departments in some areas due to potential impacts on traffic. Common injuries sustained by children include being hit by, or hitting an object or person, and from falling. The most common injuries for seniors are from falling. The available data on the number of Hospital Emergency Department visits due to injuries are summarized in Table 5.

In comparison to the City as a whole:

- All wards have a statistically significant higher rate of emergency department visits for injuries among children and youth; and
- Wards 14, 27 and 32 have a significantly higher rate of emergency department visits for injuries among seniors.

Table 5: Injury Rates

Indicator	Ward 14	Ward 18	Ward 19	Ward 20	Ward 27	Ward 28	Ward 30	Ward 32	Toronto
Injuries among children and youth	**12,521 (H)**	**12, 202 (H)**	**11,325 (H)**	**11,205 (H)**	**11,990 (H)**	**10,772 (H)**	**10,309 (H)**	**11,495 (H)**	9,902
Injuries among seniors	**12,143 (H)**	**8,666 (L)**	**8,039 (L)**	9,691	**9,883 (H)**	9,648	**8,788 (L)**	**11,092 (H)**	9,288

Source: City of Toronto, 2013b

Note:

(a) Number of Emergency Department visits per 100,000 people for 2009, 2010 and 2011.

(b) "Children and youth" are aged 19 and under; "seniors" are aged 65 and over.

(H) Indicates the estimate is considered significantly higher than Toronto based on comparison of the 95% confidence intervals.

(L) Indicates the estimate is considered significantly lower than Toronto based on comparison of the 95% confidence intervals.

3.6.4 Hospitalization and Mortality

Hospital admission data and mortality rates for cancer, cardiovascular disease and respiratory disease are summarized in Table 6. This information provides an indication of the health of the existing community and those wards that may be more susceptible to potential health impacts from the Proposal (e.g., wards with a high incidence of respiratory disease).

Cancer includes all neoplasms, cardiovascular disease includes heart and/or blood vessel disease and respiratory disease includes lung and/or throat disease. Cancer can be caused by a variety of factors, including smoking, obesity, poor diet, physical inactivity, alcohol, sun exposure, radiation, chemical exposure, and environmental toxins (City of Toronto, 2013b). Similarly, cardiovascular disease can also be caused by obesity, poor diet, physical inactivity, and smoking, as well as diabetes, high blood pressure and stress (City of Toronto, 2013b). Respiratory disease can be caused by smoking and exposure to environmental toxins (City of Toronto, 2013b). Common respiratory diseases include asthma, chronic obstructive pulmonary disease and lung conditions excluding cancer.

Table 6: Age-Standardized Hospitalization and Mortality Rates for Respiratory Disease, Cancer and Cardiovascular Disease

Indicator	Ward 14	Ward 18	Ward 19	Ward 20	Ward 27	Ward 28	Ward 30	Ward 32	Toronto
Hospitalization[(a)]									
Respiratory Disease	**685 (H)**	**540 (H)**	429	**485 (H)**	408	**624 (H)**	**497 (H)**	**486 (H)**	425
Cancer	**431 (H)**	349	324	339	333	355	349	343	340
Cardiovascular Disease	**852 (H)**	707	653	635	650	**722 (H)**	695	**784 (H)**	667

Indicator	Ward 14	Ward 18	Ward 19	Ward 20	Ward 27	Ward 28	Ward 30	Ward 32	Toronto
Mortality[(b)]									
Respiratory Disease	40	43	35	41	36	**57 (H)**	**51 (H)**	**58 (H)**	37
Cancer	**174 (H)**	149	138	140	151	157	158	**177 (H)**	141
Cardiovascular Disease	**168 (H)**	142	135	139	118	**150 (H)**	**157 (H)**	**177 (H)**	125

Source: City of Toronto, 2013b
Note:
(a) Number of hospitalizations per 100,000 people in 2009, 2010 and 2011.
(b) Number of deaths per 100,000 people in 2007, 2008 and 2009.
(H) Indicates the estimate is considered significantly higher than Toronto based on comparison of the 95% confidence intervals.
(L) Indicates the estimate is considered significantly lower than Toronto based on comparison of the 95% confidence intervals.

Hospitalization rate is defined as the number of hospital discharges per 100,000 people, which includes only patients who are admitted for at least one night. The data presented above was age-standardized to the 1991 Canadian population. Mortality rate is defined as the number of deaths per 100,000 people, also age-standardized to the 1991 Canadian population. Standardization to the 1991 Canadian population allows comparison of estimates over time and geography (City of Toronto, 2013b).

In comparison to the City as a whole:

- Wards 14, 18, 20, 28, 30 and 32 have significantly higher hospitalization rates due to respiratory disease;
- Ward 14 has a significantly higher hospitalization rate due to cancer;
- Wards 14, 28 and 32 have significantly higher hospitalization rates due to cardiovascular disease;
- Wards 14, 28, 30 and 32 have significantly higher mortality rates due to respiratory disease;
- Wards 14 and 32 have a significantly higher mortality rate due to cancer; and
- Wards 14, 28, 30 and 32 have significantly higher mortality rates due to cardiovascular disease.

The data indicate that several of the wards within the study area, including Ward 28 which encompasses the BBTCA, have significantly higher rates of respiratory and cardiovascular disease compared to the City as a whole.

3.6.5 Infectious Disease

Rates of infectious disease in each ward provide another measure of health and an indicator of which wards may have a greater proportion of individuals with existing health conditions. Incidence rates of infectious disease are defined as the number of new cases of a disease per 100,000 people, age-standardized to the 1991 Canadian population. The data presented in Table 7 for each disease parameter are expressed as incidence rates.

Tuberculosis is a bacterial infection of the lungs that is spread through coughing or sneezing, thereby expelling bacteria into the air (City of Toronto, 2013b). Tuberculosis disproportionately affects Toronto's foreign-born population, reflecting high rates of tuberculosis in their countries of origin (City of Toronto, 2013b). Influenza is a contagious virus infection that affects the nose, throat and lungs. Enteric diseases are caused by infectious agents in feces that can contaminate food and/or water sources. Enteric diseases spread through ingestion of infected food or water, or through close personal contact. Sexually transmitted infections (STIs) are the most frequently reported infectious diseases in Toronto, and are transmitted through sexual contact via exchange of bodily fluids including blood, semen, and vaginal secretions (City of Toronto, 2013b).

Table 7: Age-Standardized Incidence Rates for Infectious Diseases

Disease	Ward 14	Ward 18	Ward 19	Ward 20	Ward 27	Ward 28	Ward 30	Ward 32	Toronto
Tuberculosis	**34 (H)**	7	8	10	8	**17 (H)**	**7 (L)**	**5 (L)**	11
Influenza	**63 (H)**	54	22	51	52	47	44	38	37
Enteric Diseases	107	87	127	**151 (H)**	248	**153 (H)**	113	114	104
Sexually Transmitted Infections (STIs)	545	**640 (H)**	547	526	**1176 (H)**	**897 (H)**	**650 (H)**	484	548

Note:
(a) Reported cases per 100,000 people
(b) Tuberculosis estimates are for 2007 to 2011 combined. Influenza, Enteric Diseases and Sexually Transmitted Infections are for 2011.
(H) Indicates the estimate is considered significantly higher than Toronto based on comparison of the 95% confidence intervals.
(L) Indicates the estimate is considered significantly lower than Toronto based on comparison of the 95% confidence intervals.

In comparison to the City as a whole:

- Wards 14 and 28 have a significantly higher incidence of tuberculosis;
- Ward 14 has a significantly higher incidence of influenza;
- Wards 20 and 28 have a significantly higher incidence of enteric diseases; and
- Wards 18, 27, 28 and 30 have a significantly higher incidence of STIs.

3.7 Literature Studies

Literature studies have demonstrated that airports have impacts on human health. In order to ensure that the HIA for BBTCA evaluates the key indicators that are associated with health effects from airports, a literature review was carried out to identify studies that describe the health impacts of airport-related emission sources. Many of the studies that were found discuss the impact of airports on air quality and noise and subsequent health effects. There have been studies that link airport-related traffic as well as aircraft emissions with health impacts. There were also studies that examined the importation of infectious disease; effects on water, soil and groundwater quality; and aircraft accidents. While a detailed analysis of several of these studies is provided in Section 5, a brief review is provided below to provide background for the scoping of this HIA.

Airports, including aircraft, ground service equipment and auxiliary power units, release one or more of the following chemicals into the atmosphere: carbon dioxide (CO_2), volatile organic compounds (VOCs), nitrogen oxides, sulfur oxides and particulate matter (Lin *et al*., 2008). Aircraft air emissions vary with the engine type, the engine load and the fuel type used. Combustion of jet fuel results in the production of carbon dioxide, water, carbon monoxide, carbon, nitrogen oxide and dioxide (NO_x), particles and many organic compounds (Tesseraux *et al*., 2004). Ambient pollutant concentrations in the proximity of airports have been positively correlated with aircraft landing and takeoff activities. Hsu *et al*. (2012) (for T.F. Green Airport in Rhode Island, USA) and Westerdahl *et al.* (2008) (for Los Angeles International Airport, USA) found a positive correlation between aircraft operations and ultrafine particle concentrations. Carslaw *et al.* (2006) estimated the contribution of aircraft emissions to NO_x concentrations for a network of seven measurement sites close to London Heathrow Airport in England. The results showed that aircraft emissions accounted for approximately 23% of annual mean NO_x and NO_2 near the airport and less than 15% 2 to 3 km downwind of the airport.

It is known that poor air quality adversely impacts human health (US EPA, 2011). Epidemiological studies have found that elevated long-term exposure to fine particulate matter ($PM_{2.5}$) is associated with increased risk of early death (US EPA, 2011). Both VOCs and NOx are precursors to ground-level ozone, which can interfere with lung function and aggravate diseases such as asthma, chronic bronchitis and emphysema (Lin *et al.*, 2008). High levels of sulfur oxides or particulate matter can irritate the respiratory system, contribute to respiratory illness, and aggravate asthma and existing heart and lung diseases (Lin *et al.*, 2008). Lin *et al*. (2008) examined hospital admission data for respiratory conditions for residents living within 12 miles of the center of each of three airports (Rochester, LaGuardia in New York City and MacArthur in Long Island). They found an increased relative risk of hospital admissions for respiratory conditions for residents living within 5 miles of the airport for Rochester and LaGuardia, compared to residents living greater than 5 miles away. However for MacArthur airport in Long Island, Lin *et al*. (2008) reported no differences in hospital admission rates for respiratory conditions with distance. The lack of correlation between hospital admission rates for respiratory conditions with distance was potentially related to the population composition around MacArthur Airport and/or the cumulative air quality (i.e., lower emissions, less traffic, fewer industrial facilities near MacArthur compared to the other airports).

Numerous studies have examined the relationship between airport noise and health. Black *et al.* (2007) found that, after controlling for confounders, individuals who have been chronically exposed to high aircraft noise levels are more likely to report stress and hypertension compared with those not exposed to aircraft noise, based on noise measurements and a community questionnaire distributed at different distances from the Sydney Airport in Australia. A number of different noise thresholds and correlations have been developed for sleep disturbance. In a review of field studies on aircraft noise-induced sleep disturbance, Michaud *et al.* (2007) found that reliable generalizations of findings to population level effects is complicated by individual differences among subjects, methodological and analytic differences among studies, and predictive relationships that account for only a small fraction of the variance in the relationship between noise exposure and sleep disturbance. The effects of noise on sleep are mediated by sound level, number, duration, time of occurrence, short and long-term intermittency, and consistency of distributions of aircraft noise intrusions into sleeping quarters (Michaud *et al.,* 2007). Uncertainty in estimates of at-ear aircraft noise levels and the degree at which noise events exceed at-ear background noise levels in sleeping quarters, as well as individual differences such as age, sex, noise sensitivity, sensitization and habituation, and health status also effect the ability of aircraft noise to disturb sleep

(Michaud *et al.,* 2007). Hygge *et al.* (2002) found that children exposed to airport noise from Munich International Airport in Germany had impairments in long-term memory and reading compared to control groups that were closely matched for socioeconomic status. Similarly, Clark *et al.* (2013) found that aircraft noise exposure from London Heathrow Airport was associated with a significant increase in noise annoyance and a non-significant decrease in reading comprehension in school children. In a study on La Guardia Airport in New York (Cohen *et al.*, 2008), residents living near the airport were exposed to noise levels as much as four times greater than those experienced by residents in a comparable home further away, and more than 55% of the people living within the flight path were bothered by aircraft noise. Hansell *et al*. (2013) found that surrounding London Heathrow Airport, hospital admissions for stroke, coronary heart disease and cardiovascular disease showed statistically significant linear trends of increasing risk with higher levels of both daytime and night time aircraft noise. When areas experiencing the highest levels of daytime aircraft noise were compared with those experiencing the lowest levels, the relative risk of hospital admissions for stroke was 1.24, for coronary heart disease was 1.21, and for cardiovascular disease was 1.14. In a similar study based on data from 89 airports in the United States, Correia *et al.* (2013) found that a zip code with a 10 dB (day-night sound level (L_{dn}) higher noise exposure had a 3.5% higher cardiovascular hospital admission rate, after controlling for covariates.

Other potential health impacts of airports discussed in the literature include the importation of infectious disease (Gratz *et al*., 2000), effects on water quality (Sulej *et al*., 2012), effects on soil and groundwater quality (Nunes *et al.*, 2011) and aircraft accidents (Ayres *et al*., 2013).

3.8 Other Airport HIAs

Review of HIAs completed for other airports provides insight into some of the potential health effects that may be associated with airports. The following HIAs for airports were reviewed:

- Health Impact Assessment for Schiphol Airport (RIVM, 1999);
- A Rapid Health Impact Assessment of Birmingham International Airport's Proposed Runway Extension (University of Liverpool, 2008);
- Submission to the Manchester Airport Second Runway Enquiry (Manchester Health Authority, 1994);
- Santa Monica Airport Health Impact Assessment (UCLA, 2010);
- Health Impact Assessment, Finningley Airport (Doncaster Health Authority and Doncaster Metropolitan Borough Council, 2000); and
- The Stansted Generation 2 Project: A Health Impact Assessment (ERM, 2008).

A detailed summary of each HIA is provided in Appendix A, including a description of the project, baseline health profile, impact analysis framework, indicators, measures, findings and recommended mitigation measures. Health indicators that were evaluated in these HIAs are listed in Table 8. The literature studies and methods used in these HIAs, as well as some of the proposed mitigation measures, were used to inform the assessment for the BBTCA Proposal.

Table 8: Health Indicators Assessed in HIAs for Other Airports

Social and Cultural	Economic	Environmental	Other
Social capital[2]	Employment	Air quality	Involuntary relocation
Health care facilities	Income	Noise	Infectious disease
Perception of risk and residential satisfaction		Transport, including traffic safety	Accident/fire risk
Perceived health		Visual and light pollution	
Annoyance		Water / land quality	
		Buffer zone	
		Climate change	
		Fuel dumping	
		Vibration	
		Odour	

See Appendix A for further detail

[2] Social capital is defined as the norms and social relations embedded in the social structure of societies that enable people to coordinate action to achieve desired goals (University of Liverpool, 2008). It is an important link between economic and human development, and to reducing poverty and inequalities. It includes social relationships and networks for social support, and the integration in a community; in addition it encompasses interactions between individuals and institutions (University of Liverpool, 2008).

4.0 PUBLIC AND STAKEHOLDER CONSULTATIONS

4.1 HIA Focused Workshop

On October 9, 2013 a focused workshop with key stakeholders was held at Metro Hall to get feedback on the HIA. The activities completed and a record of feedback collected is documented in the Key Stakeholder Consultation Summary Report (Appendix B). Specifically, the goals of the workshop were to:

- Inform key stakeholders about the purpose and methodology for the HIA;
- Gain an understanding of health concerns arising from the Proposal, including concerns related to the environment, socio-economic factors and community wellbeing; and
- Collect feedback on the relative importance of issues.

This section provides an overview of the workshop and the feedback received.

The focused workshop was planned by TPH to gather community and public health experts to explore and discuss in detail their health concerns related to the proposed airport expansion. The number of participants was limited in an effort to balance representation from a range of community and public health organizations, while creating an opportunity for focused and detailed discussions to explore issues that the communities and public health experts are concerned about. The invitees were selected based on several sources including suggestions from public health staff who work in the communities near the airport, input from local councillors, identifying public health and noise experts at area universities, identifying environmental health organizations in Toronto, and reviewing the stakeholder list that was developed to support the City's public consultation activities.

A total of 40 organizations and representatives were invited to participate in the workshop. Twenty-eight people attended the workshop, representing twenty organizations. Representatives from TPH, the City and Golder were also present to provide information, collect stakeholder feedback and answer questions.

4.2 Workshop Format

The workshop was held in a round table format with participants organized into five tables based on their area of interest (e.g., medical professionals, non-governmental organizations, community organizations). The focus of the workshop was to engage participants in small groups through a series of breakout sessions designed to allow discussion and encourage participation by all stakeholders. A copy of this presentation is provided in Appendix B. Feedback was requested on specific topics to:

- Gain an understanding of health concerns arising from the Proposal, including concerns related to the environment, socio-economic factors and community wellbeing; and
- Collect feedback on the relative importance of issues.

Although a third activity was planned to collect feedback on potential risk reduction measures, participants elected to focus discussions on the scope of the HIA and the potential health impacts.

4.3 Workshop Results and Methods

4.3.1 Issues Identification

Written comments provided to TPH included email submissions, worksheets, post-it notes and workshop comment forms. All comments relating to the HIA received by TPH and Golder were reviewed, and issues relating to the potential health impacts of the Proposal were documented by frequency and content. Comments were categorized by issue category, including potential health effects associated with environmental, economic, social and cultural factors, as well as vulnerable populations and places. Within each issue category, comments were organized by issue subject (e.g., air quality). The issue list is provided below in Table 9. The list was revised based on the nature of comments received by stakeholders. For example, in response to stakeholder input, the list was revised to include additional topics such as water quality, wildlife and odour. Participant comments were reviewed and the number of times an issue was raised was counted. Although the number of times an issue was raised does speak to its relative importance, it does not capture the detail and content of the comments received (as reflected in the figures below). Comments that addressed more than one issue were counted multiple times.

Following categorization, discipline-specific comments were distributed to the human health, noise and air specialists carrying out the various aspects of the HIA for review and consideration when preparing the study. Where possible, stakeholder comments were addressed. For example, the scope of the HIA was expanded to include discussion of potential health effects related to water quality. The following sections provide a summary of the potential health impacts and other comments identified by stakeholders as part of the workshop. Specific stakeholder feedback on each issue topic is discussed in greater detail throughout the HIA report.

Table 9: Issue List

Issue Category	Issue Topic[3]
Environmental	Air quality
	Noise
	Traffic
	Climate change
	Wildlife
	Odour
	Light pollution
	Fuel transport
	Water quality

3 Each topic, with the exception of wildlife, odour, and light pollution, is discussed in a stand-alone section in the HIA Report. Other topics are discussed within relevant sections of the report.

Issue Category	Issue Topic[3]
Economic	Income
	Employment
	Tourism
	Healthcare costs
	Property values
	Infrastructure
Social and Cultural	Feeling safe in the community
	Recreation
	Cultural activities
	Community services
	Community character
	Community plan (waterfront revitalization)

4.3.2 Summary of Key Stakeholder Input

Overall key stakeholder feedback indicated that the current conditions in the area around the airport are already unacceptable and would be expected to worsen with the expansion of airport operations. Health impacts were linked to vulnerable populations in the area, namely children, low income individuals, people with disabilities, pregnant mothers and seniors. Concerns associated with the Waterfront area generally included:

- Waterfront residents, including lower income residences;
- the Toronto Islands, both for residents and visitors;
- public spaces (e.g., Little Norway Park, the Music Garden, and Hanlan's Point Beach); and
- the waterfront school/pre-school/child care facility.

In addition, concerns were also raised regarding the schedule for the HIA and the level of public consultation undertaken.

Figure 6 provides a summary of the issues relating to potential health impacts identified by key stakeholders. Concerns about current and future environmental conditions raised most frequently and identified as most important included:

- illnesses associated with air emissions (respiratory, cancer) and noise (sleep deprivation, education);
- pedestrian safety from high traffic volume, especially for children, seniors and people with disabilities;
- risks associated with fuel transport; and
- water quality impacts from increased runoff of de-icing fluids, fuel spills and runway expansion.

The most frequent social and cultural issues identified included:

- feeling unsafe due to potential for catastrophic events (fuel spills, plane strikes), air quality and pedestrian safety;
- potential ghettoization of the neighborhood and shift in community demographics; and
- impacts on recreational opportunities, including the use of Toronto Islands, various parks, and both the waterfront and harbour.

The most frequent economic issues raised included:

- infrastructure supporting current operations of the BBTCA is already overwhelmed and expected to worsen with the expansion of operations;
- costs associated with infrastructure requirements to deal with potential noise and air impacts from the airport operations (e.g., new windows, patio doors, HVAC systems etc.);
- health care costs associated with increased hospital visits, and loss of income due to increased sick days and missed work were associated with poor health due to the existing conditions, and predicted to worsen with the Proposal;
- negative impacts on the Waterfront and Toronto Islands' tourism from current and expanded operations; and
- negative impacts on property values from expanded operations.

The issues raised and the number of times each issue was raised is presented on Figure 6.

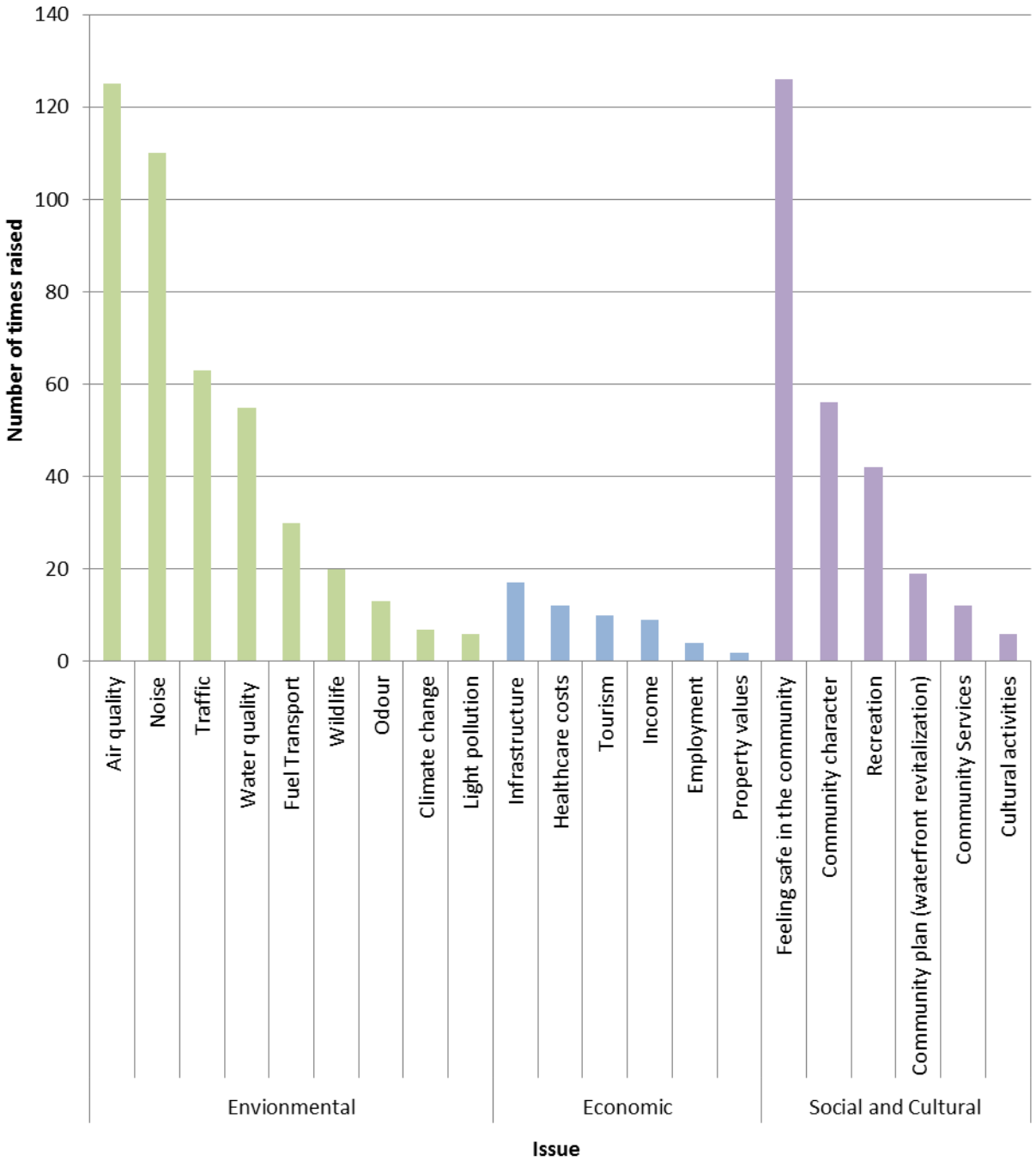

Figure 6: Summary of Key Stakeholder Feedback Received on Potential Health Impacts

4.4 Public Consultation Program

In addition to the feedback on the HIA study received by TPH, potential health impacts were also identified by the community during the public consultations completed by the City as part of the review of the BBTCA Proposal. The City retained DPRA Canada Inc. and Environics Research Group to assist with the public consultation program. The public consultation program consisted of a project website, public meetings, surveys and an information package. The following section provides a brief summary of the key issues relating to potential health effects identified during the public consultation. The results of the public consultation were documented and presented in the Executive Committee in the Further Update on Public Consultation Program on Request from Porter Airlines Exemption to Commercial Jet Ban at BBTCA Supplemental Report dated September 23, 2013 (available online at http://www.toronto.ca/legdocs/mmis/2013/ex/bgrd/backgroundfile-61867.pdf).

4.4.1 Public Consultation Meetings

Three public meetings were held in 2013: September 4 at Fort York, September 9 at Metro Hall and September 19 at the Direct Energy Centre at Exhibition Place. The key environmental health concerns from the Proposal were related to traffic, noise and air emissions. Stakeholder concerns related to potential effects on water quality resulting from runway expansion, fuel transport and chemical storage were also raised. Potential impacts to both land (e.g., parks) and aquatic (e.g., boating and swimming) recreational activities were identified. Potential negative (e.g., land values and other costs) as well as positive (e.g., tourism, employment and business) economic impacts were identified. Concerns were raised about the short timelines and the geographic scope of the HIA study.

4.4.2 Online Survey Results

The following section provides a brief summary of the key issues relating to potential health effects identified through the online survey. The online survey was launched during the week of August 27, 2013 and closed on October 11, 2013. A total of 41,879 surveys were received; however it is important to note that the number of survey responses is not statistically representative of the City's demographics, rather they provide a snapshot of opinions among the Toronto public. There was only one survey question that related to the HIA; respondents were asked how concerned they were about a number of potential health impacts. Overall, more than half of the respondents indicated some level of concern (major or minor) over the first four out of the following five potential health impacts listed on the survey:

- The effects of air pollution from jet airplanes;
- The effects of noise from the airports;
- The impacts on children who live or go to school near the airport ;
- The effects of air pollution from additional vehicular traffic going to the airport; and
- The effect on pedestrian or cyclist safety of additional vehicular traffic going to the airport.

Over half of the respondents indicated that they have either major or minor concerns about the effects of air pollution from the jet airplanes. Further, one out of four respondents had major concerns over the effects of noise from the airport (26.4%); the impacts on children who live or go to school near the airport (25.8%); and the effects of air pollution from additional vehicular traffic going to the airport (25.1%). More than half of the respondents indicated a concern with pedestrian or cyclist safety with additional vehicular traffic going to the airport. In addition, respondents were asked to indicate other health impacts that they were concerned about. Of those who did provide additional comments on this question, many reiterated their concerns over the noise and air impacts associated with the Proposal.

4.4.3 Telephone Poll Results

The following section provides a brief summary of the key issues relating to potential health effects identified through the online survey. The telephone survey was conducted among 1,002 adult Toronto residents between August 26 and September 4, 2013. Data were statistically weighted to reflect the regional, age and gender composition of the actual Toronto population according to the 2011 Census.

Although no specific questions were asked about potential health impacts, some of the feedback collected provided insight into issues related to the determinants of health. The survey results indicated that residents are most concerned about the environmental impact the expansion will have on the lake and surrounding area (77% very or somewhat concerned). There is greater concern about the increased traffic in the area (64%) than for the amount of noise made by jet aircraft (61%). Concern about the environment is similar throughout the City, while concerns about noise and traffic are greater in the airport vicinity. Fifty-two percent of residents identified that an expanded airport could not be part of the revitalized waterfront. People who live closest to the waterfront are most likely to say that an expanded airport cannot be a part of a revitalized waterfront. Of those residents who oppose the proposal, most (90%) say that they are not part of a revitalized city waterfront.

The poll indicated that residents are divided between support (47%) and opposition (45%) for the expansion of BBTCA to allow jet aircraft. People who live in the vicinity of the airport show the strongest opposition.

5.0 HEALTH IMPACT ASSESSMENT

The following sections analyse the potential impact of the Proposal on environmental, economic, social and cultural factors and health. Where possible, information specific to the BBTCA were applied based on observations of airport operations, discussions with TPA and Porter personnel related to current and proposed operations, and review of documentation provided by Porter Airlines and Bombardier. Additional information from other sources such as published literature from credible regulatory agencies, and technical reports from the City and TPH's website, were also relied upon to assess the potential health impacts associated with the Proposal. Where available, risk reduction measures were identified based on existing management practice at the BBTCA, recommendations by consultants' reports, and/or professional judgement. Risk reduction measures were provided to explore whether engineering controls and/or management measures can be implemented to reduce/prevent health impacts associated with the Proposal.

5.1 Environmental Factors

5.1.1 Climate Change

5.1.1.1 Connection to Health

Normal airport operations and the proposed BBTCA expansion generates air emissions that could contribute to climate change, which in turn can cause variations in regional weather that can affect health. The principal pollutants from air transport that could contribute to climate change include emissions of CO_2, NO_x, aerosols and their precursors (soot and sulphate), and increased cloudiness from contrails (Lee *et al.,* 2009). The health impact associated with the change in local air quality from airport emissions is discussed in Section 5.1.6.

The impact of air transport on climate change is measured by the amount of radiative forcing, defined as the difference in radiant energy received by the earth and energy radiated back to space. For the year 2005, it was estimated that the aviation sector contributed 3.5% to global anthropogenic radiative forcing (Lee *et al*., 2009). In Canada, the overall category of transport contributed approximately 28% to total greenhouse gas emissions in 2010 (Environment Canada, 2012). Among transport activities, civil aviation (domestic aviation) contributed 3% of greenhouse gas emissions, while road transport had the greatest contribution at 69% (Environment Canada, 2012).

Carbon dioxide emissions have been reported as 42 to 75 gCO_2/km/passenger for rail transport; 82 to 116 gCO_2/km/passenger for bus transport; 126 to 295 gCO_2/km/passenger for car transport; and 81 to 323 gCO_2/km/passenger for air transport (Fahrni *et al*., 2008). These carbon dioxide emission estimates indicate that air transport generally results in a higher climate change impact compared to ground transport. For air transport, long haul flights have lower CO_2 emissions per km than shorter flights because the fraction of the flight time spent in the high-thrust take off and climb out phase is reduced (i.e., as the distance at cruise increases), so the fuel efficiency per km of the trip improves (Williams and Noland, 2006). Large aircraft appear to have lower impact on climate change, per seat, than smaller aircraft because of enhanced fuel efficiency (Givoni *and Rietveld*, 2010).

Climate change can cause variations in regional weather including extreme heat, extreme weather and changes in temperature and precipitation. These changes in regional weather have the potential to lead to health effects

including increased heat-related illness and mortality, degraded air quality leading to respiratory and cardiovascular outcomes, increases in vector-borne diseases, risk of food contamination leading to foodborne illnesses, risks arising from extreme weather events such as flooding, increased disparities in health status (WHO, 2003; TPH, 2013). The effects of climate change are expected to increase threats to human health in Toronto (TPH, 2013).

5.1.1.2 Assessment for BBTCA

During the consultation process, stakeholders identified climate change as a concern, particularly CO_2 emissions from aircraft and differences in the carbon footprint between air transport and other modes of transport such as rail or bus.

The contribution of the BBTCA operations to climate change is beyond the scope of the air quality modelling that was completed as part of this HIA. The carbon footprint from BBTCA operations under current conditions and under future operational scenarios is presented in Table 10 below. Scenarios assume 202 movements per day, 365 days per year. Results indicate that the Proposal will cause an increase in the local carbon footprint by 29% to 40% over the existing operations. The total Ontario greenhouse gas emissions are 170,000,000 tonnes of CO_2 (Environment Canada, 2013). Adequate data is not available to assess whether the Proposal will contribute significantly to climate change and while the overall impact of a single source is not likely to have a measurable impact, reduction in greenhouse gases at the societal level are considered necessary to meet international goals of limiting temperature increases. .

Table 10: Carbon Footprint of BBTCA Operational Scenarios

Scenario	Aircraft	Annual CO_2 (Tonnes)
Maximum Existing Operations	Q400s	16,286
Future Scenario (25% Boeing 737s, 75% Q400s)	Q400s 737s TOTAL	11,260 11,537 22,797
Future Scenario (25% CS100s, 75% Q400s)	Q400s CS100s TOTAL	11,260 9,731 20,991

A comprehensive quantitative analysis of BBTCA's carbon footprint and overall contribution to climate change was not possible. As such, a qualitative discussion of the potential impact on climate change is presented in Table 11 below.

Table 11: Assessment of Proposal Impacts on Climate Change

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Climate change	Change in contribution to greenhouse gases	■ The future scenario represents a greater number of flights by jets in and out of BBTCA which would increase CO_2 emissions ■ The extent that the jet flights represent new air trips in and out of Toronto or displacement of jet flights from Toronto Pearson Airport is uncertain ■ The extent that the jet flights will displace transport previously taken by rail or bus is expected to be limited, as the jets are proposed to add flights to California, Nevada, Florida and the Caribbean ■ The jets are larger and newer aircraft that are expected to be more fuel efficient than the turboprop aircraft; thus, the jets have a lower impact on climate change on a per seat or per km basis. However, because the jets are larger and travel longer distances, the total contribution to climate change per flight may be higher ■ Overall, some increase in the contribution to climate change is expected based on the Proposal	Negative	Global	■ Improve aircraft engine efficiency ■ Minimize CO_2 emissions across all BBTCA operations

5.1.2 Water Quality

5.1.2.1 Connection to Health

There are a number of activities at airports that may impact water quality, including release of chemical waste during aircraft and ground vehicle washing, cleaning, aircraft maintenance and repair work (including painting and metalwork), fuelling operations, engine test cell operations, de-icing operations and ground vehicle maintenance (Sulej *et al*., 2012). Therefore, surface runoffs from point and non-point sources from airport operations may contain metals, oils, greases, hazardous materials, solids, hydrocarbons, pesticides, ethylene glycol and herbicides. During dry weather, pollutants can accumulate on impermeable surfaces, but during storms they are washed into creeks, streams, lakes or other waters causing potential water quality impacts (FAA, 2007). Therefore, one key issue is the handling of runoff water, and whether chemicals present in runoff water have the potential to enter local surface water systems.

Another potential impact on water quality may occur through fuel dumping, which is an emergency procedure that can be used by aircrafts during preparation for a difficult landing. Based on information presented in the Finningley and Manchester HIAs, the probability of fuel dumping is low.

Water may be used as a drinking water source or recreationally, and thus impacts to water quality are relevant from a human health perspective.

5.1.2.2 Assessment for BBTCA

During the consultation process the following concerns were identified:

- Impact of the existing and future operations at BBTCA on the quality of water in Lake Ontario;
- Runoff containing de-icing fluid or fuel spills resulting from transport and/or airport operations;
- Concern about fuel dumping by planes prior to landing;
- How runway expansion would affect currents, sediment quality and aquatic habitat; and
- Cumulative impact of airport activities on the use of Lake Ontario as a source of drinking water and as a recreational space.

According to Environment Canada and Health Canada (EC & HC, 2000), primary sources of ethylene glycol releases to the aquatic environment come from the paper product sector (91%) and steel industry. The air transport industry contributes approximately 95% of ethylene glycol releases to land (EC & HC, 2000). De-icing of aircraft is a mandatory requirement under aviation regulations to ensure flight safety. Under weather conditions that are conducive to ice formation, airlines which are responsible for the application of the de-icing fluid often spray large volumes of a heated ethylene glycol-based fluid on aircraft surfaces prior to departure (EC & HC, 2000). Testing results indicated that 16% of the ethylene glycol used to de-ice planes remains on the aircraft, 35% is blown behind the aircraft, and about 50% falls to the ground in the vicinity of the aircraft application (EC & HC, 2000). While ethylene glycol releases are reportedly to land, it remains in liquid form and is typically collected in de-icing collection and drainage systems as part of airport operations (EC & HC, 2000). However, there are historical examples where collection and drainage systems have failed allowing large volumes of ethylene glycol to enter surface water systems (EC & HC, 2000). At airport facilities, the entry of ethylene glycol into the environment has the potential to be under uncontrolled conditions. Ethylene glycol-based fluid that falls to the ground and is not recovered can find its way into waterways, draining from the airport property via two pathways: meltwater from snow that is contaminated by ethylene glycol, and the storm drainage system (EC & HC, 2000). As glycol has a high biochemical oxygen demand (BOD), the discharge of untreated runoff containing glycol-based de-icing fluids into receiving waters causes adverse effects on aquatic life (Transport Canada, 2005).

Transport Canada (2005) states that a number of airports throughout Canada have implemented a program of sampling and analysing storm water to ensure that airport effluent does not negatively impact the environment. Although existing environmental legislation does not specifically require water monitoring, federal, provincial and municipal laws do specify water quality standards and guidelines to be followed by industry. In accordance with regulatory requirements, it is mandatory for the Air Operator, Service Provider and local Airport Authority to prepare detailed glycol management plans and procedures to ensure responsible environmental management of glycol-based chemicals used in de-icing operations (Transport Canada, 2005).

Forty percent of the BBTCA area is impervious, covered by buildings or pavement, and 60% is pervious, covered by grass or gravel surfaces (TPA, 2013). Storm water drainage is handled by infiltration and storm sewers. The

storm sewers discharge to Lake Ontario at ten outfall locations. Seven of the outfalls are part of the underground sewer system and three outfalls manage surface areas at the west end of the airport.

The BBTCA manages aircraft de-icing fluids with a dedicated ethylene glycol containment system that traps surface runoff containing ethylene glycol from de-icing operations (TPA, 2013). The runoff effluent is pumped to the City of Toronto Sanitary Sewer System. The BBTCA have protocols and designated areas for aircraft to receive applications of ethylene glycol. These areas are located in the designated ethylene glycol application area, which incorporates the containment underground storm sewers and catch basins. According to the TPA, the system is equipped with large gate valves which, when closed, isolate the runoff effluent from overspray produced when an aircraft is being sprayed with ethylene glycol, as well as any precipitation that may fall in the containment area (TPA, 2013). The system is activated each year prior to the first spray application, and later deactivated after the final application in the spring. The City of Toronto Works and Emergency Services Department conducts grab sample operations during the de-icing season. According to the TPA, results continue to indicate that readings are within allowable discharge limits into sewers (TPA, 2013). Snow clearing from the designated aircraft de-icing area, which may contain ethylene glycol, is directed to an adjacent airfield location that is drained and directed to the sanitary sewer. It is noted that BBTCA implements a snow removal and ice control plan that details glycol mitigation procedures (AOM, 2012).

To assess the potential impact of ethylene glycol from BBTCA operations on water quality, monitoring data from discharge points from the airport operations would need to be tested for ethylene glycol and other airport-related chemicals. There is a general lack of water quality data related to BBTCA operations and potential impact on Lake Ontario water quality, including the inner harbour. Available data are focused primarily on *Escherichia coli* (E. coli), as well as phosphorus, Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD). These are general water quality parameters that indicate suitability for recreational uses such as swimming. Beaches in the area consistently maintain Blue Flag Status, suggesting that recreational water quality in the area is typically acceptable.

There were no environmental monitoring data available for ethylene glycol or other airport-related chemicals during the preparation of this HIA and as such, the lack of monitoring data presents a data gap.

City of Toronto drinking water is treated to meet health-protective standards. More importantly, the *Provincial Environmental Protection Act* prohibit chemical releases including ethylene glycol into Lake Ontario, meaning it cannot be present in any treated wastewater the City releases into the Lake. A recent study by CH2M Hill Canada Limited (CH2M Hill) for the City of Toronto evaluated the effect of the proposed BBTCA runway extension on fish habitat and ecological health (CH2M Hill, 2013). The study concluded that the proposed runway extension will have a minimal and limited effect on the surrounding environment.

Due to a lack of water quality data, a quantitative analysis of the potential effect of the Proposal on water quality was not possible, and as such, a qualitative discussion is presented in Table 12 below.

Table 12: Assessment of Proposal Impacts on Water Quality

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Water Quality	Change in water quality	■ The BBTCA incorporates engineering controls including a containment and drainage system to manage runoff and de-icing fluids ■ The addition of jets and the requirements for cleaning and maintenance may generate a higher runoff load ■ Increase potential for release to Lake Ontario from runoff and failure in containment and drainage system at BBTCA ■ The extension of the runway is not expected to significantly alter the surrounding coastal environment ■ The addition of jets increases the likelihood of jet fuel dumping on Lake Ontario in the case of an emergency, but this is considered a low probability event	Negative	Lake Ontario	■ Continued implementation of the Snow Removal and Ice Control Plan ■ Evaluate the capacity of the storm water drainage system for handling a higher runoff load and implement additional infrastructure or monitoring as required ■ Maintain and improve management practices ■ Maintain and improve monitoring programs, including sampling and analysis of ethylene glycol in effluent discharges to ensure that Lake Ontario water quality is protected for the Proposal

5.1.3 Fuel Transport

5.1.3.1 Connection to Health

Aircrafts require fuel, and thus fuel transport to airports is necessary to maintain airport operations. During fuel transport, there is the potential for accidents to occur leading to spills into the environment or explosions. These events are relatively rare, but three recent fuel tanker spills in Canada (e.g., British Columbia, Edmonton and Burlington) indicate that they continue to occur. Fuel spills into the environment can cause human health effects by inhalation of vapours or by contamination of surface water, groundwater or vegetation that may be subsequently ingested. Explosions represent a potentially catastrophic occurrence that may cause property damage and loss of life.

5.1.3.2 Assessment for BBTCA

During the consultation process, many stakeholders raised the following concerns related to fuel transport:

- Increased number of fuel tanker trucks travelling to the airport by ferry to support jets;
- Increased risk of fuel tanker truck accidents, leading to spills or explosions;
- Increased exhaust emissions by the fuel tanker trucks and effects on air quality; and
- The requirements for fuel storage at BBTCA, potentially in excess of the current capacity.

Currently, fuel is transported to the BBTCA via tanker trucks which travel by ferry to reach the airport. The Q400 has a fuel tank capacity of 6,424 litres (L), while the CS100 has a fuel tank capacity of 13,785 L (Aircraft Compare, 2013). It is expected that if jets were allowed at BBTCA, there would be a need for more fuel supply, which would mean more frequent and/or larger fuel tanker trucks, as the number of above ground storage tanks would not be expected to increase.

BBTCA has in place a Ferry Spill Action Plan that details government agency contacts as well as actions to be taken in the event of a fuel spill during ferry transport. Also, the TPA Spill Response Plan, dated November 2012, details an action plan in case of a spill on land or in water. The BBTCA Emergency Response Plan, Section 8, details an action plan to address incidents associated with hazardous materials at the airport. While there are emergency programs in place at BBTCA, these action plans have not been reviewed with respect to whether they would be adequate to handle an increased number of incidents/accidents associated with the Proposal. Also, an assessment was not carried out to determine how these action plans link with the City's overall infrastructure plan to handle a fuel transport accident associated with the Proposal.

Although it is not possible to quantitatively assess the risks from fuel transport, a qualitative assessment is provided in Table 13 below.

Table 13: Assessment of Proposal Impacts on Fuel Transport

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Fuel Transport	■ Risk of fuel tanker truck accidents ■ Exhaust emissions from fuel tanker trucks	■ The addition of jets would increase the BBTCA's fuel supply requirements, increasing the risk of fuel tanker truck accidents potentially leading to spills or explosions ■ The addition of jets would increase the BBTCA's fuel supply requirements, thus increasing the number of fuel tanker trucks and fuel tanker exhaust emissions, resulting in a negative impact on air quality	Negative	Throughout transport route from fuel source (refinery) to airport	■ Continued implementation of the Ferry Spill Action Plan, TPA Spill Response Plan and the BBTCA Emergency Response Plan ■ Management practices to minimize accident risks including vehicle maintenance and/or upgrades, and driver training ■ Evaluate the capacity of the fuel storage at BBTCA for handling a greater fuel supply ■ Review of the Ferry Spill Action Plan, TPA Spill Response Plan and the BBTCA Emergency Response Plan to determine adequacy of the plan in light of the Proposal

5.1.4 Traffic

5.1.4.1 Connection to Health

Traffic, which encompasses vehicle movement, can interact with human health in the following ways:

1) Vehicular accidents, which can cause injury or fatality;

2) Vehicle exhaust emissions, which can negatively affect air quality;

3) Noise from vehicles, which can cause annoyance; and

4) Effect on commute times and access to community, cultural and recreational spaces.

Vehicular accidents are the focus of the traffic assessment in this section, while vehicular exhaust emissions are addressed in Section 5.1.6. Noise from vehicles is addressed in Section 5.1.4 and effect on commute times and access to community, cultural and recreational spaces is discussed in the relevant sections in Section 5.3.

Risk factors associated with road accidents include vehicle type and speed, road type, traffic mix, weather conditions, time of day and personal risk factors such as alcohol or substance use. While road accidents associated with BBTCA operations currently are not available, data from the City have been provided for context. From January 1 to September 30, 2012, there were 11,086 injuries and 32 fatalities reported as a result of traffic collisions in Toronto (City of Toronto, 2013). Among the injuries, 48% were drivers, 27% were passengers, 13% were pedestrians, 9% were cyclists and 3% were motorcycle or moped drivers. Among the fatalities, 56% were pedestrians, 19% were drivers, 13% were motorcycle drivers, 9% were passengers and 3% were cyclists (City of Toronto, 2013). Seniors (65+) accounted for 10% of the injuries and 31% of the fatalities, and children (ages 14 years and under) accounted for 5% of injuries and none of the fatalities (City of Toronto, 2013).

5.1.4.2 Assessment for BBTCA

Concerns about traffic were raised throughout the public consultation process, and it was clear that there are a number of issues with the existing traffic situation surrounding the BBTCA. Relevant to pedestrian safety, stakeholders identified concerns for the intersection of Bathurst Street and Queen's Quay West, as well as Eireann Quay and Queen's Quay West. Concern was raised particularly for children attending the Waterfront School, and seniors, the disabled, and those with mobility issues that may reside in the area and utilize these intersections. A Transportation Assessment was carried out by the BA Group to assess the impact of permitting jets at the BBTCA, and also to evaluate a variety of transportation improvements that may mitigate existing and future transportation concerns (BA Group, 2013). The Transportation Assessment (BA Group, 2013) concluded the following:

- The Proposal would increase traffic volumes on Eireann Quay by approximately 20% compared to the growth baseline volume;
- The impact of the Proposal could be reduced if the private auto and taxi mode split could be reduced from approximately 65% of passengers to approximately 55% by increasing the use of shuttle buses and/or transit; and
- The impact of the Proposal (compared to the growth baseline) could likely be completely mitigated if an even higher mode shift change were achieved, specifically if the private auto/taxi mode split was reduced to 50% overall.

While the Transportation Assessment (BA Group, 2013) provided projections of the traffic volumes associated with the Proposal, the study did not assess the increase in traffic volumes resulting from projected population growth. The study also did not assess the potential increase in traffic accidents as a result of the traffic volumes associated with the Proposal, or the increase in traffic volumes resulting from projected population growth over the long-term. Table 14 provides some of the risk reduction measures that were proposed by the BA Group for

immediate implementation; the reader is referred to the BA Group report for a full discussion of the recommended short-term and long-term transportation improvements.

Dillon Consulting Limited (Dillon, 2013) compared travel patterns to the BBTCA and Pearson Airport and found that travel to the BBTCA results in fewer vehicle kilometres travelled in the Greater Toronto Area (estimated at 18 to 19 million fewer kilometers annually) because of the shorter distances travelled and the availability of non-auto travel modes. It is noted that the Union Pearson Express (UP Express) is an airport rail link service currently under construction between Canada's two busiest transportation hubs: Union Station in Downtown Toronto and Toronto Pearson International Airport. The project is estimated to be completed in time for the 2015 Pan American Games.

While it was not possible to quantitatively estimate the change in traffic accident risk, it is assessed qualitatively in Table 14 below.

Table 14: Assessment of Proposal Impacts on Traffic

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures[4]
Traffic	Risk of injury or fatality resulting from vehicular accidents	■ The Proposal would result in an increase in the number of hourly passengers ■ If the airport maintains its current mode split, approving jets would result in an estimated 20% increase in the hourly traffic volumes on Eireann Quay (BA Group, 2013) ■ An increase in traffic volume means an increased risk of vehicular accidents potentially causing injury or fatality; pedestrians, especially children, those with disabilities, and seniors are considered particularly vulnerable	Negative	Bathurst Quay neighbourhood	■ Maintain taxi/shuttle facility on Canada malting lands until an off-street replacement can be found ■ Re-stripe Eireann Quay and reconfigure existing finger lot traffic lanes ■ Modify signal timing at Eireann Quay and Queen's Quay to include a pedestrian advance phase ■ Improve crosswalks at Queen's Quay / Bathurst ■ Provide a raised crosswalk on the south intersection approach at Queen's Quay and Bathurst (or speed humps on Eireann Quay) ■ Reconfigure existing short term and long term parking spaces on Canada Malting lands into short-term only with a 10 minute free grace period

4 The risk reduction measures were taken from the Transportation Assessment for BBTCA (BA Group, 2013).

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures[4]
Traffic (cont)		■ The Proposal will likely not result in any significant impact to intersection operations in the broader study area (i.e., beyond the immediate study network of Lake Shore, Queens Quay, Dan Lackie and Stadium Road) (BA Group, 2013) ■ Displacement of flight activity from Pearson to BBTCA will likely reduce some of the total vehicle kilometres travelled in the GTA			■ Improve connection to transit by constructing a weather protection canopy connecting the BBTCA Mainland terminal to the TTC at Queen's Quay / Bathurst ■ Set baseline target for mode shift changes that BBTCA must attain in order to minimize increase in car traffic volumes associated with the jets

5.1.5 Noise

5.1.5.1 Connection to Health

Sources of noise at airports include engine noise from aircraft in the air or on the ground (including engine testing and reverse thrust during breaking), ground traffic at the airport, in addition to road, rail and industrial noise that may occur in the vicinity of an airport.

The following explanations are provided to help in understanding how noise levels can affect health. Sound pressure is a basic measure of the vibrations of air that make up sound and is generally reported on a logarithmic scale in decibels (dB). Frequency refers to the number of vibrations per second of the air in which the sound is propagating and is measured in hertz (Hz). The human ear is not equally sensitive to sounds of different frequencies and therefore, a spectral sensitivity factor is used that rates sound pressure levels at different frequencies in a way comparable to that of the human ear; this is called A-weighting. An A-weighted sound pressure level is expressed as dB(A). Sound levels fluctuate with time, and are measured as an equivalent sound level ($L_{Aeq,T}$) over a period of time, *T*. Common exposure periods *T* are 16 hours (day) and 8 hours (night).

There is a growing body of evidence that noise at certain levels could result in health effects including increased annoyance, hearing impairment, learning performance in children, sleep disturbance and cardiovascular disease.

The feeling of annoyance undermines quality of life if prolonged exposure to noise occurs. In order to evaluate annoyance, Health Canada recommends that health impact endpoints be evaluated on the change in the

percentage of the population (at a specific receptor location) who become highly annoyed (%HA) (Health Canada, 2010 and Michaud *et al*., 2008). Health Canada suggests that mitigation be proposed if the predicted change in %HA at a specific receptor is greater than 6.5% (Health Canada, 2010). Relationships between annoyance and noise have been developed on a population level for transport noise including air, rail and road, together with several effect-modifying factors (Passchier-Vermeer and Passchier, 2000). The relationships pertain to populations chronically exposed to noise at specified levels for periods of more than a year. Annoyance in populations has been evaluated using questionnaires, whereby residents evaluate their degree of annoyance related to transport noise. The effect is given as the percentage of the population highly annoyed by a specific environmental noise; those considered highly annoyed responded to the question about degree of annoyance in the worst 25% of the answer categories. It has been found that aircraft noise is significantly more annoying than road traffic noise (Miedema and Vos, 1998). Evidence has shown that annoyance to transportation sound sources differs with the mode of transportation. It is usually found that for the same equivalent continuous sound pressure level (i.e., L_{eq}), aircraft noise is more annoying than road traffic noise, especially at moderate to high levels. In determining annoyance metrics such as percent highly annoyed, there is a penalty applied to aircraft noise. As identified in ISO 1996-1 (ISO, 2003) a 3 dB – 6 dB penalty should be applied to noise emissions associated with aircraft activity. This HIA applied a 6 dB penalty associated with aircraft activity.

Hearing impairment is an increase in the threshold of hearing, which may be accompanied by tinnitus (ringing in the ears) (WHO, 1999b). The extent of hearing impairment in populations depends on the noise level, the number of noise-exposed years, and on individual susceptibility. Health endpoints related to noise (i.e., learning performance in children, sleep disturbance and cardiovascular disease) that occur at lower levels were assessed in this HIA. This maintains a conservative approach as this would protect against hearing impairment which typically occurs at higher noise levels than are typically experienced in the environment; therefore, hearing impairment was not evaluated in this assessment.

Studies have demonstrated that children with chronic aircraft, road traffic or rail noise exposure at school have poorer reading ability, memory and academic performance on nationally standardised tests than children who are exposed to less noise at school (Clark *et al*., 2013). In a study of children living close to London Heathrow airport and matched control groups living further away, chronic aircraft noise exposure was associated with higher levels of noise annoyance and poorer reading comprehension, with adjustments for age, deprivation and main language spoken (Haines *et al.,* 2001). The European Union funded the RANCH project (Road traffic noise and Aircraft Noise exposure and children's Cognition and Health) which examined the cross-sectional associations of aircraft noise and road traffic noise exposure at primary school on the cognitive performance and health of 2,844 children, ages nine to ten years old, around Heathrow (London), Schiphol (Amsterdam) and Barajas (Madrid) airports. Noise levels were estimated as $L_{Aeq,16\ hour}$ values (7 am – 11 pm) with a combination of monitored and modelled data, and ranged from 30 to 77 dBA for aircraft noise and 32 to 71 dBA for road traffic noise (Clark *et al*., 2006). The study found exposure-effect associations between aircraft noise exposure at school and children's reading comprehension, recognition memory, noise annoyance and hyperactivity scores, after adjusting for a range of socioeconomic factors (Clark *et al*., 2006; van Kempen *et al.*, 2009; Stansfeld *et al*., 2005; Stansfeld *et al*., 2009). A six-year follow-up assessment of the children involved in the Heathrow study found that aircraft noise in primary school was associated with a significant increase in noise annoyance and with a non-significant decrease in reading comprehension (Clark *et al*., 2013). Following the

closure of an airport in Munich, there was an improvement in long-term memory and reading in children living nearby; however, for children living near the new airport, declines in long-term memory and reading were identified (Hygge *et al*., 2013).

Epidemiological studies provide sufficient evidence for a causal relationship between exposure to night-time noise and changes in sleep pattern, sleep stages, awakenings, subjective sleep quality, heart rate and mood the next day (Passchier-Vermeer and Passchier, 2000). A recent study carried out for areas near Heathrow airport in London found that mortality and hospital admissions for stroke, coronary heart disease and cardiovascular disease showed statistically significant linear trends of increasing risk with higher levels of both daytime and night time aircraft noise (Hansell *et al*., 2013). In a study of 89 airports in the United States, there was a statistically significant association between exposure to aircraft noise and risk of hospitalization for cardiovascular diseases among older people (≥65 years) residing near airports (Correia *et al*., 2013). In residential neighbourhoods near Sydney Airport, residents who have been chronically exposed to high aircraft noise levels are more likely to report stress and hypertension compared to those not exposed to aircraft noise (Black *et al*., 2007).

Based on the epidemiological evidence, researchers (in review articles) have identified threshold levels and regulatory agencies have developed guidelines for different health effects of noise. Thresholds and guidelines that are relevant to the noise predictions being carried out for the BBTCA (outdoor values, environmental setting, not occupational) are provided in Table 15 below.

Table 15: Health Effect Thresholds and Guidelines for Noise

Health Effect	Threshold / Guideline	Reference
Children's Learning Performance		
Performance at school	70 $L_{Aeq,16hr}$ ("school hours")	Health Council of the Netherlands, 1999
Annoyance		
Moderate annoyance, outdoor living area	50 $L_{Aeq,16hr}$	WHO, 1999b
Serious annoyance, outdoor living area	55 $L_{Aeq,16hr}$	WHO, 1999b
Annoyance, school playground	55 L_{Aeq} ("during play")	WHO, 1999b
Annoyance, difference between baseline and project	>6.5% difference in %HA	Health Canada, 2010
Sleep Disturbance		
Sleep pattern	< 60 $L_{Aeq,8hr}$ (23-07 hr)	Passchier-Vermeer and Passchier, 2000
Subjective sleep quality	40 $L_{Aeq,8hr}$ (23-07 hr)	Health Council of the Netherlands, 1999
Mood next day	< 60 $L_{Aeq,8hr}$ (23-07 hr)	Health Council of the Netherlands, 1999
Increased average movement when sleeping	42 $L_{Aeq,8hr}$ (23-07 hr)	WHO, 2009
Self-reported sleep disturbance	42 $L_{Aeq,8hr}$ (23-07 hr)	WHO, 2009
Use of sleep-aid drugs and sedatives	40 $L_{Aeq,8hr}$ (23-07 hr)	WHO, 2009

Health Effect	Threshold / Guideline	Reference
Environmental insomnia	42 $L_{Aeq,8hr}$ (23-07 hr)	WHO, 2009
Sleep disturbance, outside bedrooms	45 $L_{Aeq,8hr}$ (23-07 hr)	WHO, 1999b
Sleep disturbance, night noise guideline	40 $L_{Aeq,8hr}$ (23-07 hr)	WHO, 2009
Sleep disturbance, interim target	55 $L_{Aeq,8hr}$ (23-07 hr)	WHO, 2009
Cardiovascular Disease		
Hypertension	70 $L_{Aeq,16hr}$ (06-22 hr)	Health Council of the Netherlands, 1999
Ischemic heart disease	70 $L_{Aeq,16hr}$ (06-22 hr)	Health Council of the Netherlands, 1999

5.1.5.2 Assessment for BBTCA

The noise modelling associated with the Proposal is described in Appendix C. The noise assessment was carried out to evaluate the following scenarios:

1) Background conditions only, without BBTCA operations (i.e., road and rail noise sources only);

2) Existing operations plus background (i.e., operations including Q400); and

3) Proposed future scenario including background (i.e., operations including both Q400 and CS100).

Background noise levels were simulated using road and rail traffic volume information obtained from the City. Noise levels were also measured at four locations within the study area. The background scenario has not included noise emissions associated with BBTCA operations or any other potential localized noise sources such as industrial facilities and construction activities.

The existing operation was based on the operation of the Bombardier Dash8-Q400 (Q400) turboprop aircraft only with a maximum annual passenger capacity of 3.8 million, which corresponds with 202 commercial movements per day. The proposed future scenario assumed the use of commercial jets operating at BBTCA such as the Bombardier CS100 (CS100). However, as the noise emissions data associated with the Bombardier CS100 have not yet been formally established, the use of the Boeing 737-700 has been considered in the analysis as a surrogate to the CS100. To account for some of the potential uncertainty with the noise emissions data, the Boeing 737-700 noise data was modified to the maximum levels allowable by the Tripartite Agreement, since it is understood the CS100 will be required to meet these levels if the Proposal is approved.

In the future scenario, it was assumed that 25% of the 202 total movements will be jet aircrafts and 75% of the movements will be Q400 aircraft which would result in an annual capacity of 4.3 million passengers.

In preparing this noise assessment, Golder has not attempted to establish the Noise Exposure Forecast (NEF) contours for the existing operation or proposed future BBTCA scenario. The focus of this assessment was to provide support to the HIA and therefore, only noise indicators that were considered suitable for providing useful information to the HIA were evaluated.

To assess the health impacts of noise, metrics with available health-based thresholds/guidelines were predicted, specifically $L_{Aeq,16hr}$ (07:00 – 23:00) ("L_{day}"), %HA and $L_{Aeq,8hr}$ (23:00 – 07:00) ("L_{night}").

The study area for noise included Wards 19, 20, 27, 28, 30 and 32 (Figure 3). A grid resolution of 50 m x 50 m was used throughout the study area with predictions generated at 2 m, 15 m and 70 m elevations to account for potential differences in noise exposure at different elevations. In addition to noise predictions across the grid in the study area, noise predictions were provided for the following discrete locations that have been specifically identified either by TPH or the public as locations of interest (Figure 7):

- Stadium Road;
- Toronto Music Garden;
- Harbour Square;
- Ward's Island;
- Harbour Side Co-op Homes;
- Windward Co-op Homes;
- Little Norway Park;
- The Waterfront School / City School; and
- The Island Public School.

The noise predictions for the study grid and the relevant discrete locations are evaluated with reference to the identified health endpoints of children's learning performance, annoyance, sleep disturbance and cardiovascular disease.

LEGEND

- Receptor Location
- Billy Bishop Toronto City Airport

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

250 125 0 250 500 750
SCALE 1:15,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Receptor Locations for Noise

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008		
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

FIGURE: 7

G:\CLIENTS\CITY_OF_TORONTO\BBTCA\99_PROJ\13-1151-0215\05_PRODUCTION\HIA\Update\131151021 5HIA003.mxd

Children's Learning Performance

Studies have demonstrated the effects of noise on children's learning. The schools that are closest to the BBTCA are the Waterfront School (junior kindergarten to grade eight), City School (grade eleven / twelve alternative school) and the Island Public / Natural Science Junior Public School (junior kindergarten to grade six) (Urban Strategies Inc., 2013). The Waterfront School and City School are neighbours and thus, one receptor point to represent the noise at both schools was used in the noise modelling. The WHO (1999) provides a guideline value of 55 dBA (L_{day}) for annoyance on a school playground. The RANCH study indicated that an increase in aircraft noise of 5 dBA (L_{day}) was associated with a two month delay in reading age in the UK and an one month delay in reading age in the Netherlands (Clark *et al*., 2006). The modelled noise values for L_{day} for the background, existing and future scenarios are provided in Table 16.

Table 16: Predicted Noise Levels at Schools Near the BBTCA

Location	Background Scenario (without BBTCA) L_{day} (dBA)	Existing Scenario (with BBTCA) L_{day} (dBA)	Future Scenario L_{day} (dBA)
The Waterfront School / City School	**60**	**62**	**61**
The Island Public School	39	51	48

Values in bold are above the WHO guideline of 55 dBA for school playgrounds.
All predicted levels are at a 2 m elevation.

Based on the noise modelling, the Waterfront School / City School have noise levels above the WHO guideline for school playgrounds for all scenarios, and the Island Public School has noise levels below the WHO guideline for all scenarios. The existing BBTCA operations result in an increase of 2 dBA (L_{day}) at the Waterfront School / City School and 11.7 dBA (L_{day}) at the Island Public School, compared to the background conditions. Although there are expected differences in the environmental conditions and demographics of the children in Toronto, the results of the European RANCH study (Clark *et al*., 2006) suggest that the increase exposure to aircraft noise at the Island Public School could be linearly associated with a decrease in reading comprehension. The Proposal was predicted to reduce the L_{day} by 1 dBA at the Waterfront School / City School and by 3 dBA at the Island Public School, compared to existing conditions.

Annoyance

The relevant guidelines for annoyance are 50 dBA (L_{day}) for moderate annoyance (WHO, 1999b), 55 dBA (L_{day}) for serious annoyance (L_{day}) and a difference of greater than 6.5% in %HA (Health Canada *et al*., 2010). In Appendix C, figures are provided which show the predicted L_{day} values across the study area for background, existing and future scenarios. Figures are also provided in Appendix C that shows the %HA for comparison between background, existing and future scenarios. Table 17 shows the predicted L_{day} values at the selected receptor locations at 2 m, 15 m and 70 m. Schools are excluded from this table as they have been evaluated above. Noise levels at higher heights are relevant because of the number of condos in the area and the potential for annoyance to be experienced at these heights, particularly while on balconies or rooftop patios.

Table 17: Predicted Noise Levels for the Evaluation of Annoyance

Location	Background Scenario (without BBTCA) L_{day} (dBA)	Existing Scenario (with BBTCA) L_{day} (dBA)	Future Scenario L_{day} (dBA)
2 m Elevation			
Stadium Road	55	**61**	**61**
Toronto Music Garden	**64**	**65**	**65**
Harbour Square	**58**	**59**	**59**
Ward's Island	47	51	51
Harbour Side Co-op Homes	**61**	**62**	**62**
Windward Co-op Homes	**56**	**62**	**61**
Little Norway Park	**57**	**62**	**61**
15 m Elevation			
Stadium Road	**57**	**64**	**63**
Toronto Music Garden	**67**	**67**	**67**
Harbour Square	**60**	**61**	**60**
Ward's Island	48	52	52
Harbour Side Co-op Homes	**58**	**63**	**63**
Windward Co-op Homes	**60**	**62**	**61**
Little Norway Park	**60**	**64**	**63**
70 m Elevation			
Stadium Road	**62**	**65**	**65**
Toronto Music Garden	**72**	**72**	**72**
Harbour Square	**65**	**65**	**65**
Ward's Island	48	51	51
Harbour Side Co-op Homes	**69**	**69**	**69**
Windward Co-op Homes	**64**	**66**	**66**
Little Norway Park	**66**	**67**	**67**

Values in bold are above the WHO guideline of 55 dBA for serious annoyance.

For the background scenario, all of the locations have predicted noise levels above the WHO guideline for serious annoyance (55 dBA) for all elevations which indicates that the study area is an already "noisy" environment even without BBTCA contribution. Predicted L_{day} values at Ward's Island at 2 m, 15 m and 70 m elevation were below the WHO guideline of 55 dBA for serious annoyance.

The increase in predicted L_{day} values from background to existing scenarios due to BBTCA at these locations was:

- 1 dBA – 7 dBA at 2 m;
- <1 dBA – 7 dBA at 15 m; and
- <1 dBA – 3 dBA at 70 m.

Therefore, including BBTCA operations under the existing scenario only worsens an already noisy environment for Toronto Music Garden, Harbour Square, Harbour Side Co-op Homes, Windward Co-op Homes and Little Norway Park, The largest difference in predicted L_{day} values (i.e., ≥5 dBA) from background to existing scenarios occurred at Stadium Road, Windward Co-Op Homes and Little Norway Park.

Also, predicted L_{day} values for both the background (without BBTCA) and existing scenarios (with BBTCA) increases approximately 1 to 7 dBA for most receptor locations with elevation which indicates a potentially higher health impact for people who live in multi-storey condominium buildings.

Between existing and future scenarios at these locations, the predicted L_{day} values at 2 m, 15 m and 70 m either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

Table 18 shows the predicted %HA values at the selected receptor locations at 2 m, 15 m and 70 m for the change between background and existing and future conditions. Health Canada (2010) suggests that mitigation measures be proposed when a predicted change in %HA is greater than 6.5%. For the change between background and existing conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at:

- Stadium Road (2 m, 15 m, 70 m);
- Windward Co-op Homes (2 m, 70 m);
- Little Norway Park (2 m, 15 m); and
- Harbour Side Co-op Homes (15 m).

For the change between background and future conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at:

- Stadium Road (2 m, 15 m, 70 m);
- Windward Co-op Homes (2 m);
- Little Norway Park (2 m, 15 m); and
- Harbour Side Co-op Homes (15).

Overall, the change in %HA is less between the background and future scenarios than between the background and existing scenarios. This means that the proposed use of jets would result in a lower percentage of the population that would be considered highly annoyed in comparison to existing conditions. The average change in %HA from background to existing at these locations across all elevations is 5.6%, while the average change from background to future is 4.8%. This indicates that the Proposal would result in lower percentage of population that would be considered highly annoyed compared to the existing scenario.

Table 18: Change in Predicted Percent Highly Annoyed Values

Location	Change in %HA from Background to Existing	Change in %HA from Background to Future
2 m Elevation		
Stadium Road	**11.7**	**10.2**
Toronto Music Garden	4.3	3.2
Harbour Square	3.0	2.1
Ward's Island	2.3	2.3

Location	Change in %HA from Background to Existing	Change in %HA from Background to Future
Harbour Side Co-op Homes	4.6	3.7
Windward Co-op Homes	**13.2**	**10.2**
Little Norway Park	**10.7**	**8.9**
15 m Elevation		
Stadium Road	**14.1**	**11.4**
Toronto Music Garden	2.6	1.8
Harbour Square	2.5	1.7
Ward's Island	2.9	2.6
Harbour Side Co-op Homes	**11.9**	**9.6**
Windward Co-op Homes	5.7	4.2
Little Norway Park	**9.1**	**7.1**
70 m Elevation		
Stadium Road	**12.3**	**10.1**
Toronto Music Garden	1.5	1.1
Harbour Square	1.2	0.80
Ward's Island	2.3	2.3
Harbour Side Co-op Homes	3.0	2.2
Windward Co-op Homes	**8.1**	6.5
Little Norway Park	5.7	4.4

Values in bold are above the Health Canada guideline of a change of >6.5%.

Sleep Disturbance

The WHO night noise guideline (WHO, 2009) is based on adverse health effects and is 40 dBA (L_{night}). This is an outdoor value, and is based on the assumption of a 21 dB attenuation of noise from outside to inside bedrooms (WHO, 2009). The amount that noise is attenuated from outside to inside is highly dependent on building conditions (windows and insulation) and window-opening behaviour. With a window slightly open noise levels are reduced by 10 – 15 dB (WHO, 2009). With a closed window and insulation, the noise attenuation can range from 24 dB – 45 dB (WHO, 2009). Night noise levels above 40 dBA thus may not cause sleep disturbance if the windows are closed and the building insulation provides sufficient sound reduction. However, 40 dBA is a conservative threshold that is applied to be protective of window-open and poor insulation situations. It is expected that there is a range in the noise attenuation capacity of the condos and buildings within the study area.

In Appendix C, figures are provided which show the L_{night} values across the study area for the background, existing and future scenarios. The predicted L_{night} levels for the background, existing and future scenarios are provided in Table 19. Except for background conditions at Ward's Island, all of the predicted noise levels are above the 40 dBA guideline. The WHO also has an interim target of 55 dBA, for situations where the achievement of 40 dBA is not feasible in the short-term. However, it is expected that above 55 dBA, a large proportion of the population would be sleep-disturbed (WHO, 2009).

Table 19: Predicted Noise Levels for the Evaluation of Sleep Disturbance

Location	Background Scenario (without BBTCA) L_{night} (dBA)	Existing Scenario (with BBTCA) L_{night} (dBA)	Future Scenario L_{night} (dBA)
2 m Elevation			
Stadium Road	46	51	50
Toronto Music Garden	**55**	**56**	**55**
Harbour Square	49	50	49
Ward's Island	39	41	40
Harbour Side Co-op Homes	51	52	52
Windward Co-op Homes	47	52	51
Little Norway Park	48	52	51
15 m Elevation			
Stadium Road	49	53	52
Toronto Music Garden	**58**	**58**	**58**
Harbour Square	51	52	51
Ward's Island	39	41	40
Harbour Side Co-op Homes	50	53	52
Windward Co-op Homes	50	52	51
Little Norway Park	51	54	53
70 m Elevation			
Stadium Road	53	55	55
Toronto Music Garden	**64**	**64**	**64**
Harbour Square	**56**	**56**	**56**
Ward's Island	40	41	40
Harbour Side Co-op Homes	**60**	**61**	**61**
Windward Co-op Homes	**56**	**57**	**57**
Little Norway Park	**58**	**58**	**58**

Values in bold are above the WHO interim target value of 55 dBA.

Except for the Toronto Music Garden, all other receptor locations were below 55 dBA (L_{night}) for all scenarios at 2 m and 15 m elevation. However, at higher elevation of 70 m, predicted L_{night} values are above 55 dBA for all scenarios for Harbour Square, Harbour Side Co-Op Homes, Windward Co-Op Homes and Little Norway Park in addition to the Toronto Music Garden which indicates a potentially higher health impact for people who live in multi-storey condominium buildings. It is noted that the elevated predicted L_{night} values appear to be unrelated to BBTCA.

The change in L_{night} from background to existing scenarios at these locations was:

- 1 dBA – 5 dBA at 2 m;
- 0 dBA – 4 dBA at 15 m; and
- 0 dBA – 2 dBA at 70 m.

Between existing and future scenarios at these locations, the predicted L_{night} values at 2 m, 15 m and 70 m either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

Cardiovascular Disease

The Health Council of the Netherlands (1999) identified an increased risk of hypertension and ischemic heart disease at a threshold of 70 dBA L_{day}. Correia *et al*. (2013) identified that a zip code with a 10 dB higher noise exposure had a 3.5% higher cardiovascular admission rate. The predicted L_{day} values for the background, existing and future scenarios are provided in Table 20. The only location with L_{day} values above 70 dBA was the Toronto Music Garden for all scenarios at 70 m elevation. This is not a residential location, however there are condos located directly north across Queen's Quay West that may experience similar noise levels at 70 m. As discussed above for sleep disturbance, the exposure of condo residents at higher elevations to noise depends on window-opening behaviour and the insulation properties of the building. As discussed previously for annoyance, L_{day} values increase by up to 7 dBA from the background to existing scenario and decrease by up to 1 dBA from existing to future scenario.

Table 20: Predicted Noise Levels for the Evaluation of Cardiovascular Disease

Location	Background Scenario (without BBTCA) L_{day} (dBA)	Existing Scenario (with BBTCA) L_{day} (dBA)	Future Scenario L_{day} (dBA)
2 m Elevation			
Stadium Road	55	61	61
Toronto Music Garden	64	65	65
Harbour Square	58	59	59
Ward's Island	47	51	51
Harbour Side Co-op Homes	61	62	62
Windward Co-op Homes	56	62	61
Little Norway Park	57	62	61
15 m Elevation			
Stadium Road	57	64	63
Toronto Music Garden	67	67	67
Harbour Square	60	61	60
Ward's Island	48	52	52
Harbour Side Co-op Homes	58	63	63
Windward Co-op Homes	60	62	61
Little Norway Park	60	64	63
70 m Elevation			
Stadium Road	62	65	65
Toronto Music Garden	**72**	**72**	**72**
Harbour Square	65	65	65
Ward's Island	48	51	51
Harbour Side Co-op Homes	69	69	69
Windward Co-op Homes	64	66	66
Little Norway Park	66	67	67

Values in bold are above the Health Council of the Netherlands threshold of 70 dBA for hypertension or ischemic heart disease.

5.1.5.2.1 Engine Maintenance Run-Ups

This report has identified specific operations that result in noise effects that require further consideration. Specifically, engine maintenance run-ups, ferry operation and taxiing have been identified by local residents as concerns and predicted levels support this view in the community. Noise modelling was completed separately for engine run-ups which are part of aircraft engine maintenance requirements. Engine run-ups at BBTCA occur

during the airport operating hours and typically generate a high level of noise for a short duration (i.e., less than 5 minutes), however longer run-ups may also occur depending on the type of maintenance test required. Rather than including engine run-ups as part of the normal overall airport operations, this activity was assessed separately to address stakeholders' concerns related to sleep disturbance. Typically, there are approximately sixty run-ups per year for the Q400. The CS100 requires fewer maintenance run-ups and does not require the same duration or power output compared to the Q400.

Table 21 shows the noise levels associated with engine run-ups. It was predicted that the future scenario with jets would result in a decrease in the noise levels associated with run-ups of between 9 and 19 dBA for the selected locations. However, these procedures can result in an abrupt increase in very high sound pressure levels at locations with increased exposure to the run-up area. As a result, such events may lead to sleep disturbance during evening and morning hours.

Table 21: Summary of Engine Run-Ups During Daytime Hours

Location	Engine Run-ups (dBA)	
	Q400	CS100
2 m Elevation		
Stadium Road	82	67
Toronto Music Garden	72	55
Harbour Square	75	62
Ward's Island	67	53
Harbour Side Co-op Homes	64	45
Windward Co-op Homes	77	63
Little Norway Park	76	62
The Waterfront School / City School	75	61
The Island Public School	77	68
15 m Elevation		
Stadium Road	86	72
Toronto Music Garden	74	59
Harbour Square	75	62
Ward's Island	69	54
Harbour Side Co-op Homes	85	71
Windward Co-op Homes	75	61
Little Norway Park	84	70
The Waterfront School / City School	83	69
The Island Public School	77	67
70 m Elevation		
Stadium Road	85	72
Toronto Music Garden	81	66
Harbour Square	73	60
Ward's Island	68	53
Harbour Side Co-op Homes	83	69
Windward Co-op Homes	84	70
Little Norway Park	83	69
The Waterfront School / City School	82	68
The Island Public School	75	66

What should be acknowledged is that noise effects from the CS100 are significantly lower for both engine run-ups and taxiing compared to the Q400. However, during nighttime hours, taxiing with the CS100 can result in slightly higher noise levels compared to Q400. Therefore, moving towards the incorporation of CS100 jets would be preferable compared with current from a noise perspective. With respect to the ferry operation, additional detailed investigations may be warranted to help identify whether or not noise effects in the early morning hours (i.e., after 4 am) when background noise levels are lower, are resulting in noise impacts to the nearby residents.

Table 22 summarizes the assessment findings related to the Proposal impacts on noise and how predicted noise levels may affect the health and well-being of the community. The comprehensive noise assessment indicated that the background noise pollution in the study area is already elevated even without contribution from the BBTCA. The HIA evaluated the following health effects associated with noise exposure: children's learning performance, annoyance, sleep disturbance and cardiovascular disease. The following summarizes the key findings:

- **Children's learning performance** - Predicted noise levels (L_{day}) at the Waterfront School / City School are above the WHO guideline for school playgrounds for background (without BBTCA), existing (with BBTCA) and future scenarios. The existing BBTCA operations result in an increase of 2 dBA (L_{day}) at the Waterfront School / City School and 11.7 dBA (L_{day}) at the Island Public School, compared to the background scenario (without BBTCA). While predicted L_{day} values at the Island Public School are below the WHO guideline for all scenarios, the predicted increase in exposure to aircraft noise suggests a linear decrease in reading comprehension based on the results of the European RANCH study (Clark *et al*., 2006). The Proposal was predicted to reduce the L_{day} by 1 dBA at the Waterfront School / City School and by 3 dBA at the Island Public School, compared to existing conditions.

- **Annoyance** – Predicted L_{day} values at Ward's Island at 2 m, 15 m and 70 m elevation were below the WHO guideline of 55 dBA for serious annoyance. For all other receptor locations, the predicted noise levels are already above the WHO guideline of 55 dBA (L_{day}) for serious annoyance for the background scenario (without BBTCA). Therefore, including BBTCA under the existing scenario only worsens an already noisy environment for the following receptor locations: Little Norway Park, Windward Co-op Homes, Harbour Side Co-op Homes, Harbour Square, Toronto Music Garden. Predicted noise level increases an additional 1 to 7 dBA (L_{day}) depending on the location when contribution from BBTCA is considered.

  Also, predicted noise levels (without BBTCA) increases approximately 1 to 7 dBA (L_{day}) for most receptor locations with elevation (i.e., 2 m, 15 m, and 70 m); which indicates a potentially higher health impact for people who live in multi-storey condominium buildings.

  Between existing and future scenarios at these locations, the predicted L_{day} values at 2 m, 15 m and 70 m either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

  For the change between background and existing conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at: Stadium Road (2 m, 15 m, 70 m); Windward Co-op Homes (2 m, 70 m); Little Norway Park (2 m, 15 m); and Harbour Side Co-op Homes (15 m).

For the change between background and future conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at: Stadium Road (2 m, 15 m, 70 m); Windward Co-op Homes (2 m); Little Norway Park (2 m, 15 m); and Harbour Side Co-op Homes (15).

Overall, the change in %HA is less between the background and future scenarios than between the background and existing scenarios. This means that the proposed use of jets would result in a lower percentage of the population that would be considered highly annoyed in comparison to existing conditions. The average change in %HA from background to existing at these locations across all elevations is 5.6%, while the average change from background to future is 4.8%. This indicates that the Proposal would result in lower percentage of population that would be considered highly annoyed compared to the existing scenario.

- **Sleep Disturbance** – Except for background at Ward's Island, all the predicted L_{night} levels are above the WHO guideline of 40 dBA for sleep disturbance. The WHO has an interim target of 55 dBA (L_{night}) for situations where 40 dBA cannot be achieved in the short run. However, it is expected that above 55 dBA (L_{night}), a higher proportion of the population would be sleep-disturbed (WHO, 2009).

  Except for the Toronto Music Garden, all other receptor locations were below 55 dBA (L_{night}) for all scenarios at 2 m elevation. However, at higher elevation of 70 m, predicted L_{night} values are above 55 dBA for all scenarios for Harbour Square, Harbour Side Co-Op Homes, Windward Co-Op Homes and Little Norway Park in addition to the Toronto Music Garden which indicates a potentially higher health impact for people who live in multi-storey condominium buildings. It is noted that the elevated predicted L_{night} values appear to be unrelated to BBTCA.

  The change in L_{night} from background (without BBTCA) to existing (with BBTCA) ranges from <1 - 5 dBA at 2 m, 0 – 4 dBA at 15 m, and 0 to <1 dBA at 70 m.

  Between existing and future scenarios at these locations, the predicted L_{night} values at 2 m, 15 m and 70 m either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

- **Cardiovascular –** The Health Council of the Netherlands (1999) identified an increased risk of hypertension and ischemic heart disease at a threshold of 70 dBA (L_{day}). The only location with L_{day} values above 70 dBA was the Toronto Music Garden for all scenarios at 70 m elevation. This is not a residential location, however there are condos located directly north across Queen's Quay West that may experience similar noise levels at 70 m. As discussed above for sleep disturbance, the exposure of condo residents at higher elevations to noise depends on window-opening behaviour and the insulation properties of the building. As discussed previously for annoyance, L_{day} values increase by up to 7 dBA from the background to existing scenario and decrease by up to 1 dBA from existing to future scenario.

Table 22: Assessment of Proposal Impacts on Noise

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Risk Reduction Measures
Noise	Change in children's learning performance, annoyance, sleep disturbance and cardiovascular disease related to noise	■ Background noise pollution (without BBTCA) in the study area is already elevated ■ In the absence of BBTCA, noise levels would already exceed health guidelines which have been established to prevent annoyance, sleep disturbance and impaired learning performance in most locations considered, mainly a result of traffic in the area ■ The Proposal was predicted to decrease L_{day} by up to 1 dBA at school locations near BBTCA, indicating potential improvement in conditions for children's learning compared to existing conditions. ■ The change in the percentage of the population highly annoyed (%HA) from background (without BBTCA) to existing (with BBTCA) scenarios is greater than the Health Canada guideline of 6.5% at Stadium Road (2 m, 15 m, 70 m); Windward Co-op Homes (2 m, 70 m); Little Norway Park (2 m, 15 m); and Harbour Side Co-op Homes (15 m). ■ Both the existing conditions and future scenario with jets were predicted to cause an increase in %HA above the Health Canada guideline at several locations, compared to background. However, the future scenario with jets had lower %HAs, indicating a smaller number of individuals would be highly annoyed compared to existing conditions	Positive and Negative	Primarily southern part of Wards 20 and 28	■ Once the formal testing of the CS100 is complete and all the noise data is validated, the noise modelling carried out as part of this assessment should be updated ■ Complaint investigation(s) should be carried out for some residents that have direct exposure to noise from ferry operation. Complete a more detailed investigation to establish whether or not the ferry operation is an issue that may require the implementation of exhaust mufflers or other noise control measures on the ferry ■ Engine run-ups to be limited to daytime hours, if possible after 9 am and no later than 8 pm. Testing should be avoided during weekends ■ If limiting maintenance testing is not possible, consider the use of a Ground Run-up Enclosure (GRE), or completing testing at other facilities where greater separation distance between testing and sensitive locations exists ■ Taxiing routes should be selected to minimize noise exposure ■ Increase minimum shoreline crossing altitude to minimize noise effect

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Risk Reduction Measures
Noise (cont)		■ The Proposal was predicted to cause a small decrease in L_{day} (e.g., 1 dBA) and levels across the study area are generally below the threshold for cardiovascular disease ■ Noise levels from aircraft activities due to the Proposal including take-off, landing and flyovers do not result in meaningful change to the cumulative noise levels including background ■ The Proposal was predicted to cause a decrease in night noise at some locations and a slight increase (e.g., 1 dB) at other locations ■ Noise levels from run-ups and taxiing are predicted to be lower for the Proposal			

5.1.6 Air Quality

5.1.6.1 Connection to Health

Air quality in the vicinity of airports is affected by emissions from aircraft and other airport-related activities such as auxiliary power units and ground support equipment. Aircraft emissions vary with the engine type, engine load, and fuel type. Field studies have demonstrated the influence of aviation activity on concentrations of volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), particulate matter (ultra-fine and fine [$PM_{2.5}$]) and criteria pollutants (e.g., nitrogen oxides [NO_x], sulfur dioxide [SO_2], carbon monoxide [CO]) (Carslaw *et al*., 2006, Levy *et al*., 2012, Hu *et al*., 2009, Hsu *et al*., 2012, Tessaraux, 2004, Westerdahl *et al*., 2008).

The effect of airports on air quality and the health of the surrounding community have been evaluated in studies in the United States and the UK, in addition to the HIAs summarized in Appendix A. Levy *et al*. (2012) modelled the risk of premature mortality based on $PM_{2.5}$ emissions during landing and takeoff from aircraft at 99 airports across the United States. They estimated that the risk of premature mortality from aviation activities would increase by a factor of 6.1 from 2005 to 2025, with a factor of 2.1 attributable to emissions increases, a factor of 1.3 attributable to population factors (population growth and aging) and a factor of 2.3 attributable to changing non-aviation concentrations which enhance secondary $PM_{2.5}$ formation. Lin *et al*. (2008) found increased risks of hospital admissions for respiratory conditions for residents living within 5 miles of the Rochester Airport and LaGuardia Airport, compared to residents living more than 5 miles away, after adjusting for potential demographic confounders. Lin *et al*. (2008) also evaluated data for MacArthur Airport in Long Island and did not observe differences in hospital admission rates with distance, potentially related to the population composition

around MacArthur Airport and/or the cumulative air quality (lower emissions, less traffic, fewer industrial facilities near MacArthur compared to the other airports). In the UK, it has been estimated that 110 premature deaths occur as a result of UK airport emissions (Yim *et al*., 2013). Mitigation measures proposed to reduce health impacts in the UK included de-sulphurising jet fuel, electrifying ground support equipment, avoiding the use of aircraft auxiliary power units and use of single engine taxiing (Yim *et al*., 2013).

In Toronto, studies have been carried out that demonstrate the connection between air quality and health. These studies are not focused on airports in Toronto but the general air quality in the city. Significant, positive associations have been identified for the following health endpoints and chemicals, based on data from Toronto hospitals and air concentrations measured in Toronto:

- Respiratory and cardiac hospital admissions: $PM_{2.5}$, PM_{10}, NOx, SO_2, carbon monoxide, ozone (Burnett *et al*. 1997a, Burnett *et al*. 1999);
- Mortality: $PM_{2.5}$ (Burnett *et al*., 2000), NOx (Chen *et al*., 2013, Jerrett *et al*., 2009);
- Ambulatory physician consultations for asthma for children: $PM_{2.5}$, NO_x, SO_2 (Burra *et al*., 2009);
- Risk of ischemic heart disease: NO_x (Beckerman *et al*., 2012); and
- Hospitalization for congestive heart failure for the elderly: ozone (Burnett *et al*., 1997b).

There are some populations that are particularly susceptible to the effects of air pollution. These include fetuses, children, the elderly, and those with pre-existing breathing and heart problems (TPH, 2007).

5.1.6.2 Assessment for BBTCA

The assessment for health effects associated with changes in air quality from the Proposal has been carried out consistent with methodology prescribed by Toronto Public Health (TPH, 2011a). The following 30 priority air contaminants were evaluated for the Proposal:

1. Acetaldehyde
2. Acrolein
3. Benzene
4. 1,3-Butadiene
5. Cadmium
6. Carbon tetrachloride
7. Chloroform
8. Chloromethane
9. Chromium
10. 1,4-Dichlorobenzene
11. 1,2-Dichloroethane
12. Dichloromethane
13. Ethylene dibromide
14. Formaldehyde
15. Lead
16. Manganese
17. Mercury
18. Nickel compounds
19. Nitrogen Dioxide
20. Benzo(a)pyrene[5]
21. $PM_{2.5}$
22. Tetrachloroethylene
23. Toluene
24. Trichloroethylene
25. Vinyl Chloride
26. Carbon Monoxide
27. PM10
28. Sulphur Dioxide
29. VOC
30. Ozone

An air quality model was utilized to predict ambient air concentrations for Wards 19, 20, 27, 28, 30 and 32 (Figure 5), described in detail in Appendix D.

5 Benzo(a)pyrene was modelled as a marker for the mixture of PAHs (not as PAH-equivalent)

Two different jets were modelled to represent the range of outcomes that could occur if jets were permitted. Details and assumptions for the air quality modelling are provided in Appendix D. The modelling accounts for local and regional activities that influence Toronto's air quality. A number of activities at the BBTCA were accounted for in the air quality model, including aircraft movements, ground support, de-icing, power generation, fuel storage and transportation to/from airport. The air quality modeling completed did not account for deposition into Lake Ontario or land surfaces which maximizes the availability of air contaminants for inhalation. The air modeling used the modal shift in transportation identified in the Traffic Assessment Study (BA Group, 2013) for existing and future flows. Therefore, the health assessment provided herein depends on the successful achievement of the modal shift in transportation for existing and future scenarios.

The air quality modelling was carried out for the same scenarios as described in the noise assessment, namely 202 aircraft movements daily for existing and future scenarios, but 25% of the fleet as jets for the future scenario. In addition, the air quality assessment took into account existing jets (i.e., Boeing 737-700) and the Bombardier CS100 being part of the mix. The air quality model estimated annual average concentrations and 24-hour average concentrations for the priority air contaminants at receptor points across a grid in the study area (Figure 5). The findings of the air quality modelling, including comparison of concentrations to Ontario's ambient air quality criteria (AAQCs) and discussion of the contribution of source categories to the concentrations for each scenario, are provided in Appendix D.

The assessment considered two health outcomes: cancer and non-cancer endpoints, which includes a range of systemic effects in the respiratory system, cardiovascular system, nervous system, organs, etc. The methodology applied is consistent with TPH's approach (2011a) to estimate the risk of developing cancer and non-cancer health outcomes. Also, the HIA estimates the excess risk of premature mortality from selected common air contaminants (CACs). The details of the method are provided in Appendix D.

The predicted incremental lifetime cancer risks associated with the nineteen chemicals identified as carcinogens are summarized in Table 23. These risks represent the average, maximum and minimum incremental lifetime cancer risk across the study area for each of the scenarios that were evaluated. Predicted annual average concentrations were used to represent ambient air concentrations to which the general public is exposed for long-term duration. TPH considers a target risk level of 10^{-6} or "one in a million" to represent a situation without appreciable risk. In Table 23, values that exceed a risk level of 10^{-6} are in bold.

Table 23: Summary of Cancer Risks for the Air Modelling Scenarios

Chemical	Cancer Risk											
	Scenario 1 – Background (no airport)			Scenario 2 – Existing (current airport)			Scenario 3 – Future (Boeing 737-700)			Scenario 4 – Future (Bombardier CS100)		
	minimum	mean	maximum	minimum	Mean	maximum	minimum	mean	maximum	minimum	mean	maximum
Ethylene dibromide	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}	1.2×10^{-9}
chloromethane	2.7×10^{-9}	2.7×10^{-9}	2.8×10^{-9}	2.7×10^{-9}	2.7×10^{-9}	2.8×10^{-9}	2.7×10^{-9}	2.7×10^{-9}	2.8×10^{-9}	2.7×10^{-9}	2.7×10^{-9}	2.8×10^{-9}
Vinyl chloride	6.8×10^{-8}	6.9×10^{-8}	6.9×10^{-8}	6.8×10^{-8}	6.9×10^{-8}	6.9×10^{-8}	6.8×10^{-8}	6.9×10^{-8}	6.9×10^{-8}	6.8×10^{-8}	6.9×10^{-8}	6.9×10^{-8}
Carbon tetrachloride	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}	4.4×10^{-9}
1,2-dichloroethane	4.3×10^{-9}	5.8×10^{-9}	7.1×10^{-9}	4.3×10^{-9}	5.8×10^{-9}	7.1×10^{-9}	4.3×10^{-9}	5.8×10^{-9}	7.1×10^{-9}	4.3×10^{-9}	5.8×10^{-9}	7.1×10^{-9}
Lead	2.2×10^{-8}	2.4×10^{-8}	2.7×10^{-8}	2.2×10^{-8}	2.4×10^{-8}	3.0×10^{-8}	2.2×10^{-8}	2.5×10^{-8}	3.1×10^{-8}	2.2×10^{-8}	2.4×10^{-8}	3.0×10^{-8}
Trichloroethylene	9.4×10^{-8}	1.3×10^{-7}	1.5×10^{-7}	9.4×10^{-8}	1.3×10^{-7}	1.5×10^{-7}	9.4×10^{-8}	1.3×10^{-7}	1.5×10^{-7}	9.4×10^{-8}	1.3×10^{-7}	1.5×10^{-7}
Chloroform	3.4×10^{-8}	4.8×10^{-8}	6.2×10^{-8}	3.4×10^{-8}	4.8×10^{-8}	6.2×10^{-8}	3.4×10^{-8}	4.8×10^{-8}	6.2×10^{-8}	3.4×10^{-8}	4.8×10^{-8}	6.2×10^{-8}
Nickel	4.0×10^{-7}	4.5×10^{-7}	5.5×10^{-7}	4.0×10^{-7}	4.5×10^{-7}	5.5×10^{-7}	4.0×10^{-7}	4.5×10^{-7}	5.5×10^{-7}	4.0×10^{-7}	4.5×10^{-7}	5.5×10^{-7}
Dichloromethane	1.6×10^{-7}	2.6×10^{-7}	3.7×10^{-7}	1.6×10^{-7}	2.6×10^{-7}	3.7×10^{-7}	1.6×10^{-7}	2.6×10^{-7}	3.7×10^{-7}	1.6×10^{-7}	2.6×10^{-7}	3.7×10^{-7}
Cadmium	6.0×10^{-7}	9.2×10^{-7}	**1.7×10^{-6}**	6.2×10^{-7}	9.8×10^{-7}	**2.2×10^{-6}**	6.2×10^{-7}	9.7×10^{-7}	**2.2×10^{-6}**	6.2×10^{-7}	9.7×10^{-7}	**2.2×10^{-6}**
Acetaldehyde	5.2×10^{-7}	6.6×10^{-7}	9.3×10^{-7}	5.2×10^{-7}	6.8×10^{-7}	**1.1×10^{-6}**	5.2×10^{-7}	6.8×10^{-7}	**1.1×10^{-6}**	5.2×10^{-7}	6.8×10^{-7}	**1.1×10^{-6}**
1,4-dichlorobenzene	**1.2×10^{-6}**	**2.1×10^{-6}**	**3.2×10^{-6}**	**1.2×10^{-6}**	**2.1×10^{-6}**	**3.2×10^{-6}**	**1.2×10^{-6}**	**2.1×10^{-6}**	**3.2×10^{-6}**	**1.2×10^{-6}**	**2.1×10^{-6}**	**3.2×10^{-6}**
Formaldehyde	**2.7×10^{-6}**	**3.3×10^{-6}**	**4.4×10^{-6}**	**2.7×10^{-6}**	**3.4×10^{-6}**	**4.7×10^{-6}**	**2.7×10^{-6}**	**3.4×10^{-6}**	**4.7×10^{-6}**	**2.7×10^{-6}**	**3.4×10^{-6}**	**4.7×10^{-6}**
Chromium VI	**4.5×10^{-6}**	**5.2×10^{-6}**	**6.3×10^{-6}**	**4.5×10^{-6}**	**5.4×10^{-6}**	**8.6×10^{-6}**	**4.5×10^{-6}**	**5.4×10^{-6}**	**9.0×10^{-6}**	**4.5×10^{-6}**	**5.4×10^{-6}**	**8.5×10^{-6}**
1,3-butadiene	**3.1×10^{-6}**	**4.5×10^{-6}**	**6.2×10^{-6}**	**3.2×10^{-6}**	**4.6×10^{-6}**	**6.9×10^{-6}**	**3.2×10^{-6}**	**4.6×10^{-6}**	**6.9×10^{-6}**	**3.2×10^{-6}**	**4.6×10^{-6}**	**6.9×10^{-6}**
Tetrachloroethylene	**1.5×10^{-6}**	**2.6×10^{-6}**	**4.5×10^{-6}**	**1.5×10^{-6}**	**2.6×10^{-6}**	**4.5×10^{-6}**	**1.5×10^{-6}**	**2.6×10^{-6}**	**4.5×10^{-6}**	**1.5×10^{-6}**	**2.6×10^{-6}**	**4.5×10^{-6}**
Benzene	**1.8×10^{-5}**	**2.4×10^{-5}**	**4.3×10^{-5}**	**1.8×10^{-5}**	**2.5×10^{-5}**	**4.3×10^{-5}**	**1.8×10^{-5}**	**2.5×10^{-5}**	**4.3×10^{-5}**	**1.8×10^{-5}**	**2.5×10^{-5}**	**4.3×10^{-5}**
Benzo(a)pyrene	**5.9×10^{-4}**	**6.9×10^{-4}**	**8.2×10^{-4}**	**5.9×10^{-4}**	**6.9×10^{-4}**	**8.2×10^{-4}**	**5.9×10^{-4}**	**6.9×10^{-4}**	**8.2×10^{-4}**	**5.9×10^{-4}**	**6.9×10^{-4}**	**8.2×10^{-4}**
Cumulative	**6.2×10^{-4}**	**7.3×10^{-4}**	**8.9×10^{-4}**	**6.3×10^{-4}**	**7.4×10^{-4}**	**9.0×10^{-4}**	**6.3×10^{-4}**	**7.4×10^{-4}**	**9.0×10^{-4}**	**6.3×10^{-4}**	**7.4×10^{-4}**	**9.0×10^{-4}**

Values greater than 10^{-6} are in **bold.** **Chemicals that are emitted at the BBTCA are highlighted in grey.**

The range from minimum to maximum represents the variation in risk that occurs within the entire study area. The minimum values represent the risk at the location in the study area where the lowest yearly average concentration is predicted, and the maximum values indicate the risk at the location of the highest predicted concentration in the study area. Minimum, average and maximum risks for benzene, benzo(a)pyrene, 1,3-butadiene, chromium VI, 1,4-dichlorobenzene, formaldehyde and tetrachloroethylene are greater than one in a million in all Scenarios. Maximum risks for cadmium are greater than one in a million in all Scenarios and maximum risks for acetaldehyde are greater than one in a million for Scenarios 2, 3 and 4. Benzo(a)pyrene contributes approximately 94% and benzene contributes approximately 3% of the average cumulative cancer risk for all Scenarios.

Table 24 shows the change in the maximum cancer risk (across the study area) between the scenarios. Among the 19 carcinogens, ten of them are not emitted at the airport under existing or future scenarios. The current airport contributes to an increase in cancer risk compared to background (no airport) conditions for lead, nickel, cadmium, acetaldehyde, formaldehyde, chromium VI, 1,3-butadiene, benzene and benz(a)pyrene, resulting in an increase in the maximum cumulative cancer risk of 4×10^{-6}. The model results indicate that, compared to the current airport operations, the operation of a Boeing 737-700 would increase the cancer risk for lead, nickel and chromium VI and decrease the cancer risk for five chemicals, resulting in an increase in the maximum cumulative cancer risk of 3×10^{-7}. The operation of the Bombardier CS100, compared to the current airport operations, would lead to an increase in the cancer risk for nickel and a decrease in the cancer risk for seven chemicals, resulting in an overall decrease in the cumulative cancer risk.

The distribution of carcinogenic risk across the study area for each scenario is provided on Figures 8 – 11 for cumulative risks, and Figures 12 – 15 for chromium VI risks. Chromium VI was chosen because it is the chemical that has the greatest increase in cancer risk from background (no airport) to existing (current airport) and also from existing (current airport) to future (Boeing 737-700).

Table 24: Change in Maximum Cancer Risks

Chemical	Change in Maximum Cancer Risk		
	Scenario 1 – Background (no airport) to Scenario 2 –Existing (current airport)	Scenario 2 – Existing (current airport) to Scenario 3 – Future (Boeing 737-700)	Scenario 2 – Existing (current airport) to Scenario 4 – Future (Bombardier CS100)
Ethylene dibromide	⇔	⇔	⇔
chloromethane	⇔	⇔	⇔
Vinyl chloride	⇔	⇔	⇔
Carbon tetrachloride	⇔	⇔	⇔
1,2-dichloroethane	⇔	⇔	⇔
Lead	↑ (3×10^{-9})	↑ (9×10^{-10})	↓
Trichloroethylene	⇔	⇔	⇔
Chloroform	⇔	⇔	⇔
Nickel	↑ (9×10^{-10})	↑ (4×10^{-10})	↑ (8×10^{-11})
Dichloromethane	⇔	⇔	⇔
Cadmium	↑ (5×10^{-7})	↓	↓
Acetaldehyde	↑ (1×10^{-7})	↓	↓
1,4-dichlorobenzene	⇔	⇔	⇔

Chemical	Change in Maximum Cancer Risk		
	Scenario 1 – Background (no airport) to Scenario 2 –Existing (current airport)	Scenario 2 – Existing (current airport) to Scenario 3 – Future (Boeing 737-700)	Scenario 2 – Existing (current airport) to Scenario 4 – Future (Bombardier CS100)
Formaldehyde	↑ (4×10^{-7})	↓	↓
Chromium VI	↑ (2×10^{-6})	↑ (4×10^{-7})	↓
1,3-butadiene	↑ (7×10^{-7})	↓	↓
Tetrachloroethylene	⇔	⇔	⇔
Benzene	↑ (1×10^{-7})	↓	↓
Benzo(a)pyrene	↑ (2×10^{-8})	⇔	⇔
Cumulative	↑ (4×10^{-6})	↑ (3×10^{-7})	↓

⇔ = No change; ↑= increase (by noted risk estimate); ↓ = decrease

627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
BAY STREET
YONGE STREET
UNIVERSITY AVENUE
YORK STREET
CARLTON STREET
JARVIS STREET
PARLIAMENT STREET
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
HARBOUR STREET
GERRARD STREET EAST
DUNDAS STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
LAKE SHORE BOULEVARD EAST
F G GARDINER EXPRESSWAY EAST
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE DIVERSION
EASTERN AVENUE
WARD 18
WARD 14
Lake Ontario

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Cancer Risk

- 0.000875 - 0.0009
- 0.00085 - 0.000875
- 0.000825 - 0.00085
- 0.0008 - 0.000825
- 0.000775 - 0.0008
- 0.00075 - 0.000775
- 0.000725 - 0.00075
- 0.0007 - 0.000725
- 0.000675 - 0.0007
- 0.00065 - 0.000675
- 0.000625 - 0.00065

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250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Cancer Risks
Scenario 1: Background (No Airport)

Golder Associates
Mississauga, Ontario

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FIGURE: 8

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627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
CARLTON STREET
GERRARD STREET EAST
BAY STREET
YONGE STREET
JARVIS STREET
DUNDAS STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
PARLIAMENT STREET
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE
EASTERN AVENUE DIVERSION
RICHMOND STREET WEST
ADELAIDE STREET WEST
UNIVERSITY AVENUE
FRONT STREET WEST
YORK STREET
HARBOUR STREET
F G GARDINER EXPRESSWAY EAST
LAKE SHORE BOULEVARD EAST
Lake Ontario
Lighthouse Pond
Lake Ontario

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Cancer Risk

- 0.000875 - 0.0009
- 0.00085 - 0.000875
- 0.000825 - 0.00085
- 0.0008 - 0.000825
- 0.000775 - 0.0008
- 0.00075 - 0.000775
- 0.000725 - 0.00075
- 0.0007 - 0.000725
- 0.000675 - 0.0007
- 0.00065 - 0.000675
- 0.000625 - 0.00065

REFERENCE

Base Data - MNR LIO, obtained 2009
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250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Cancer Risks
Scenario 2: Existing (Current Airport)

Golder Associates
Mississauga, Ontario

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FIGURE: 9

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627500
630000
632500
4835000
4832500
4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
BAY STREET
YONGE STREET
UNIVERSITY AVENUE
JARVIS STREET
YORK STREET
CARLTON STREET
DUNDAS STREET EAST
GERRARD STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
PARLIAMENT STREET
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE
EASTERN AVENUE DIVERSION
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
HARBOUR STREET
LAKE SHORE BOULEVARD EAST
F G GARDINER EXPRESSWAY EAST
WARD 18
WARD 14
Lake Ontario
Lighthouse Pond

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Cancer Risk

- 0.000875 - 0.0009
- 0.00085 - 0.000875
- 0.000825 - 0.00085
- 0.0008 - 0.000825
- 0.000775 - 0.0008
- 0.00075 - 0.000775
- 0.000725 - 0.00075
- 0.0007 - 0.000725
- 0.000675 - 0.0007
- 0.00065 - 0.000675
- 0.000625 - 0.00065

REFERENCE

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250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Cancer Risks
Scenario 3: Future with Boeing 737-700

Golder Associates
Mississauga, Ontario

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627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
BAY STREET
YONGE STREET
UNIVERSITY AVENUE
YORK STREET
CARLTON STREET
JARVIS STREET
PARLIAMENT STREET
GERRARD STREET EAST
DUNDAS STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE
EASTERN AVENUE DIVERSION
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
HARBOUR STREET
LAKE SHORE BOULEVARD EAST
F G GARDINER EXPRESSWAY EAST
Don River (rivière Don)
WARD 18
WARD 14
Lake Ontario
Lighthouse Pond
N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Cancer Risk

- 0.000875 - 0.0009
- 0.00085 - 0.000875
- 0.000825 - 0.00085
- 0.0008 - 0.000825
- 0.000775 - 0.0008
- 0.00075 - 0.000775
- 0.000725 - 0.00075
- 0.0007 - 0.000725
- 0.000675 - 0.0007
- 0.00065 - 0.000675
- 0.000625 - 0.00065

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250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Cancer Risks
Scenario 4: Future with Bombardier CS100

Golder Associates
Mississauga, Ontario

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FIGURE: 11

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627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
CARLTON STREET
GERRARD STREET EAST
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
DUNDAS STREET EAST
QUEEN STREET EAST
EASTERN AVENUE DIVERSION
EASTERN AVENUE
COLLEGE STREET
OSSINGTON AVENUE
BAY STREET
JARVIS STREET
YONGE STREET
RICHMOND STREET EAST
PARLIAMENT STREET
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
DUFFERIN STREET
DUNDAS STREET WEST
BATHURST STREET
RICHMOND STREET WEST
UNIVERSITY AVENUE
ADELAIDE STREET WEST
QUEEN STREET WEST
LAKE SHORE BOULEVARD EAST
FRONT STREET WEST
YORK STREET
KING STREET WEST
HARBOUR STREET
WARD 18
WARD 14
F.G GARDINER EXPRESSWAY EAST
F.G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
Don River (rivière Don)
Lake Ontario
Lighthouse Pond

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Chromium VI Cancer Risk

- 0.0000085 - 0.000009
- 0.000008 - 0.0000085
- 0.0000075 - 0.000008
- 0.000007 - 0.0000075
- 0.0000065 - 0.000007
- 0.000006 - 0.0000065
- 0.0000055 - 0.000006
- 0.000005 - 0.0000055
- 0.0000045 - 0.000005

REFERENCE

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259 129.5 0 259 518 777 1,036 1,295
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Chromium VI Cancer Risks
Scenario 1: Background (No Airport)

Golder Associates
Mississauga, Ontario

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FIGURE: 12

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BLOOR STREET WEST
HARBORD STREET
CARLTON STREET
GERRARD STREET EAST
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
DUNDAS STREET EAST
QUEEN STREET EAST
EASTERN AVENUE DIVERSION
EASTERN AVENUE
Don River (rivière Don)
OSSINGTON AVENUE
COLLEGE STREET
BAY STREET
YONGE STREET
JARVIS STREET
RICHMOND STREET EAST
PARLIAMENT STREET
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
DUFFERIN STREET
DUNDAS STREET WEST
BATHURST STREET
RICHMOND STREET WEST
UNIVERSITY AVENUE
ADELAIDE STREET WEST
QUEEN STREET WEST
LAKE SHORE BOULEVARD EAST
FRONT STREET WEST
YORK STREET
KING STREET WEST
HARBOUR STREET
WARD 18
WARD 14
F.G GARDINER EXPRESSWAY EAST
F.G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
Lake Ontario
Lighthouse Pond

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Chromium VI Cancer Risk

- 0.0000085 - 0.000009
- 0.000008 - 0.0000085
- 0.0000075 - 0.000008
- 0.000007 - 0.0000075
- 0.0000065 - 0.000007
- 0.000006 - 0.0000065
- 0.0000055 - 0.000006
- 0.000005 - 0.0000055
- 0.0000045 - 0.000005

REFERENCE

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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

259 129.5 0 259 518 777 1,036 1,295
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Chromium VI Cancer Risks
Scenario 2: Existing (Current Airport)

Golder Associates
Mississauga, Ontario

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FIGURE: 13

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627500
630000
632500
4835000
4832500
4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
WARD 18
WARD 14
CARLTON STREET
BAY STREET
YONGE STREET
JARVIS STREET
GERRARD STREET EAST
DUNDAS STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE
EASTERN AVENUE DIVERSION
PARLIAMENT STREET
RICHMOND STREET WEST
ADELAIDE STREET WEST
UNIVERSITY AVENUE
FRONT STREET WEST
YORK STREET
HARBOUR STREET
LAKE SHORE BOULEVARD EAST
F G GARDINER EXPRESSWAY EAST
Lake Ontario
Lighthouse Pond

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Chromium VI Cancer Risk

- 0.0000085 - 0.000009
- 0.000008 - 0.0000085
- 0.0000075 - 0.000008
- 0.000007 - 0.0000075
- 0.0000065 - 0.000007
- 0.000006 - 0.0000065
- 0.0000055 - 0.000006
- 0.000005 - 0.0000055
- 0.0000045 - 0.000005

REFERENCE

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259 129.5 0 259 518 777 1,036 1,295
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Chromium VI Cancer Risks
Scenario 3: Future with Boeing 737-700

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
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627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F.G.GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
BAY STREET
UNIVERSITY AVENUE
YONGE STREET
YORK STREET
HARBOUR STREET
CARLTON STREET
JARVIS STREET
F.G.GARDINER EXPRESSWAY EAST
GERRARD STREET EAST
DUNDAS STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
PARLIAMENT STREET
LAKE SHORE BOULEVARD EAST
DON VALLEY PARKWAY SOUTH
EASTERN AVENUE DIVERSION
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE

WARD 18
WARD 14

Lake Ontario
Lighthouse Pond

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Chromium VI Cancer Risk

- 0.0000085 - 0.000009
- 0.000008 - 0.0000085
- 0.0000075 - 0.000008
- 0.000007 - 0.0000075
- 0.0000065 - 0.000007
- 0.000006 - 0.0000065
- 0.0000055 - 0.000006
- 0.000005 - 0.0000055
- 0.0000045 - 0.000005

REFERENCE

Base Data - MNR LIO, obtained 2009
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259 129.5 0 259 518 777 1,036 1,295
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Chromium VI Cancer Risks
Scenario 4: Future with Bombardier CS100

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008		
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

FIGURE: 15

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The predicted hazard ratios associated with the 22 non-carcinogens are summarized in Table 25. Health Canada uses a hazard ratio of 0.2 as an indicator for potentially high exposure for a single exposure pathway and individual substance. In Table 25, values that exceed a hazard ratio of 0.2 are in bold. For individual chemicals, minimum, average and maximum hazard ratios across the study area were all less than 0.2, except for acrolein, for which the maximum hazard ratios were greater than 0.2 for existing and future scenarios. The chemicals that contribute the greatest amount to the cumulative hazard ratio are nickel, acrolein, formaldehyde, cadmium and manganese which contribute approximately 28%, 18%, 14%, 11% and 9% of the hazard ratio, respectively, for all scenarios.

Table 25: Summary of Non-Cancer Hazard Ratios for the Air Modelling Scenarios

Chemical	Non-Cancer Hazard Ratios											
	Scenario 1 – Background (no airport)			Scenario 2 – Existing (current airport)			Scenario 3 – Future (Boeing 737-700)			Scenario 4 – Future (Bombardier CS100)		
	minimum	mean	maximum	minimum	Mean	maximum	minimum	mean	maximum	minimum	mean	maximum
ethylene dibromide	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}	2.0×10^{-5}
chloromethane	1.9×10^{-5}	2.2×10^{-5}	2.3×10^{-5}	1.9×10^{-5}	2.2×10^{-5}	2.3×10^{-5}	1.9×10^{-5}	2.2×10^{-5}	2.3×10^{-5}	1.9×10^{-5}	2.2×10^{-5}	2.3×10^{-5}
carbon tetrachloride	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}
1,2-dichloroethane	5.1×10^{-7}	6.9×10^{-7}	8.4×10^{-7}	5.1×10^{-7}	6.9×10^{-7}	8.4×10^{-7}	5.1×10^{-7}	6.9×10^{-7}	8.4×10^{-7}	5.1×10^{-7}	6.9×10^{-7}	8.4×10^{-7}
trichloroethylene	7.9×10^{-5}	1.1×10^{-4}	1.3×10^{-4}	7.9×10^{-5}	1.1×10^{-4}	1.3×10^{-4}	7.9×10^{-5}	1.1×10^{-4}	1.3×10^{-4}	7.9×10^{-5}	1.1×10^{-4}	1.3×10^{-4}
chloroform	2.2×10^{-5}	3.0×10^{-5}	3.9×10^{-5}	2.2×10^{-5}	3.0×10^{-5}	3.9×10^{-5}	2.2×10^{-5}	3.0×10^{-5}	3.9×10^{-5}	2.2×10^{-5}	3.0×10^{-5}	3.9×10^{-5}
chromium VI	9.2×10^{-4}	1.1×10^{-3}	1.3×10^{-3}	9.3×10^{-4}	1.1×10^{-3}	1.8×10^{-3}	9.4×10^{-4}	1.1×10^{-3}	1.8×10^{-3}	9.3×10^{-4}	1.1×10^{-3}	1.7×10^{-3}
dichloromethane	4.0×10^{-4}	6.6×10^{-4}	9.2×10^{-4}	4.0×10^{-4}	6.6×10^{-4}	9.2×10^{-4}	4.0×10^{-4}	6.6×10^{-4}	9.2×10^{-4}	4.0×10^{-4}	6.6×10^{-4}	9.2×10^{-4}
mercury	4.4×10^{-3}	5.1×10^{-3}	6.6×10^{-3}	4.4×10^{-3}	5.1×10^{-3}	6.6×10^{-3}	4.4×10^{-3}	5.1×10^{-3}	6.6×10^{-3}	4.4×10^{-3}	5.1×10^{-3}	6.6×10^{-3}
lead	1.4×10^{-3}	1.0×10^{-2}	1.1×10^{-2}	1.4×10^{-3}	1.0×10^{-2}	1.3×10^{-2}	1.4×10^{-3}	1.0×10^{-2}	1.3×10^{-2}	1.4×10^{-3}	1.0×10^{-2}	1.2×10^{-2}
acetaldehyde	1.4×10^{-3}	1.7×10^{-3}	2.5×10^{-3}	1.4×10^{-3}	1.8×10^{-3}	2.8×10^{-3}	1.4×10^{-3}	1.8×10^{-3}	2.8×10^{-3}	1.4×10^{-3}	1.8×10^{-3}	2.8×10^{-3}
manganese	3.9×10^{-2}	4.1×10^{-2}	4.2×10^{-2}	3.9×10^{-2}	4.1×10^{-2}	4.2×10^{-2}	3.9×10^{-2}	4.1×10^{-2}	4.2×10^{-2}	3.9×10^{-2}	4.1×10^{-2}	4.2×10^{-2}
1,3-butadiene	3.1×10^{-3}	4.5×10^{-3}	6.2×10^{-3}	3.2×10^{-3}	4.6×10^{-3}	6.9×10^{-3}	3.2×10^{-3}	4.6×10^{-3}	6.9×10^{-3}	3.2×10^{-3}	4.6×10^{-3}	6.9×10^{-3}
chromium III	5.1×10^{-3}	5.9×10^{-3}	6.9×10^{-3}	5.1×10^{-3}	6.1×10^{-3}	9.3×10^{-3}	5.1×10^{-3}	6.1×10^{-3}	9.1×10^{-3}	5.1×10^{-3}	6.1×10^{-3}	9.2×10^{-3}
1,4-dichlorobenzene	3.2×10^{-3}	5.5×10^{-3}	7.6×10^{-3}	3.2×10^{-3}	5.5×10^{-3}	7.6×10^{-3}	3.2×10^{-3}	5.5×10^{-3}	7.6×10^{-3}	3.2×10^{-3}	5.5×10^{-3}	7.6×10^{-3}
benzene	1.0×10^{-2}	1.4×10^{-2}	2.4×10^{-2}	1.1×10^{-2}	1.4×10^{-2}	2.5×10^{-2}	1.1×10^{-2}	1.4×10^{-2}	2.5×10^{-2}	1.1×10^{-2}	1.4×10^{-2}	2.5×10^{-2}
toluene	1.2×10^{-2}	1.8×10^{-2}	2.3×10^{-2}	1.2×10^{-2}	1.8×10^{-2}	2.3×10^{-2}	1.2×10^{-2}	1.8×10^{-2}	2.3×10^{-2}	1.2×10^{-2}	1.8×10^{-2}	2.3×10^{-2}
nickel	1.1×10^{-1}	1.2×10^{-1}	1.5×10^{-1}	1.1×10^{-1}	1.2×10^{-1}	1.5×10^{-1}	1.1×10^{-1}	1.2×10^{-1}	1.5×10^{-1}	1.1×10^{-1}	1.2×10^{-1}	1.5×10^{-1}
tetrachloroethylene	7.4×10^{-3}	1.3×10^{-2}	2.2×10^{-2}	7.4×10^{-3}	1.3×10^{-2}	2.2×10^{-2}	7.4×10^{-3}	1.3×10^{-2}	2.2×10^{-2}	7.4×10^{-3}	1.3×10^{-2}	2.2×10^{-2}
cadmium	2.9×10^{-2}	4.4×10^{-2}	8.2×10^{-2}	2.9×10^{-2}	4.6×10^{-2}	1.0×10^{-1}	2.9×10^{-2}	4.6×10^{-2}	1.0×10^{-1}	2.9×10^{-2}	4.6×10^{-2}	1.0×10^{-1}
formaldehyde	5.0×10^{-2}	6.1×10^{-2}	8.1×10^{-2}	5.0×10^{-2}	6.2×10^{-2}	8.8×10^{-1}	5.0×10^{-2}	6.2×10^{-2}	8.7×10^{-1}	5.0×10^{-2}	6.2×10^{-2}	8.7×10^{-1}
acrolein	5.9×10^{-2}	7.8×10^{-2}	1.1×10^{-1}	6.1×10^{-2}	8.8×10^{-2}	**2.2×10^{-1}**	6.0×10^{-2}	8.7×10^{-2}	**2.2×10^{-1}**	6.1×10^{-2}	8.8×10^{-2}	**2.2×10^{-1}**
Cumulative	**3.4×10^{-1}**	**4.3×10^{-1}**	**5.8×10^{-1}**	**3.4×10^{-1}**	**4.4×10^{-1}**	**7.3×10^{-1}**	**3.4×10^{-1}**	**4.4×10^{-1}**	**7.2×10^{-1}**	**3.4×10^{-1}**	**4.4×10^{-1}**	**7.2×10^{-1}**

Values greater than 0.2 are in **bold. Chemicals that are emitted at the BBTCA are highlighted in grey.**

Table 26 shows the change in the hazard ratio between the scenarios. Among the 22 non-carcinogens, ten of them are not emitted at the airport under existing or future scenarios. The current airport contributes to an increase in hazard ratios compared to background (no airport) conditions for chromium VI, lead, acetaldehyde, manganese, 1,3-butadiene, chromium III, benzene, toluene, nickel, cadmium, formaldehyde and acrolein, resulting in an increase in the maximum cumulative hazard ratio of 0.15. The model results indicate that, compared to the current airport operations, the operation of a Boeing 737-700 would increase the hazard ratio for chromium VI, lead, chromium III and nickel, and decrease the hazard ratio for seven chemicals, resulting in an overall decrease in the maximum cumulative hazard ratio. The operation of the Bombardier CS100, compared to the current airport operations, would lead to an increase in the hazard ratio for nickel and a decrease in the hazard ratio for nine chemicals, resulting in an overall decrease in the cumulative hazard ratio.

The distribution of non-carcinogenic risk across the study area for each scenario is provided on Figures 16 - 19 for cumulative risks.

Table 26: Change in Maximum Non-Carcinogenic Risk

Chemical	Change in Maximum Hazard Ratio		
	Scenario 1 – Background (no airport) to Scenario 2 –Existing (current airport)	Scenario 2 – Existing (current airport) to Scenario 3 – Future (Boeing 737-700)	Scenario 2 – Existing (current airport) to Scenario 4 – Future (Bombardier CS100)
ethylene dibromide	⇔	⇔	⇔
chloromethane	⇔	⇔	⇔
carbon tetrachloride	⇔	⇔	⇔
1,2-dichloroethane	⇔	⇔	⇔
trichloroethylene	⇔	⇔	⇔
chloroform	⇔	⇔	⇔
chromium VI	↑ (0.0005)	↑ (0.0001)	↓
dichloromethane	⇔	⇔	⇔
mercury	⇔	⇔	⇔
lead	↑ (0.001)	↑ (0.0004)	↓
acetaldehyde	↑ (0.0004)	↓	↓
manganese	↑ (0.00003)	⇔	⇔
1,3-butadiene	↑ (0.0007)	↓	↓
chromium III	↑ (0.002)	↑ (0.0005)	↓
1,4-dichlorobenzene	⇔	⇔	⇔
benzene	↑ (0.00007)	↓	↓
toluene	↑ (0.000001)	⇔	⇔
nickel	↑ (0.0003)	↑ (0.0001)	↑ (0.00002)
tetrachloroethylene	⇔	⇔	⇔
cadmium	↑ (0.02)	↓	↓
formaldehyde	↑ (0.007)	↓	↓
acrolein	↑ (0.11)	↓	↓
Cumulative	↑ (0.15)	↓	↓

⇔ = No change; ↑= increase in Hazard Ratio (by noted value); ↓ = decrease

627500
630000
632500
4835000
4832500
4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F.G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
BAY STREET
YONGE STREET
UNIVERSITY AVENUE
JARVIS STREET
YORK STREET
CARLTON STREET
GERRARD STREET EAST
DUNDAS STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
PARLIAMENT STREET
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE
EASTERN AVENUE DIVERSION
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
HARBOUR STREET
LAKE SHORE BOULEVARD EAST
F.G GARDINER EXPRESSWAY EAST
WARD 18
WARD 14
Lake Ontario
Lighthouse Pond

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Hazard Ratio

- 0.64 - 0.68
- 0.6 - 0.64
- 0.56 - 0.6
- 0.52 - 0.56
- 0.48 - 0.52
- 0.44 - 0.48
- 0.4 - 0.44
- 0.36 - 0.4
- 0.32 - 0.36

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Hazard Ratios
Scenario 1: Background (No Airport)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008		
GIS	JO	18 Nov. 2013		
CHECK	GD	18 Nov. 2013		
REVIEW	TRS	18 Nov. 2013		

FIGURE: 16

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627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F.G.GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
BAY STREET
YONGE STREET
UNIVERSITY AVENUE
JARVIS STREET
YORK STREET
CARLTON STREET
DUNDAS STREET EAST
GERRARD STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
PARLIAMENT STREET
DON VALLEY PARKWAY SOUTH
EASTERN AVENUE DIVERSION
BROADVIEW AVENUE
EASTERN AVENUE
CARLAW AVENUE
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
HARBOUR STREET
LAKE SHORE BOULEVARD EAST
F.G.GARDINER EXPRESSWAY EAST
WARD 18
WARD 14
Lake Ontario
Lighthouse Pond

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Hazard Ratio

- 0.64 - 0.68
- 0.6 - 0.64
- 0.56 - 0.6
- 0.52 - 0.56
- 0.48 - 0.52
- 0.44 - 0.48
- 0.4 - 0.44
- 0.36 - 0.4
- 0.32 - 0.36

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250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Hazard Ratios
Scenario 2: Existing (Current Airport)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008		
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

FIGURE: 17

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627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F.G.GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
BAY STREET
YONGE STREET
UNIVERSITY AVENUE
JARVIS STREET
YORK STREET
CARLTON STREET
DUNDAS STREET EAST
GERRARD STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
PARLIAMENT STREET
DON VALLEY PARKWAY SOUTH
EASTERN AVENUE DIVERSION
BROADVIEW AVENUE
EASTERN AVENUE
CARLAW AVENUE
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
HARBOUR STREET
LAKE SHORE BOULEVARD EAST
F.G.GARDINER EXPRESSWAY EAST
WARD 18
WARD 14
Lake Ontario
Lighthouse Pond

N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Hazard Ratio

- 0.64 - 0.68
- 0.6 - 0.64
- 0.56 - 0.6
- 0.52 - 0.56
- 0.48 - 0.52
- 0.44 - 0.48
- 0.4 - 0.44
- 0.36 - 0.4
- 0.32 - 0.36

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250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Hazard Ratios
Scenario 3: Future with Boeing 737-700

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008	FIGURE: 18	
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

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627500 630000 632500

4835000 4832500 4830000

BLOOR STREET WEST
HARBORD STREET
COLLEGE STREET
DUNDAS STREET WEST
QUEEN STREET WEST
KING STREET WEST
F.G GARDINER EXPRESSWAY WEST
LAKE SHORE BOULEVARD WEST
OSSINGTON AVENUE
DUFFERIN STREET
BATHURST STREET
BAY STREET
YONGE STREET
UNIVERSITY AVENUE
JARVIS STREET
YORK STREET
CARLTON STREET
DUNDAS STREET EAST
GERRARD STREET EAST
QUEEN STREET EAST
RICHMOND STREET EAST
ADELAIDE STREET EAST
KING STREET EAST
FRONT STREET EAST
PARLIAMENT STREET
DON VALLEY PARKWAY SOUTH
BROADVIEW AVENUE
CARLAW AVENUE
EASTERN AVENUE
EASTERN AVENUE DIVERSION
RICHMOND STREET WEST
ADELAIDE STREET WEST
FRONT STREET WEST
HARBOUR STREET
LAKE SHORE BOULEVARD EAST
F.G GARDINER EXPRESSWAY EAST
WARD 18
WARD 14
Lake Ontario
Lighthouse Pond
N

LEGEND

- Major Roads
- Watercourse
- Waterbody
- Billy Bishop Toronto City Airport
- Air Quality Assessment Study Area

Cumulative Hazard Ratio

- 0.64 - 0.68
- 0.6 - 0.64
- 0.56 - 0.6
- 0.52 - 0.56
- 0.48 - 0.52
- 0.44 - 0.48
- 0.4 - 0.44
- 0.36 - 0.4
- 0.32 - 0.36

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250 125 0 250 500 750 1,000 1,250
SCALE 1:25,000 METRES

PROJECT
CITY OF TORONTO
HUMAN HEALTH IMPACT ASSESSMENT
BILLY BISHOP AIRPORT

TITLE
Cumulative Hazard Ratios
Scenario 4: Future with Bombardier CS100

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0215			SCALE AS SHOWN	REV. 0.0
DESIGN	JO	14 Nov. 2008		
GIS	JO	5 Nov. 2013		
CHECK	GD	5 Nov. 2013		
REVIEW	TRS	5 Nov. 2013		

FIGURE: 19

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The predicted increased risk for premature deaths associated with the five criteria air contaminants are shown in Table 27. For background (without BBTCA), the added risk for premature deaths based on maximum conditions associated with the five criteria air contaminants are 0.06, 0.5, 7, 4 and 4 per 100 for carbon monoxide, sulphur dioxide, $PM_{2.5}$, ozone and NO_x, respectively. Table 28 shows the change in increased risk of premature deaths per 100 people based on maximum conditions and between the scenarios. The change in added risk of premature deaths per 100 people is less than 0.005 across all scenarios for carbon monoxide and sulphur dioxide. Between background and current airport scenario, the change in added risk is 0.24 per 100 people for $PM_{2.5}$ and 0.12 per 100 people for NO_x. Between the current airport and future airport scenarios, there are additional minimal changes in risk of premature deaths for $PM_{2.5}$ (i.e., <0.02 increase) and an increase of 0.22 (Boeing 737-700) and 0.18 (Bombardier CS100) for NO_x.

Table 27: Summary of Increased Risk for Premature Deaths for the Air Modelling Scenarios

Chemical	Increased Risk of Premature Deaths (per 100 people)											
	Scenario 1 – Background (no airport)			Scenario 2 – Existing (current airport)			Scenario 3 – Future (Boeing 737-700)			Scenario 4 – Future (Bombardier CS100)		
	minimum	mean	maximum	minimum	mean	maximum	minimum	mean	maximum	minimum	mean	maximum
Carbon monoxide	0.03	0.05	0.06	0.03	0.05	0.06	0.03	0.05	0.06	0.03	0.05	0.06
Sulphur dioxide	0.30	0.33	0.49	0.30	0.33	0.50	0.30	0.33	0.50	0.30	0.33	0.50
PM2.5	3.74	4.71	6.75	3.76	4.77	6.99	3.76	4.78	7.01	3.76	4.77	6.99
Ozone	3.41	3.46	3.60	0.60	3.30	3.43	1.93	3.33	3.43	2.00	3.34	3.44
Nitrogen Oxides	1.93	2.59	4.19	1.94	2.64	4.31	1.95	2.67	4.53	1.95	2.67	4.49
Cumulative	*9.41*	*11.14*	*15.09*	*6.63*	*11.09*	*15.29*	*7.97*	*11.16*	*15.53*	*8.04*	*11.16*	*15.47*

Table 28: Change in Increased Risk for Premature Deaths*

Chemical	Change in Increased Risk of Premature Deaths (per 100 people)*		
	Scenario 1 – Background (no airport) to Scenario 2 –Existing (current airport)	Scenario 2 – Existing (current airport) to Scenario 3 – Future (Boeing 737-700)	Scenario 2 – Existing (current airport) to Scenario 4 – Future (Bombardier CS100)
Carbon monoxide	↑ (0.0007)	↑ (0.0001)	↓
Sulphur dioxide	↑ (0.003)	↑ (0.001)	↑ (0.0009)
$PM_{2.5}$	↑ (0.24)	↑ (0.01)	↓
Ozone	↓	↑ (0.003)	↑ (0.004)
Nitrogen Oxides	↑ (0.12)	↑ (0.22)	↑ (0.18)
Cumulative	↑ (0.21)	↑ (0.24)	↑ (0.18)

⇔ = No change; ↑= increase in Hazard Ratio (by noted value); ↓ = decrease
* Based on maximum conditions

Table 29: Assessment of Proposal Impacts on Air Quality

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Air Quality	Change in cancer risk, non-cancer risk and risk of premature mortality	■ The results of the health assessment are dependent on the successful achievement of the modal shift assumed in the transportation assessment for existing and future scenarios ■ Background air pollution (without BBTCA) in the study area is already elevated ■ Boeing 737-700 increases cancer risk by up to 4 x 10^{-7} primarily a result of chromium VI emissions; whereas, Bombardier CS100 results in a decrease in cancer risk ■ Non-cancer exposures are not expected to pose a health hazard under any scenarios ■ For background (without BBTCA), the added risk for premature deaths based on maximum conditions associated with the five criteria air contaminants are 0.06, 0.5, 7, 4 and 4 per 100 for carbon monoxide, sulphur dioxide, PM2.5, ozone and NOx, respectively. The change in added risk of premature deaths per 100 people is less than 0.005 across all scenarios for carbon monoxide and sulphur dioxide. Between background and current airport scenario, the change in added risk is 0.24 per 100 people for PM2.5 and 0.12 per 100 people for NOx. Between the current airport and future airport scenarios, there are additional minimal changes in risk of premature deaths for PM2.5 (i.e., <0.02 increase) and an increase of 0.22 (Boeing 737-700) and 0.18 (Bombardier CS100) for NOx.	Positive and Negative	Primarily southern part of Wards 20 and 28	■ Use of CS100 in preference to Boeing 737-700, as emissions are less ■ Ferry is a significant source of emissions from the BBTCA operations and should be upgraded

5.2 Economic Factors

5.2.1 Employment

5.2.1.1 Connection to Health

Employment contributes to an improved quality of life and increased sense of personal security of individuals or households. Studies have found significant positive associations between unemployment and many adverse health outcomes, including mortality (Lin *et al*., 1995).

5.2.1.2 Assessment for BBTCA

HLT Advisory (2013) evaluated economic impacts of the proposal to permit jets. It was estimated that the number of jobs created would be between 977 and 1,918 (estimates include direct, indirect and induced effects).

A number of these jobs would be with Bombardier in Montreal and Toronto, as well as Greater Toronto Area (GTA) companies that supply Bombardier with materials, including Honeywell and aluminum production facilities such as Rio Tinto. The economic assessment (HLT Advisory, 2013) did not identify whether the employment opportunities would benefit the City, specifically the residents in the immediate vicinity of BBTCA. In addition, the economic assessment (HLT Advisory, 2013) did not include a cost-benefit analysis that incorporated the costs of negative health and other impacts of the Proposal.

Table 30: Assessment of Proposal Impacts on Employment

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Employment	Number of jobs created	■ HLT Advisory (2013) estimated between 977 and 1,918 jobs created as a result of permitting jets ■ Employment benefits not specific to local residents	Positive and Negative	Primarily Quebec and Ontario	Not assessed

5.2.2 Income

5.2.2.1 Connection to Health

People's lifestyle and quality of life are defined through achievement of personal financial objectives. Income provides a sense of security and contributes to a person's own self-image and status within a community. Income provides the financial means to residents to undertake a variety of educational, social and community activities that strengthen a community's human and social assets. Individuals living with low incomes generally experience higher burdens of illness, decreased life-expectancy and higher rates of mortality than high-income earners (Dorman *et al.*, 2013).

5.2.2.2 Assessment for BBTCA

HLT Advisory (2013) estimated that permitting jets at BBTCA would create an increase in labour income of between $42 million and $83 million (including direct, indirect and induced effects). The increase in income is a result of the creation of new jobs, and is expected to benefit the health particularly of those individuals transitioning from unemployed or under-employed to employed at a higher income level. However, as discussed in the previous section, the economic assessment (HLT Advisory, 2013) did not identify whether the employment opportunities would benefit the GTA. In addition, the economic assessment (HLT Advisory, 2013) did not include a cost-benefit analysis that incorporated the costs of negative health and other impacts of the Proposal.

Table 31: Assessment of Proposal Impacts on Income

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Income	Change in labour income	■ HLT Advisory (2013) estimated between $42 million and $83 million in increased labour income as a result of permitting jets ■ Income benefits not specific to local residents	Positive and Negative	Primarily Quebec and Ontario	Not assessed

5.2.3 Cost of Transportation Infrastructure

5.2.3.1 Connection to Health

Costs for infrastructure improvements are often paid for by the government through tax-payer dollars. Money that is required for such improvements that are not privately funded decreases the amount of tax dollars that are available for government programs such as community services or as tax breaks to low-income or vulnerable populations. Differences in the viability of these programs or availability of tax breaks may affect health.

5.2.3.2 Assessment for BBTCA

The economic analysis by HLT Advisory (2013) did not consider the cost of infrastructure improvements, in particular transit, which would be required to support the expansion of the BBTCA operations and mitigate negative impacts. The economic impacts of the Proposal (HLT Advisory, 2013) identified opportunities for increased revenues resulting from a thriving tourism industry. However, the analysis failed to evaluate the net economic effect to the City in consideration of the cost associated with infrastructure upgrades including transportation services. In addition, the economic assessment (HLT Advisory, 2013) did not include a cost-benefit analysis that incorporated the costs of negative health and other impacts of the Proposal.

Many of the stakeholders identified that the cost of infrastructure upgrades such as public transit and roads should be accounted for in the overall economic analysis of the proposal. Additional costs related to other infrastructure improvements may be impacted by the Proposal; for example, concerns were also raised related to the costs of building upgrades to address noise and air quality impacts. BA Group (2013) provided order of magnitude cost estimates for possible transit improvements to mitigate existing and future transit issues.

Table 32: Assessment of Proposal Impacts on Cost of Transportation Infrastructure

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Transportation Costs	Cost of transit upgrades	■ $65 - $165 million to extend TTC Streetcar Line ■ $30 - $300 million to extend BBTCA Pedestrian Tunnel ■ <$1 million to provide a new TTC bus route ■ $50 - $60 million for Dan Leckie Way Extension ■ $110 - $135 million for BBTCA underpass million in road network improvements ■ Increase cost of transportation upgrades were not considered in the economic assessment prepared by HLT Advisory (2013)	Negative	Ontario (tax base)	Not assessed

5.2.4 Healthcare Costs

5.2.4.1 Connection to Health

Using an 'environmental cost' calculation that considered damage to human health, vegetation, buildings and climate change as a result of noise and aircraft emissions at three British airports and two Dutch airports, Lu and Morrell (2006) estimated environmental costs ranging from €237 to €1779 per aircraft landing (approximately equivalent to $396 to $2,974 Canadian dollars).

In Ontario in 2005, economic damages as a result of air pollution-associated illnesses were estimated at $7.8 billion, including approximately $374 million for lost productivity, $507 million for healthcare costs, $537 million for pain and suffering and $6.4 billion for loss of life (OMA, 2005). In Toronto, the mortality-related economic impact of traffic-related air pollution in 2004 was estimated to be $2.2 billion (TPH, 2007).

5.2.4.2 Assessment for BBTCA

The potential health impacts associated with the Proposal were quantitatively assessed related to noise (see Section 5.1.5) and air quality (see Section 5.1.6). Several health outcomes were assessed including cancer and non-cancer endpoints, namely asthma, cardiovascular disease and mortality, as well as increased risk of premature deaths per capita. The health outcomes from noise associated with the Proposal included learning performance in children, annoyance, sleep disturbance and cardiovascular effects.

The existing environment in the study area is already elevated with respect to noise and air pollution (even without the contribution from BBTCA). The assessment of air quality indicated that non-cancer exposures are not likely to pose a health hazard with the Proposal, and the cancer risks are likely to decrease for Bombardier CS100s but increase for Boeing 737-700s. For background without contribution from BBTCA, the risk of premature deaths is already elevated with added 7, 4 and 4 premature deaths per 100 people estimated for $PM_{2.5}$, ozone and NO_x, respectively. The change in added risk of premature deaths per 100 people is less than

0.005 across all scenarios for carbon monoxide and sulphur dioxide. Between background and existing airport scenario, the change in added risk is 0.24 per 100 people for $PM_{2.5}$ and 0.12 per 100 people for NO_x. Between the current airport and future airport scenarios, there are minimal changes in risk of premature deaths for $PM_{2.5}$ (i.e., <0.02 increase) and an increase of 0.22 (Boeing 737-700) and 0.18 (Bombardier CS100) for NO_x.

The noise assessment indicated that in the absence of BBTCA, noise levels would already exceed health guidelines which have been established to prevent annoyance, sleep disturbance and impaired learning performance in most locations considered, mainly a result of traffic in the area. The change in the percentage of the population highly annoyed (%HA) from background (without BBTCA) to existing (with BBTCA) scenarios is greater than the Health Canada guideline of 6.5% at several locations (see Section 5.1.5). Both the existing conditions and future scenario with jets were predicted to cause an increase in %HA above the Health Canada guideline at several locations, compared to background. However, the future scenario with jets had lower %HAs, indicating a smaller number of individuals would be highly annoyed compared to existing conditions. Some health impacts from noise may improve slightly because the newer jets are expected to be quieter than the turboprops.

While a quantitative assessment of the costs related to these health outcomes was not carried out, Table 33 below provides a qualitative discussion.

Table 33: Assessment of Proposal Impacts on Healthcare Costs

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Healthcare Costs	Direction of change in healthcare costs	■ Increased healthcare costs is anticipated as a result of exposures to elevated levels of noise and air pollution for background scenario even without consideration of BBTCA ■ For background scenario (without BBTCA), the added risk of premature deaths as a result of exposures to $PM_{2.5}$, ozone and NO_x is 7, 4 and 4 per 100 people, respectively ■ The Proposal is not expected to increase healthcare costs related to noise and air impacts as predicted noise and air levels from aircraft activities due to the Proposal including take-off, landing and flyovers do not result in meaningful change to the cumulative noise levels including background ■ Increased healthcare costs is anticipated related to increased risk of vehicular accidents potentially causing injury or fatality; pedestrians, especially children, those with disabilities, and seniors are considered particularly vulnerable	Positive or Negative	Ontario (tax base)	Not assessed

5.2.5 Tourism

5.2.5.1 Connection to Health

Tourism can be an important source of economic resources to a community. Tourism brings visitors to a community for the purposes of business, recreation, entertainment or leisure, and it strongly relies on the character of an area to attract visitors and generate spending. Tourism can provide opportunities for permanent and seasonal employment and a source of income. Tourism can boost business activity and provide a tax base for municipalities. The tourism industry can affect social assets and bring pride to a community.

5.2.5.2 Assessment for BBTCA

During the public consultation, stakeholders expressed concerns that the air quality, noise and traffic surrounding BBTCA would create a negative experience for tourists spending time on the islands and on the waterfront. The HLT Advisory report (2013) estimated that spending of non-resident passengers as a result of jet service would be between $68 million and $134 million. The extent that this represents new spending as opposed to spending that would have occurred had the passengers flown in through Pearson is not known.

The economic assessment associated with the Proposal (HLT Advisory, 2013) identified opportunities for increased revenues resulting from a thriving tourism industry. However, the analysis failed to evaluate the net economic effect on the City in consideration of the cost associated with infrastructure upgrades including transportation, community and healthcare services. The Proposal may increase tourism, but this will in turn increase the demand on existing services including transportation, health care and community services. The economic assessment did not carry out a comprehensive economic analysis to determine the net effect to the City and residents with respect to overall costs of infrastructure maintenance and upgrades. More importantly, the economic assessment (HLT Advisory, 2013) did not include a cost-benefit analysis that incorporated the costs of negative health and other impacts of the Proposal.

Table 34: Assessment of Proposal Impacts on Tourism

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Tourism	Direction of change in tourism spending	■ Some stakeholders feel the tourism experience will be diminished by the air quality, noise and traffic issues related to the BBTCA ■ The HLT Advisory Group (2013) reported significant spending by tourists as a result of jet service, although the extent that this is displaced from Pearson is not known ■ Net economic effect on the City in consideration of the costs associated with infrastructure upgrades including transportation, health care and community services	Positive or Negative	Ontario (tax base)	Not assessed

5.2.6 Property Values

5.2.6.1 Connection to Health

Typically, an individual's residence is their largest personal investment and as such, it is a key determinant of one's financial status. The value of residential property has a substantial effect on a person's spending power and so, it is one of the most important determinants of a person's use and enjoyment of property and their satisfaction with the community. Property values can affect the character and cohesion of a community by affecting physical, financial and social assets.

5.2.6.2 Assessment for BBTCA

Stakeholders have stated that the air quality, noise and traffic situation in the vicinity of BBTCA is causing residents to relocate, and there is concern that the proposed expansion at BBTCA will cause further vacancies, which may reduce property values, and potentially even cause the closure of some co-op buildings. The HLT Advisory (2013) interviewed waterfront real estate developers who were favourable to the existence of the airport and believed that the advantages for the typical condo resident outweighed the negatives. Developers noted that the soundproofing standards required in current high-rise construction in the waterfront area would be sufficient to mitigate aircraft noise. The state of noise proofing for other residential buildings close to BBTCA is not known, but based on the complaints of sleep disturbance by many area residents, the sound proofing may not be sufficient.

The surrounding condominium market has experienced stable demand through the recent period of significant airport growth. Increases in pricing in adjacent condominiums are in keeping with the overall Toronto condominium market (City of Toronto, 2013d).

Table 35: Assessment of Proposal Impacts on Property Value

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Property Value	Direction of change in property value	■ Some stakeholders feel that the Proposal will reduce property values, result in relocations and even cause closure of co-op buildings ■ Condo developers seem to be favourable to the presence of the airport ■ Stable demand in condominium market with unit pricing consistent with overall Toronto condominium market	Positive or Negative	Primarily southern part of Wards 20 and 28	Not assessed

5.3 Social and Cultural Factors

5.3.1 Recreation

5.3.1.1 Connection to Health

The ability to access nearby recreational spaces contributes to the maintenance of an active and healthy lifestyle. The enjoyment of recreational spaces contributes to overall feelings of well-being and contentment.

Parks, gardens and other public green spaces play an important role in the health of Toronto and its residents. These areas provide opportunities for exercise, physical activity and relaxation. There is evidence that contact with nature is associated with health benefits such as lower blood pressure and cholesterol levels, enhanced survival after a heart attack, more rapid recovery from surgery, fewer minor medical complaints, and lower self-reported stress. In children with attention disorders and in teens with behavioural disorders, contact with nature has resulted in significant improvement in attention and behaviour. Living near green space has also been found to benefit mental health (Croucher *et al*., 2008; Maas *et al*., 2006)

Parks also build healthy communities by contributing to stable neighbourhoods and strengthening community development. Research shows that residents of neighbourhoods with greenery in common spaces enjoy stronger social ties (Gies, 2006). Increasingly, parks are also being used for community gardens which provide residents with healthy, affordable food and opportunities for physical activity and socialization. As an ecosystem, green space – particularly trees, but also grass, perennials, shrubs and other vegetation – also provide benefits to health by improving air and water quality and mitigating the health impacts of climate change. Climate change can cause variations in regional weather including heat waves. Heat contributes to an average of 120 premature deaths per year in Toronto and the likelihood of mortality increases on each day of a heat episode (TPH, 2011b). As Toronto experiences hotter days and longer heat episodes, the impact of heat on health is expected to increase. Certain populations, such as the frail, elderly and isolated, are more vulnerable to heat than others.

5.3.1.2 Assessment for BBTCA

Based on the Parks Plan for 2013 to 2017 (City of Toronto, 2013c), Toronto's level of parkland as a percentage of total City area is comparable to other North American cities with high population densities. Figure 20 illustrates that most residents are within 500 m from parkland, or approximately a five-to-ten minute walk, from a park.

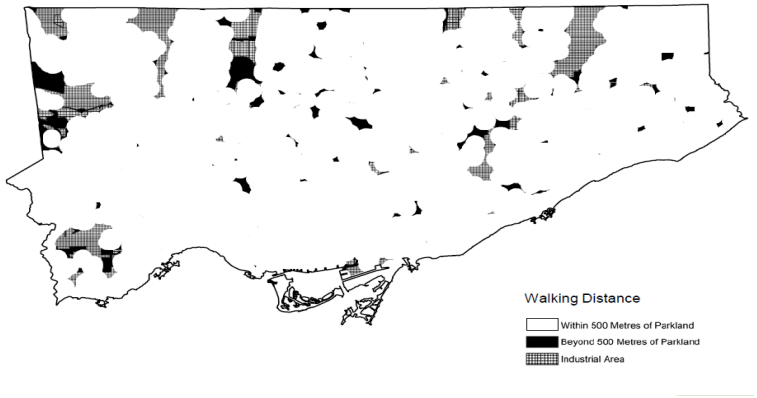

Figure 20: Walking Distance to City Parkland

Toronto is Canada's most populous city, and it is continually growing. In keeping with Toronto's Official Plan, most of the expected population growth in Toronto will be concentrated in the Downtown and Central Waterfront areas, the four city centres, and along the "Avenues" (City of Toronto, 2013c).

Toronto leads North American municipalities in high-rise development with 184 high-rise buildings under construction as of February 2013. New York City (91%) and Mexico City (88%) follow in second and third place,

respectively, and combined have fewer high-rise buildings under construction than Toronto. High-rise construction in Toronto makes up 92% of all residential units approved since 2006 (City of Toronto, 2013c).

The Downtown and Central Waterfront area is the main location for strong residential and office development, with availability of parkland in these areas being low relative to other areas of the City (City of Toronto, 2013c). Limited land availability and high land prices make it challenging to increase public parkland for a rapidly growing population (City of Toronto, 2013c).

Residential development is strong throughout Toronto, which means that more people will use Toronto's entire network of existing parkland. Addressing the challenge of increasing density requires strong and creative parks planning. It also signals a need for an overall rethink of the planning, design and management of green space in high-density areas by the City of Toronto, its development partners and residents in order to ensure that residents in high density areas across the city will continue to have access to parkland that meets their needs.

Parks that are located directly adjacent to the BBTCA on the mainland include Ireland Park, Stadium Road South Park, Little Norway Park and the school yard of the Waterfront School. During the public consultation, residents identified concerns regarding the effects of the airport on noise and air quality and thus the enjoyment of local recreational spaces. Stakeholders felt that the cumulative impact of air, noise and traffic related to the BBTCA serve to degrade the park user experience, in the current situation. There was also concern that parkland may be lost and turned into additional parking or other support systems related to BBTCA.

Table 36: Assessment of Proposal Impacts on Recreation

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Recreation	Access to and enjoyment of recreational space	■ The increase in traffic in the area may increase the time it takes to access recreational space ■ The addition of jets may increase the light pollution in the area which may interfere with the enjoyment of recreational space ■ Any increase in aircraft movements at BBTCA and jets in particular may increase the risk of wildlife strikes	Negative	the City of Toronto as a whole	Not assessed
Indicators	**Measures**	**Findings**	**Direction of Impact on Health**	**Geographic Extent**	**Potential Risk Reduction Measures**

Recreation (cont)		■ The addition of jets may change the odour characteristic of BBTCA, affecting the enjoyment of recreational spaces ■ Many stakeholders feel that the current air quality, noise and traffic degrades the park user experience; without significant improvements this is unlikely to change			

5.3.2 Cultural Activities

5.3.2.1 Connection to Health

Cuypers *et al*. (2012) showed that participation in cultural activities was significantly associated with good health, good satisfaction with life, and low anxiety and depression scores in both genders.

5.3.2.2 Assessment for BBTCA

Cultural sites that are located near the waterfront in Toronto include the National Ballet School, Toronto Music Garden, Fort York, Queen's York Rangers Museum, Power Plant Contemporary Art Gallery, Enwave Theatre, Museum of Inuit Art Gallery, Ontario Place and Canadian National Exhibition. Stakeholders identified that there are numerous cultural sites in the vicinity of the BBTCA such as boating clubs, waterside cafes, entertainment venues and amusement parks. There was concern that the enjoyment of these sites could be negatively affected by the air quality and noise impacts of the BBTCA.

Table 37: Assessment of Proposal Impacts on Cultural Activities

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Cultural Activities	Access to and enjoyment of cultural activities	■ The increase in traffic in the area may increase the time it takes to access cultural activities ■ The impact of the BBTCA on air quality and noise at nearby cultural sites may continue to diminish the enjoyment of cultural activities for some individuals	Negative	the City of Toronto as a whole	Not assessed

5.3.3 Access to Community Services

5.3.3.1 Connection to Health

Access to community services such as hospitals, senior's centres, community centres and community groups allow a community to function by providing a consistent level of service. It serves to attract people and help to influence personal health and satisfaction with a community by providing the ability to access services, community and recreational facilities. As such, access to these services help maintain community well-being.

5.3.3.2 Assessment for BBTCA

As discussed in Section 5.1.4.2, the Transportation Assessment (BA Group, 2013) concluded that the Proposal would increase traffic volumes on Eireann Quay by approximately 20% compared to the growth baseline volume and that the impact of the Proposal could be reduced if more people use local transit. While the Transportation Assessment (BA Group, 2013) provided projections of the traffic volumes associated with the Proposal, the study did not assess the increase in traffic volumes resulting from projected population growth.

The increase in traffic volume associated with the Proposal and the projected population growth of the City will result in longer travel times to access work, school, hospitals and other community services. The traffic congestion on major roadways will affect people's ability to access community services and may result in increased stress and anxiety, resulting in the overall deterioration of community well-being in the long-term.

The traffic assessment (Section 5.1.4) indicated that significant investments in transit and infrastructure are required to mitigate even the existing traffic situation related to the BBTCA operations.

Table 38: Assessment of Proposal Impacts on Community Services

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Community Services	Access to community services	■ The increase in traffic in the area may increase the travel time it takes to access community services	Negative	Waterfront communities	Not assessed

5.3.4 Community Character

5.3.4.1 Connection to Health

Feelings regarding the character of a community may affect one's satisfaction with living in a certain area, which can affect health through feelings of contentment or well-being.

5.3.4.2 Assessment for BBTCA

There were concerns from stakeholders that the noise, air quality and traffic related to the airport are creating an environment that is no longer enjoyable. Residents noted that investments in re-developing the waterfront and encouraging residential growth did not line-up with the presence of an expanding airport operation. Residents wanted their voice to be heard in the decision-making and planning process for their community.

Table 39: Assessment of Proposal Impacts on Community Character

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Community Character	Satisfaction with Neighbourhood	■ Some stakeholders feel that the Proposal would decrease their satisfaction of the neighbourhood due to the perception that the air quality, noise, and traffic related to the BBTCA are already impairing the enjoyment of their homes and community	Negative	Waterfront communities	Not assessed

5.3.5 Community Plan

5.3.5.1 Connection to Health

Local governments influence the future health and prosperity of a city through visioning, development of strategic policy, and urban and social planning. Land-use and transportation planning guides the development of the built and physical environments to improve communities and neighbourhoods for inclusiveness and sustainability (Cities Alliance & UNEP, 2007). Planning includes urban renewal strategies that turn previously neglected and decaying areas into active and vibrant spaces.

Planning that keeps health in mind encourages physical activity and social interactions by ensuring availability of services, shops and facilities, access to programs, and parks and green spaces based on the local needs of people in the community (TPH, 2011c).

Good governance and social inclusion contribute to the creation of healthy and prosperous cities. Good governance is transparent, accountable, effective, efficient, and follows the rule of law (TPH, 2011c). It is participatory and inclusive; it engages the public in the decision-making process to build consensus and foster equity. This results in all residents having a stake in the community and the future of the city.

Like governance, social inclusion is made up of many different aspects. In a city that is inclusive everybody feels they belong. It provides for a strong sense of pride in the city and helps people feel engaged with the community around them. It also means that a city makes the best use of the available human capital. Inclusion is fostered when there is less disparity in income, less discrimination and more participation in society.

5.3.5.2 Assessment for BBTCA

Toronto's official plan (City of Toronto, 2010) states the following:

"*Increased public enjoyment and use of lands along the water's edge will be promoted by ensuring that future development and actions on the part of both the public and private sectors, including Toronto Port Authority, the Toronto Waterfront Revitalization Corporation and the Toronto and Region Conservation Authority, will help achieve the following objectives:*

a) Minimize physical and visual barriers between the City and Lake Ontario;

b) Increase and improve public access to lands along water's edge and between parts of the waterfront

c) Improve water quality and the quality of beaches;

d) Improve the public realm with more parks, public squares and natural settings that please the eye and lift the spirit and support a sense of belonging to the community;

e) Increase the availability, choice and awareness of recreational opportunities and public activities throughout the year; and

f) Protect, improve and where possible extend the Martin Goodman / Waterfront Trail as a continuous waterfront route for cyclists, pedestrians and people with disabilities.

Private development and public works on lands along the water's edge or in its vicinity will:

a) Improve public spaces in the waterfront; and

b) Maintain and increase opportunities for public views of the water, and supports a sense of belonging to the community.

The year-round recreational use of unique regional resources such as Toronto Islands' Park and Rouge Park will be encouraged."

Residents noted that the idea of expanded operations at the BBTCA does not seem to fit with plans for the City. They mentioned the high-level of investment in waterfront redevelopment, and that the air quality and noise impacts of the BBTCA would diminish enjoyment of the waterfront, both recreationally and for residents. Stakeholders also noted the investment in the transit link to Pearson, and the inconsistency of that with the idea of expanding operations at the BBTCA.

Table 40: Assessment of Proposal Impacts on Community Plan

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Community Plan	Satisfaction with Neighbourhood	■ The expansion of the BBTCA does not seem to align with the Toronto Official Plan ■ The investment in the transit link to Pearson airport suggests a plan to increase Pearson utilization and not BBTCA	Negative	City of Toronto	Not assessed

5.3.6 Feeling Safe in the Community

5.3.6.1 Connection to Health

Airport operations and expansions can potentially affect the environment, and subsequently human health through people's exposure to emissions from the proposed airport. In addition to the risk of fire or explosion

resulting from airport operations at the terminal, there is an inherent risk of aircraft crashes that can result in injuries or fatalities of not only the flight personnel and passengers but also of nearby residents who are vulnerable to air crashes. The main risks are the physical destruction caused by an aircraft hitting the ground and the fires that can result. Crashes that occur immediately after take-off have more catastrophic effects because fuel tanks are full. People's feelings of personal safety in the community are an important indicator of individual and community wellbeing.

5.3.6.2 Assessment for BBTCA

Stakeholders raised concerns associated with feeling safe in the community. Potential health impacts identified related to feeling safe in the community included concerns regarding illnesses associated with emissions (i.e., increased incidences of asthma, respiratory disease and cancer) and noise, concerns regarding pedestrian safety and increased injuries due to vehicular accidents. Concerns were especially expressed for children, seniors, and people with disabilities who are crossing the streets, the threats posed by high traffic volume and inadequate crosswalks, as well as the potential for catastrophic events (fuel spills, plane strikes).

Figure 21 presents the number of aircraft incidents (INC) and accidents (ACC) globally by year from 1978 to 2008 (Ayres *et al*., 2013). The number of events reported in the 1970s was relatively low, most likely due to under-reporting and lower volumes of traffic. It is noted that there is a sharp drop from 2005 (Ayres *et al*., 2013).

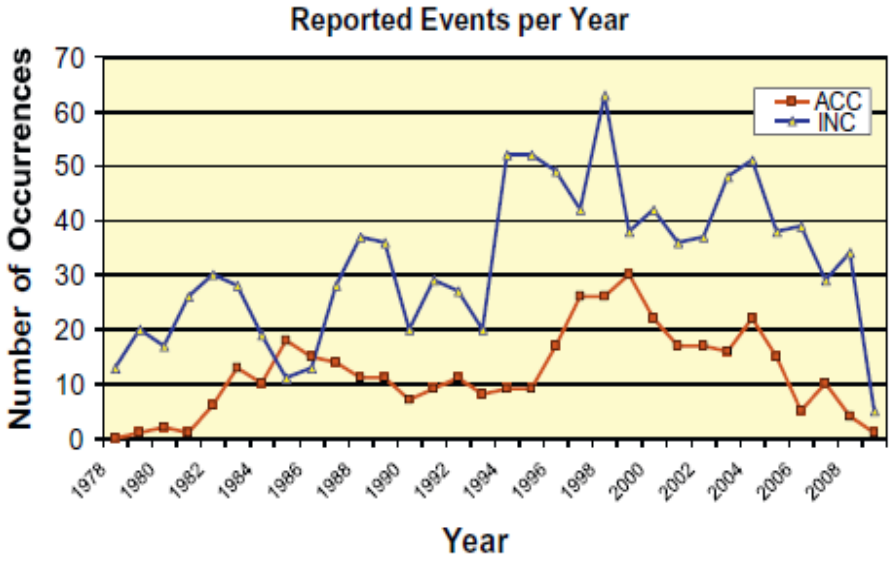

Figure 21: Number of Reported Aircraft Accidents and Incidents from 1978 to 2008

Table 41 provides a comparison of accidental death risks from data drawn for 1999 to 2003 prepared by the US Department of Transportation (2013). The risks of accidental death from flying are lower than risks by other forms of transit, on a per vehicle miles basis.

Table 41: Comparison of Accidental Death Risks for United States (1999 - 2003)

	Deaths per Year (5 yr average)	General Population Risk Per Year*	Risk Based on Exposure
Motor Vehicles	36,676	1 out of 7,700	1.3 deaths per 100 million vehicle miles
Motorcycles	3,112	1 out of 91,500	31.3 deaths per 100 million vehicle miles
Railroads	931	1 out of 306,000	1.3 deaths per million vehicle miles
Bicycles	695	1 out of 410,000	Not applicable
Aircrafts	138**	1 out of 2,067,000	1.9 deaths per 100 million aircraft miles

* The US Department of Transportation used an average US population figure of approximately 285,000,000 over the five-year period in computations.
** Other than those aboard the aircraft who were killed, fatalities resulting from the 9/11 terrorist acts were excluded.

Table 42: Assessment of Proposal Impacts on Feeling Safe in the Community

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Feeling Safe in the Community	Accidents from vehicular traffic or aircraft crashes	■ The increase in traffic in the area may decrease the feelings of safety for pedestrians, particularly the disabled, seniors and children ■ The increase in the number of fuel tanker trucks required to support the fueling requirements of jets will likely decrease the feelings of safety for individuals concerned about spills and explosions ■ The presence of jets, which are larger than turboprop aircraft and carry more passengers, may raise concerns about the impacts of a crash – jets may be more likely to have engine problems resulting from bird strikes	Negative	Waterfront communities and the Islands	Not assessed

6.0 SUMMARY

The approach taken for this report was based on TPH's Health Impact Assessment (HIA) Framework. Health Impact Assessments are used as a tool to identify potential health risks, benefits, challenges, issues and opportunities that may result from allowing jets or further expansion of the BBTCA. The health impacts of the Proposal considered in this report included the following:

- environmental factors specifically climate change, water quality, fuel transport, traffic, noise and air quality;
- economic factors namely employment, income, cost of transportation, cost of healthcare, tourism and property values; and
- social and cultural factors such as recreation, cultural activities, access to community services, community character, community planning and feeling safe in the community.

Decisions made in these areas can have important impacts on community health. The following summarizes the available evidence to predict the changes that the Proposal might have on each factor and, the subsequent impact on health, and community wellbeing.

The comprehensive noise assessment indicated that the background noise pollution in the study area is already elevated even without contribution from the BBTCA. The HIA evaluated the following health effects associated with noise exposure: children's learning performance, annoyance, sleep disturbance and cardiovascular disease. The following summarizes the key findings:

- **Children's learning performance** - Predicted noise levels (L_{day}) at the Waterfront School / City School are above the WHO guideline for school playgrounds for background (without BBTCA), existing (with BBTCA) and future scenarios. The existing BBTCA operations result in an increase of 2 dBA (L_{day}) at the Waterfront School / City School and 11.7 dBA (L_{day}) at the Island Public School, compared to the background scenario (without BBTCA). While predicted L_{day} values at the Island Public School are below the WHO guideline for all scenarios, the predicted increase in exposure to aircraft noise suggests a linear decrease in reading comprehension based on the results of the European RANCH study (Clark *et al*., 2006). The Proposal was predicted to reduce the L_{day} by 1 dBA at the Waterfront School / City School and by 3 dBA at the Island Public School, compared to existing conditions.
- **Annoyance** – Predicted L_{day} values at Ward's Island at 2 m, 15 m and 70 m elevation were below the WHO guideline of 55 dBA for serious annoyance. For all other receptor locations, the predicted noise levels are already above the WHO guideline of 55 dBA (L_{day}) for serious annoyance for the background scenario (without BBTCA). Therefore, including BBTCA under the existing scenario only worsens an already noisy environment for the following receptor locations: Little Norway Park, Windward Co-op Homes, Harbour Side Co-op Homes, Harbour Square, Toronto Music Garden. Predicted noise level increases an additional 1 to 7 dBA (L_{day}) depending on the location when contribution from BBTCA is considered.

  Also, predicted noise levels (without BBTCA) increases approximately 1 to 7 dBA (L_{day}) for most receptor locations with elevation (i.e., 2 m, 15 m, and 70 m); which indicates a potentially higher health impact for people who live in multi-storey condominium buildings.

Between existing and future scenarios at these locations, the predicted Lday values at 2 m, 15 m and 70 m either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

For the change between background and existing conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at: Stadium Road (2 m, 15 m, 70 m); Windward Co-op Homes (2 m, 70 m); Little Norway Park (2 m, 15 m); and Harbour Side Co-op Homes (15 m).

For the change between background and future conditions, there was a change in %HA greater than the Health Canada guideline of 6.5% at: Stadium Road (2 m, 15 m, 70 m); Windward Co-op Homes (2 m); Little Norway Park (2 m, 15 m); and Harbour Side Co-op Homes (15).

Overall, the change in %HA is less between the background and future scenarios than between the background and existing scenarios. This means that the proposed use of jets would result in a lower percentage of the population that would be considered highly annoyed in comparison to existing conditions. The average change in %HA from background to existing at these locations across all elevations is 5.6%, while the average change from background to future is 4.8%. This indicates that the Proposal would result in lower percentage of population that would be considered highly annoyed compared to the existing scenario.

- **Sleep Disturbance** – Except for background at Ward's Island, all the predicted L_{night} levels are above the WHO guideline of 40 dBA for sleep disturbance. The WHO has an interim target of 55 dBA (L_{night}) for situations where 40 dBA cannot be achieved in the short run. However, it is expected that above 55 dBA (L_{night}), a higher proportion of the population would be sleep-disturbed (WHO, 2009).

  Except for the Toronto Music Garden, all other receptor locations were below 55 dBA (L_{night}) for all scenarios at 2 m elevation. However, at higher elevation of 70 m, predicted L_{night} values are above 55 dBA for all scenarios for Harbour Square, Harbour Side Co-Op Homes, Windward Co-Op Homes and Little Norway Park in addition to the Toronto Music Garden which indicates a potentially higher health impact for people who live in multi-storey condominium buildings. It is noted that the elevated predicted L_{night} values appear to be unrelated to BBTCA.

  The change in L_{night} from background (without BBTCA) to existing (with BBTCA) ranges from <1 - 5 dBA at 2 m, 0 – 4 dBA at 15 m, and 0 to <1 dBA at 70 m.

  Between existing and future scenarios at these locations, the predicted L_{night} values at 2 m, 15 m and 70 m either remained the same or showed a decrease of 1 dBA, indicating that the use of jets would not further add to the noise pollution.

- **Cardiovascular –** The Health Council of the Netherlands (1999) identified an increased risk of hypertension and ischemic heart disease at a threshold of 70 dBA (Lday). The only location with L_{day} values above 70 dBA was the Toronto Music Garden for all scenarios at 70 m elevation. This is not a residential location, however there are condos located directly north across Queen's Quay West that may experience similar noise levels at 70 m. As discussed above for sleep disturbance, the exposure of condo residents at higher elevations to noise depends on window-opening behaviour and the insulation properties of the building. As discussed previously for annoyance, L_{day} values increase by up to 7 dBA from the background to existing scenario and decrease by up to 1 dBA from existing to future scenario.

In addition, this report has identified specific operations that result in noise effects that require further consideration. Specifically, engine maintenance run-ups, ferry operation and taxiing have been identified by local residents as concerns and predicted levels support this view in the community. What should be acknowledged is that noise effects from the CS100 are significantly lower for both engine run-ups and taxiing compared to the Q400. However, during nighttime hours, taxiing with the CS100 can result in slightly higher noise levels compared to Q400. Therefore, moving towards the incorporation of CS100 jets would be preferable compared with current from a noise perspective. With respect to the ferry operation, additional detailed investigations may be warranted to help identify whether or not noise effects in the early morning hours (i.e., after 4 am) when background noise levels are lower, are resulting in noise impacts to the nearby residents.

The comprehensive air assessment indicated that the baseline air pollution in the study area is already elevated without the contribution of the BBTCA. The following summarizes key findings:

- The results of the health assessment are dependent on the successful achievement of the modal shift assumed in the transportation assessment for existing and future scenarios.
- Boeing 737-700 increases cancer risk by up to 4×10^{-7} primarily a result of chromium VI emissions; whereas, Bombardier CS100 results in a decrease in cancer risk.
- Non-cancer exposures are not expected to pose a health hazard under any scenarios.
- For background (without BBTCA), the added risk for premature deaths based on maximum conditions associated with the five criteria air contaminants are 0.06, 0.5, 7, 4 and 4 per 100 for carbon monoxide, sulphur dioxide, $PM_{2.5}$, ozone and NO_x, respectively. The change in added risk of premature deaths per 100 people is less than 0.005 across all scenarios for carbon monoxide and sulphur dioxide. Between background and current airport scenario, the change in added risk is 0.24 per 100 people for $PM_{2.5}$ and 0.12 per 100 people for NO_x. Between the current airport and future airport scenarios, there are additional minimal changes in risk of premature deaths for $PM_{2.5}$ (i.e., <0.02 per 100 increase) and an increase of 0.22 per 100 (Boeing 737-700) and 0.18 per 100 (Bombardier CS100) for NO_x.

The following table provides a high level overview of the factors considered and their potential impact on health based on the assessment carried out.

Table 43: Summary of Potential Health Impacts

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Environmental Factors					
Climate change	Change in contribution to greenhouse gases	■ The future scenario represents a greater number of flights by jets in and out of BBTCA which would increase CO_2 emissions ■ The extent that the jet flights represent new air trips in and out of Toronto or displacement of jet flights from Toronto Pearson Airport is uncertain ■ The extent that the jet flights will displace transport previously taken by rail or bus is expected to be limited, as the jets are proposed to add flights to California, Nevada, Florida and the Caribbean ■ The jets are larger and newer aircraft that are expected to be more fuel efficient than the turboprop aircraft; thus, the jets have a lower impact on climate change on a per seat or per km basis. However, because the jets are larger and travel longer distances, the total contribution to climate change per flight may be higher ■ Overall, some increase in the contribution to climate change is expected based on the Proposal	Negative	Global	■ Improve aircraft engine efficiency ■ Minimize CO_2 emissions across all BBTCA operations
Water Quality	Change in water quality	■ The BBTCA incorporates engineering controls including a containment and drainage system to manage runoff and de-icing fluids ■ The addition of jets and the requirements for cleaning and maintenance may generate a higher runoff load ■ Increase in potential for release to Lake Ontario from runoff and/or failure in containment and drainage system at BBTCA ■ The extension of the runway is not expected to significantly alter the surrounding coastal environment	Negative	Lake Ontario	■ Continued implementation of the Snow Removal and Ice Control Plan ■ Evaluate the capacity of the storm water drainage system for handling a higher runoff load and implement additional infrastructure or monitoring as required ■ Maintain and improve management practices

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Water Quality (cont)		■ The addition of jets increases the likelihood of jet fuel dumping on Lake Ontario in the case of an emergency, but this is considered a low probability event			■ Maintain and improve monitoring programs, including sampling and analysis of ethylene glycol in effluent discharges to ensure that Lake Ontario water quality is protected for the Proposal
Fuel Transport	■ Risk of fuel tanker truck accidents ■ Exhaust emissions from fuel tanker trucks	■ The addition of jets would increase the BBTCA's fuel supply requirements, increasing the risk of fuel tanker truck accidents potentially leading to spills or explosions ■ The addition of jets would increase the BBTCA's fuel supply requirements, thus increasing the number of fuel tanker trucks and fuel tanker exhaust emissions, resulting in a negative impact on air quality	Negative	Throughout transport route from fuel source (refinery) to airport	■ Continued implementation of the Ferry Spill Action Plan, TPA Spill Response Plan and the BBTCA Emergency Response Plan ■ Management practices to minimize accident risks including vehicle maintenance and/or upgrades, and driver training ■ Evaluate the capacity of the fuel storage at BBTCA for handling a greater fuel supply ■ Review of the Ferry Spill Action Plan, TPA Spill Response Plan and the BBTCA Emergency Response Plan to determine adequacy of the plan in light of the Proposal

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Traffic	Risk of injury or fatality resulting from vehicular accidents	■ The Proposal would result in an increase in the number of hourly passengers ■ If the airport maintains its current mode split, approving jets would result in an estimated 20% increase in the hourly traffic volumes on Eireann Quay (BA Group, 2013) ■ An increase in traffic volume means an increased risk of vehicular accidents potentially causing injury or fatality; pedestrians, especially children, those with disabilities, and seniors are considered particularly vulnerable ■ The Proposal will likely not result in any significant impact to intersection operations in the broader study area (i.e., beyond the immediate study network of Lake Shore, Queens Quay, Dan Lackie and Stadium Road) (BA Group, 2013) ■ Displacement of flight activity from Pearson to BBTCA will likely reduce some of the total vehicle kilometres travelled in the GTA	Negative	Bathurst Quay neighbourhood	■ Maintain taxi/shuttle facility on Canada malting lands until an off-street replacement can be found ■ Re-stripe Eireann Quay and reconfigure existing finger lot traffic lanes ■ Modify signal timing at Eireann Quay and Queen's Quay to include a pedestrian advance phase ■ Improve crosswalks at Queen's Quay / Bathurst ■ Provide a raised crosswalk on the south intersection approach at Queen's Quay and Bathurst (or speed humps on Eireann Quay) ■ Reconfigure existing short term and long term parking spaces on Canada Malting lands into short-term only with a 10 minute free grace period ■ Improve connection to transit by constructing a weather protection canopy connecting the BBTCA Mainland terminal to the TTC at Queen's Quay / Bathurst ■ Set baseline target for mode shift changes that BBTCA must attain in order to minimize increase in car traffic volumes associated with the jets

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Noise	Change in children's learning performance, annoyance, sleep disturbance and cardiovascular disease related to noise	■ Background noise pollution (without BBTCA) in the study area is already elevated ■ In the absence of BBTCA, noise levels would already exceed health guidelines which have been established to prevent annoyance, sleep disturbance and impaired learning performance in most locations considered, mainly a result of traffic in the area ■ The Proposal was predicted to decrease L_{day} by up to 1 dBA at school locations near BBTCA, indicating potential improvement in conditions for children's learning compared to existing conditions. ■ The change in the percentage of the population highly annoyed (%HA) from background (without BBTCA) to existing (with BBTCA) scenarios is greater than the Health Canada guideline of 6.5% at Stadium Road (2 m, 15 m and 70 m elevations); Windward Co-op Homes (2 m and 70 m elevations); Little Norway Park (2 m and 15 m elevations); and Harbour Side Co-op Homes (15 m elevation). ■ Both the existing conditions and future scenario with jets were predicted to cause an increase in %HA above the Health Canada guideline at several locations, compared to background. However, the future scenario with jets had lower %HAs, indicating a smaller number of individuals would be highly annoyed compared to existing conditions ■ The Proposal was predicted to cause a small decrease in L_{day} (e.g., 1 dB) and levels across the study area are generally below the threshold for cardiovascular disease	Positive and Negative	Primarily southern part of Wards 20 and 28	■ Once the formal testing of the CS100 is complete and all the noise data is validated, the noise modelling carried out as part of this assessment should be updated ■ Complaint investigation(s) should be carried out for some residents that have direct exposure to noise from ferry operation. Complete a more detailed investigation to establish whether or not the ferry operation is an issue that may require the implementation of exhaust mufflers or other noise control measures on the ferry ■ Engine run-ups to be limited to daytime hours, if possible after 9 am and no later than 8 pm. Testing should be avoided during weekends ■ If limiting maintenance testing is not possible, consider the use of a Ground Run-up Enclosure (GRE), or completing testing at other facilities where greater separation distance between testing and sensitive locations exists ■ Taxiing routes should be selected to minimize noise exposure ■ Increase minimum crossing altitude to minimize noise effect

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Noise (cont)		■ Noise levels from aircraft activities due to the Proposal including take-off, landing and flyovers do not result in meaningful change to the cumulative noise levels including background ■ The Proposal was predicted to cause a decrease in night noise at some locations and a slight increase (e.g., 1 dB) at other locations ■ Noise levels from run-ups and taxiing are predicted to be lower for the Proposal			
Air Quality	Change in cancer risk, non-cancer risk and risk of premature mortality	■ The results of the health assessment are dependent on the successful achievement of the modal shift assumed in the transportation assessment for existing and future scenarios ■ Background air pollution (without BBTCA) in the study area is already elevated ■ Boeing 737-700 increases cancer risk by up to 4×10^{-7} primarily a result of chromium VI emissions; whereas, Bombardier CS100 results in a decrease in cancer risk ■ Non-cancer exposures are not expected to pose a health hazard under any scenarios ■ For background (without BBTCA), the added risk for premature deaths based on maximum conditions associated with the five criteria air contaminants are 0.06, 0.5, 7, 4 and 4 per 100 for carbon monoxide, sulphur dioxide, $PM_{2.5}$, ozone and NOx, respectively. The change in added risk of premature deaths per 100 people is less than 0.005 across all scenarios for carbon monoxide and sulphur dioxide.	Positive and Negative	Primarily southern part of Wards 20 and 28	■ Use of CS100 in preference to Boeing 737-700, as emissions are less ■ Ferry is a significant source of emissions from the BBTCA operations and should be upgraded

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Air Quality (cont)		Between background and current airport scenario, the change in added risk is 0.24 per 100 people for $PM_{2.5}$ and 0.12 per 100 people for NOx. Between the current airport and future airport scenarios, there are minimal changes in risk of premature deaths for $PM_{2.5}$ (i.e., <0.02 per 100 increase) and an increase of 0.22 per 100 (Boeing 737-700) and 0.18 per 100(Bombardier CS100) for NOx.			
Economic Factors					
Employment	Number of jobs created	■ **Increase** in employment but benefit not specific to local residents	Positive and Negative	Primarily Quebec and Ontario	■ Not assessed
Income	Change in labour income	■ **Increase** in income but benefit not specific to local residents	Positive and Negative	Primarily Quebec and Ontario	■ Not assessed
Transportation Costs	Cost of transit upgrades	■ **Increase** in costs of transportation upgrades which were not considered in the economic assessment	Negative	Ontario (tax base)	■ Not assessed
Healthcare Costs	Direction of change in healthcare costs	■ **Increased** healthcare costs are anticipated as a result of exposures to elevated levels of noise and air pollution for background scenario even without consideration of BBTCA ■ For background scenario (without BBTCA), the added risk of premature deaths as a result of exposures to $PM_{2.5}$, ozone and NO_x is 7, 4 and 4 per 100 people, respectively. ■ The Proposal is not expected to increase healthcare costs related to noise and air impacts as predicted noise and air levels from aircraft activities due to the Proposal including take-off, landing and flyovers do not result in meaningful change to the cumulative noise levels including background.	Positive or Negative	Ontario (tax base)	■ Not assessed

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Healthcare Costs (cont)		■ **Increased** healthcare costs are anticipated related to increased risk of vehicular accidents potentially causing injury or fatality; pedestrians, especially children, those with disabilities, and seniors are considered particularly vulnerable			
Tourism	Direction of change in tourism spending	■ Some stakeholders feel the tourism experience will be diminished by the air quality, noise and traffic issues related to the Proposal ■ The HLT Advisory Group reported significant spending by tourists as a result of jet service, although the extent that this is displaced from Pearson is not known ■ Net economic effect on the City in consideration of the costs associated with infrastructure upgrades including transportation, health care and community services	Positive or Negative	Ontario (tax base)	■ Not assessed
Property Value	Direction of change in property value	■ Some stakeholders feel that the Proposal may decrease property values, result in relocations and even cause closure of co-op buildings ■ Condo developers seem to be favourable to the presence of the airport ■ Stable demand in condominium market with unit pricing consistent with overall Toronto condominium market	Positive or Negative	Primarily southern part of wards 20 and 28	■ Not assessed
Social and Cultural Factors					
Recreation	Access to and enjoyment of recreational space	■ Decrease in opportunities for access of recreational space due to longer travel times resulting from traffic congestion and delays ■ Diminished enjoyment of recreational space due to the ongoing impact of the BBTCA on air quality, traffic, odour and noise at nearby recreational space ■ Increase in light pollution in the area which may interfere with the enjoyment of recreational space	Negative	The City of Toronto as a whole	■ Not assessed

Indicators	Measures	Findings	Direction of Impact on Health	Geographic Extent	Potential Risk Reduction Measures
Recreation (cont)		■ The addition of jets at BBTCA may increase the risk of wildlife strikes			
Cultural Activities	Access to and enjoyment of cultural activities	■ Decrease in opportunities for access due to longer travel times resulting from traffic congestion and delays ■ Diminish enjoyment of cultural activities due to the ongoing impact of the BBTCA on air quality and noise at nearby cultural sites	Negative	The City of Toronto as a whole	■ Not assessed
Community Services	Access to community services	■ Decrease opportunities for access due to longer travel times resulting from traffic congestion and delays	Negative	Waterfront communities	■ Not assessed
Community Character	Satisfaction with Neighbourhood	■ Some stakeholders feel that the Proposal would decrease their satisfaction of the neighbourhood due to the perception that the air quality, noise, and traffic related to the BBTCA are already impairing the enjoyment of their homes and community	Negative	Waterfront communities	■ Not assessed
Community Plan	Satisfaction with Neighbourhood	■ Decrease in satisfaction because the Proposal does not seem to align with the Toronto Official Plan	Negative	City of Toronto	■ Not assessed
Feeling Safe in the Community	Accidents from vehicular traffic or aircraft crashes	■ Decrease the feelings of safety for pedestrians, particularly seniors and children due to increase in traffic volume ■ The increase in the number of fuel tanker trucks required to support the fueling requirements of jets will likely decrease the feelings of safety for individuals concerned about spills and explosions ■ Decrease feeling of safety due to presence of jets, which are larger than turboprop aircraft and carry more passengers, and may raise concerns about the impacts of a crash because they are more likely to be affected by a bird strike	Negative	Waterfront communities	■ Not assessed

7.0 REFERENCES

Airbiz Aviation Strategies (Airbiz). 2013. Billy Bishop Toronto City Airport, Porter Airlines Proposal Review, Interim Results / Findings. June 26, 2013.

Aircraftcompare.com. 2013. Bombardier C Series CS100 and Bombardier Q400. Accessed at www.aircraftcompare.com on November 4th, 2013.

Ayres, M.A., Shirazi, H., Carvalho, R., Hall, J., Speir, R., Arambula, E., David, R., Gadzinski, J., Caves, R., Wong, D., Pitfield, D. 2013. Modelling the location and consequences of aircraft accidents. Safety Science, 51, 178-186.

BA Group. 2013. DRAFT Billy Bishop Toronto City Airport Transportation Assessment of Proposed Jet Activity. Executive Summary and Key Findings. Preliminary Draft – Version 1. October 2013.

Airside Operations Manager (AOM). 2012. Snow Removal and Ice Control Plan for the Billy Bishop Toronto City Airport (BBTCA), Original date of issue August 2, 2002, Revised November 2012.

Beckerman, B.S., Jerrett, M., Finkelstein, M., Kanaroglou, P., Brook, J.R., Arain, M.A., Sears, M.R., Stieb, D., Balmes, J., Chapman, K. 2012. The association between chronic exposure to traffic-related air pollution and ischemic heart disease. Journal of Toxicology and Environmental Health, Part A, 75(7), 402-411.

Black, D.A., Black, J.A., Issarayangyun, T., Samuels, S.E. 2007. Aircraft noise exposure and resident's stress and hypertension: A public health perspective for airport environmental management. Journal of Air Transport Management, 13, 264-276.

Burnett, R.T., Cakmak, S., Brook, J.R., Krewski, D. 1997a. The role of particulate size and chemistry in the association between summertime ambient air pollution and hospitalization for cardiorespiratory diseases. Environmental Health Perspectives, 105(6), 614-620.

Burnett, R.T., Dales, R.E., Brook, J.R., Raizenne, M.E., Krewski, D. 1997b. Association between ambient carbon monoxide levels and hospitalizations for congestive heart failure in the elderly in 10 Canadian cities. Epidemiology, 8(2), 162-167.

Burnett, R.T., Smith-Doiron, M., Stieb, D., Cakmak, S., Brook, J.R. 1999. Effects of particulate and gaseous air pollution on cardiorespiratory hospitalizations. Archives of Environmental Health: An International Journal, 54(2), 130-139.

Burnett, R.T., Brook, J., Dann, T., Delocla, C., Philips, O., Cakmak, S., Vincent, R., Goldberg, M.S., Krewski, D. 2000. Associations between particulate and gas phase components of urban air pollution and daily mortality in eight Canadian Cities. Inhalation Toxicology, 12(4), 15-39.

Burra, T.A., Moineddin, R., Agha, M.M., Glazier, R.H. 2009. Social disadvantage, air pollution, and asthma physician visits in Toronto, Canada. Environmental Research, 109, 567-574.

Carslaw, D.C., Beevers, S.D., Ropkins, K., Bell, M.C. 2006. Detecting and quantifying aircraft and other on-airport contributions to ambient nitrogen oxides in the vicinity of a large international airport. Atmospheric Environment 40, 2006, 5424-2434.

CH2M Hill Canada Limited. 2013. DRAFT Porter Airlines Runway Extension Proposal Review Costal Processes and Environments. Prepared for the City of Toronto, August 2013. Epidemiology, 24(1), 35-43.

Chen, H., Goldberg, M.S., Burnett, R.T., Jerrett, M., Wheeler, A.J., Villeneuve, P.J. 2013. Long-term exposure to traffic-related air pollution and cardiovascular mortality.

City of Toronto. 2010. Toronto Official Plan. Adopted by City council November 2002. Approved, in part, with modifications by the Ontario Municipal Board June 2006 and further approved by the Board December 2010.

City of Toronto. 2013. Transportation Services, Traffic Management Centre, Traffic Safety Unit, 2012.

City of Toronto. 2013a. City of Toronto Neighbourhood Profiles for 2011. Social Profile #1 – Age and Gender. Neighbourhoods 70, 77, 82 and 85. Downloaded from http://www.toronto.ca/demographics/profiles_map_and_index.htm in October, 2013.

City of Toronto. 2013b. City of Toronto Ward Health Profiles for 2011. Wards 19, 20, 27, 28, 30 and 32. Downloaded from http://app.toronto.ca/wards/jsp/wards.jsp in October, 2013.

City of Toronto. 2013c. Parks Plan 2013 – 2017. Downloaded from http://www1.toronto.ca/staticfiles/city_of_toronto/parks_forestry__recreation/community_involvement/files/pdf/parksplan.pdf

City of Toronto. 2013d. Request to Amend the Tripartite Agreement for Billy Bishop Airport, Staff report to Executive Committee (Draft), December 5, 2013.

Clark, C., Head, J., Stansfeld, S.A. 2013. Longitudinal effects of aircraft noise exposure on children's health and cognition: A six-year follow-up of the UK RANCH chohort. Journal of Environmental Psychology, 35, 1-9.

Clark, C., Martin, R., van Kempen, E., Alfred, T., Head, J., Davies, H.W., Haines, M.M., Barrio, I.L., Matheson, M., Stansfeld, S.A. 2005. Exposure-Effect Relations between Aircraft and Road Traffic Noise Exposure at School and Reading Comprehension. American Journal of Epidemiology, 163(1), 27-37.

Croucher, K., Myers, L., & Bretherton, J. (2008). The links between green space and health: A critical literature review (Greenspace Scotland Research Report). Stirling, Scotland: Greenspace Scotland. Retrieved from http://www.greenspacescotland.org.uk/upload/File/the%20links%20between%20greenspace%20and%20health%20critical%20literature%20review%20Oct07.pdf

Cohen, B.S., Bronzaft, A.L., Heikkinen, M., Goodman, J., Nadas, A. 2008. Airport-related air pollution and noise. Journal of Occupational and Environmental Hygiene, 5(2), 119-129.

Correia, A.W., Peters, J.L., Levy, J.I., Melly, S., Dominici, F. 2013. Residential exposure to aircraft noise and hospital admissions for cardiovascular diseases: multi-airport retrospective study. British Medical Journal, 347:f5561.

Cuypers, K., Krokstad, S., Holmen, T.L., Knudtsen, M.S., Bygren, L.O., Holmen, J. 2011. Patterns of receptive and creative cultural activities and their association with perceived health, anxiety, depression and satisfaction with life among adults: the HUNT study, Norway. Journal of Epidemiology and Community Health, 66, 698-703.

Dillon Consulting Limited (Dillon). 2013. Porter Airlines Inc. BBTCA Traffic Diversion Assessment. November 6, 2013.

Doncaster Health Authority and Doncaster Metropolitan Borough Council. 2000. Health Impact Assessment, Finningley Airport. Abdel Aziz, M.I., Radford, J., McCabe, J. September 2000.

Dorman, K., Pellizzari, R., Rachlis, M., Green, S. 2013. Why poverty is a medical problem. Ontario Medical Review, October 2013.

Environment Canada (EC) and Health Canada (HC). 2000. Canadian Environmental Protection Act (CEPA, 1999), Priority Substance List, State of the Science Report for Ethylene Glycol, December.

Environment Canada. 2012. National Inventory Report, 1990 – 2010, Greenhouse Gas Sources and Sinks in Canada, Executive Summary.

Environment Canada, 2013. Greenhouse Gas Emissions by Province and Territory, http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=18F3BB9C-1.

Environmental Resources Management (ERM). 2008. The Stansted Generation 2 Project: A Health Impact Assessment. Barrowcliffe, R., Phillips, C. April 2008.

Fahrni, L., Rydin, Y., Tunesi, S., Maslin, M. 2008. Travel Related Carbon Footprint: A Case Study Using the UCL Environment Institute. Sponsored by University College London (UCL) Environment Institute and Urban Buzz.

Federal Aviation Administration (FAA). 2007. Environmental Desk Reference for Airport Actions, Federal Aviation Administration Office of Airports, dated October 2007. Retrieved from http://www.faa.gov/airports/environmental/environmental_desk_ref/media/desk_ref.pdf

Gies, E. (2006). The health benefits of parks: How parks help keep americans and their communities fit and healthy. San Francisco, CA: The Trust for Public Land. Retrieved from http://actrees.org/files/Research/parkbenefits_health.pdf

Givoni, M., Rietveld, P. 2010. The environmental implications of airlines' choice of aircraft size. Journal of Air Transport Management, 16, 159-167.

Gratz, N., Steffen, R., Cocksedge, W. 2000. Why aircraft disinsection? Bulletin of the World Health Organization, 78(8), 995-1004.

Haines, M.M., Stansfeld, S.A., Job, R.F.S., Berglund, B., Head, J. 2001. Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children. Psychological Medicine, 2001, 31, 265-277.

Hansell, A.L., Biangiardo, M., Fortunato, L., Floud, S., de Hoogh, K., Fecht, D., Ghosh, R.E., Laszlo, H.E., Pearson, C., Beale, L., Beevers, S., Gulliver, J., Best, N., Richardson, S., Elliott, P. 2013. Aircraft noise and cardiovascular disease near Heathrow airport in London: small area study. British Medical Journal, 347:f5432.

Health Canada. 2010. Useful Information for Environmental Assessments.

Health Council of the Netherlands. 1999. Public health impacts of large airports.

Health Officers Council of British Columbia (BC). 2008. Health Inequities in British Columbia, Discussion Paper. November 2008.

HLT Advisory. 2013. DRAFT Economic Impact Considerations of an Expanded Billy Bishop Toronto City Airport. Draft for Discussion – Interim Findings, June 26, 2013.

Hsu, H.H., Adamkiewicz, G., Houseman, E.A., Vallarino, J., Melly, S.J., Wayson, R.L., Spengler, J.D., Levy, J.I., 2012. The relationship between aviation activities and ultrafine particulate matter concentrations near a mid-sized airport. Atmospheric Environment 50, 328-337.

Hu, S., Fruin, S., Kozawa, K., Mara, S., Winer, A.R., Paulson, S.E. 2009. Aircraft emission impacts in a neighbourhood adjacent to a general aviation airport in Southern California. Environmental Science and Technology, 43, 8039-8045.

Hygge, S., Evans, G.W., Bullinger, M. 2002. A prospective study of some effects of aircraft noise on cognitive performance in schoolchildren. Psychological Science, 13(5), 469-474.

International Organization for Standardization. 1996. Acoustics – Description, measurement and assessment of environmental noise.

Jerrett, M., Finkelstein, M.M., Brook, J.R., Arain, M.A., Kanaroglou, P., Stieb, D.M., Gilbert, N.L., Verma, D., Finkelstein, N., Chapman, K.R., Sears, M.R. 2009. A cohort study of traffic-related air pollution and mortality in Toronto, Ontario, Canada. Environmental Health Perspectives, 117(5), 772-777.

Lee, D.S., Fahey, D.W., Forster, P.M., Newton, P.J., Wit, R.C.N., Lim, L.L., Owen, B., Sausen, R. 2009. Aviation and global climate change in the 21st century. Atmospheric Environment, 43, 3520-3537.

Levy, J.I., Woody, M., Baek, B.H., Shankar, U., Arunachalam, S. 2012. Current and future particulate matter related mortality risks in the United States from aviation emissions during landing and takeoff. Risk Analysis, 32, 237-249.

Lin, R.L., Chandrakant, P.S., Svoboda, T.J. 1995. The impact of unemployment on health: A review of the evidence. Canadian Medical Association Journal, September 1, 1995, 153(5), 529-540.

Lin, S., Munsie, J.P., Herdt-Losavio, M., Hwang, S.A., Civerolo, K., McGarry, K., Gentile, T. 2008. Residential proximity to large airports and potential health impacts in New York State. International Archives of Occupational and Environmental Health. 81(7), 797-804.

Lu, C., Morrell, P. 2006. Determination and applications of environmental costs and different sized airports – aircraft noise and engine emissions. Transportation, 33, 45-61.

Maas, J., Verheij, R. A., Groenewegen, P. P., de Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: How strong is the relation? Journal of Epidemiology and Community Health, 60(7), 587–592.

Manchester Health Authority. 1994. Submission to the Manchester Airport Second Runway Enquiry. Will, S., Ardern, K., Spencely, M., Watkins, D. April 1994.

Michaud, D., Fidell, P., Pearsons, K., Campbell, K.C., Keith, S.E. 2006. Review of field studies of aircraft noise-induced sleep disturbance. Acoustical Society of America, 121(1), 32-41.

Michaud, D.S., Bly, S.H.P., Keith, S.E. 2008. Using a change in percent highly annoyed with noise as a potential health effect measure for projects under the Canadian Environmental Assessment Act. Canadian Acoustics, 36(2), 13-8.

Miedema, H.M.E., Vos, H. 1998. Exposure-response relationships for transportation noise. Journal of the Acoustical Society of America. 104(6), 3432-3445.

Nunes, L.M., Zhu, Y.G., Stigter, T.Y., Monteiro, J.P., Teixeira, M.R. 2011. Environmental impacts on soil and groundwater at airports: origin, contaminants of concern and environmental risks. Journal of Environmental Monitoring, 13, 3026.

Ontario Medical Association (OMA). 2005. The Illness Costs of Air Pollution, Health and Economic Damage Estimates. June 2005.

Passchier-Vermeer, W., Passchier, W.F. 2000. Noise exposure and public health. Environmental Health Perspectives, 108(1), 123-131.

Research for Man and Environment (RIVM). 1999. Health Impact Assessment Schiphol Airport, Overview of results until 1999. Franssen, E.A.M., Lebret, E., and Staatsen, B.A.M. September 1999.

Stansfeld, S.A., Berglund, B., Clark, C., Lopez-Barrio, I., Fischer, P., Ohrstrom, E., Haines, M.M., Head, J., Hygge, S., van Kamp, I., Berry, B.F. 2005. Aircraft and road traffic noise and children's cognition and health: a cross-national study. Lancet, 365, 1942-1949.

Stansfeld, S.A., Clark, C., Cameron, R.M., Alfred, T., Head, J., Haines, M.M., van Kamp, I., van Kempen, E., Lopez-Barrio, I. 2009. Aircraft and road traffic noise exposure and children's mental health. Journal of Environmental Psychology, 29, 203-207.

Sulej, A.M., Polkowska, Z., Namiesnik, J. 2012. Pollutants in airport runoff waters. Critical Reviews in Environmental Science and Technology, 42, 1691-1734.

Tesseraux, I. 2004. Risk factors of jet fuel combustion products. Toxicology Letters, 149, 294-300.

The Cities Alliance, & United Nations Environment Programme. (2007). Liveable cities: The benefits of urban environmental planning. Washington, DC: The Cities Alliance. Retrieved from http://www.unep.org/urban_environment/PDFs/LiveableCities.pdf

Toronto Port Authority (TPA). 2013. Personal communication regarding water/wastewater management operations at the BBTCA from Gene Cabral, TPA BBTCA Airport Director, dated October 29, 2013.

Toronto Public Health (TPH). 2007. Air Pollution Burden of Illness from Traffic in Toronto, Problems and Solutions.

TPH. 2008. TPH Health Impact Assessment Framework. Prepared by Jacques Whitford for Toronto Public Health. February 21, 2008.

TPH. 2011a. Health Assessment for the Cumulative Air Quality Modelling Study – Wards 30 and 32 including the South Riverdale and The Beaches neighbourhoods.

TPH. 2011b. Protecting vulnerable people from health impacts of extreme heat. Toronto, ON: Author. Retrieved from http://www.toronto.ca/legdocs/mmis/2011/hl/bgrd/backgroundfile-39469.pdf

TPH. 2011c. Healthy Toronto by Design. Toronto.

TPH, 2013. Exploring Health and Social Impacts of Climate Change in Toronto, dated October 21, 2013. Retrieved from: http://www.toronto.ca/legdocs/mmis/2013/hl/bgrd/backgroundfile-62786.pdf

Transport Canada, 2005. TP 14052 – Guidelines for Aircraft Ground – Icing Operations. Retrieved from http://www.tc.gc.ca/eng/civilaviation/publications/tp14052-chapter13-1818.htm

United States Environmental Protection Agency (US EPA), 2011. The benefits and costs of the clean air act: 1990 to 2020. Final Report of U.S. Environmental Protection Agency Office of Air and Radiation, pp. 5e10.

University of California, Los Angeles (UCLA) Medical Center. 2010. Santa Monica Airport Health Impact Assessment. Castro, A., Chen, L., Edison, B., Huang, J., Mitha, K., Orkin, M., Tejani, Z., Tu, D., Wells, L., Yeh, J., Guerrero, A., Kuo, A., Yazdani, S. February 2010.

University of Liverpool. 2008. A Rapid Health Impact Assessment of Birmingham International Airport's Proposed Runway Extension. Abrahams, D., Haigh, F., Pennington, A., Dreaves, H. February 2008.

Urban Strategies Inc. 2013. Billy Bishop Toronto City Airport Review Preliminary Land Use Evaluation. For the City of Toronto Waterfront Secretariat. August 27, 2013.

Van Kempen, E.E.M.M., van Kamp, I., Stellato, R.K., Lopez-Barrio, I., Haines, M.M., Nilsson, M.E., Clark, C., Houthuijs, D., Brunekreef, B., Berglund, B., Stansfeld, S.A. 2009. Children's annoyance reactions to aircraft and road traffic noise. Acoustical Society of America, 125(2), 895-904.

Westerdahl, D., Fruin, S.A., Fine, P.L., Sioutas, C. 2008. The Los Angeles International Airport as a source of ultrafine particles and other pollutants to nearby communities. Atmospheric Environment, 42, 3143-3155.

Williams, V., Noland, R.B. 2006. Comparing the CO_2 emissions and contrail formation from short and long haul air traffic routes from London Heathrow. Environmental Science and Policy, 9, 487-495.

World Health Organization (WHO). 1946. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June 1946, signed on July 1946 by the representatives of 61 States.

WHO. 1999a. Gothenburg consensus paper, Health Impact Assessment – Main concepts and suggested approach. December 1999. European Centre for Health Policy, WHO Regional Office for Europe, Brussels.

WHO. 1999b. Guidelines for Community Noise. Edited by B. Berglund, T. Lindvall and D.H. Schwela. Geneva.

WHO. 2003. Climate Change and Human Health – Risks and Responses, Summary.

WHO. 2008. Commission on Social Determinants of Health, Closing the gap in a generation: Health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health. Geneva, Switzerland: World Health Organization. Retrieved from http://whqlibdoc.who.int/publications/2008/9789241563703_eng.pdf

WHO. 2009. Night noise guidelines for Europe.

WHO & UN-HABITAT. (2010). Hidden cities: Unmasking and overcoming health inequities in urban settings. Geneva, Switzerland: Author. Retrieved from http://hiddencities.org/downloads/WHO_UN-HABITAT_Hidden_Cities_Web.pdf

Woodward, A., & Kawachi, I., (2000). Why reduce health inequalities? Journal of Epidemiology and Community Health, 54, 923-929.

Yim, S.H.L., Stettler, M.E.J., Barrett, S.R.H. 2013. Air quality and public health impacts of UK airports. Part II: Impacts and policy assessment. Atmospheric Environment, 67, 184-192.

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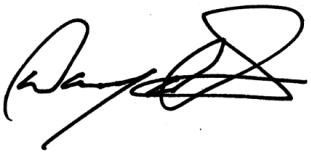

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