SCIENCE INTEGRITY KNOWLEDGE

AIR QUALITY STUDY AT TORONTO PEARSON INTERNATIONAL AIRPORT

HUMAN HEALTH RISK ASSESSMENT (HHRA) REPORT

Final Report

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List of Abbreviations

AAQC	Ambient Air Quality Criteria
ADI	Acceptable Daily Intake
ATSDR	Agency for Toxic Substances and Disease Registry
CACs	Criteria Air Contaminants
Cal EPA	California Environmental Protection Agency
CCME	Canadian Council of Ministers of the Environment
COC	Compound of Concern
CR	Concentration Ratio
CSM	Conceptual Site Model
EPC	Exposure Point Concentration
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
LADD	Lifetime Average Daily Dose
LCR	Lifetime Cancer Risk
MPOI	Maximum Point of Impingement
MOECC	Ontario Ministry of the Environment and Climate Change
NAAQO	National Ambient Air Quality Objective
NOAEL	No Observable Adverse Effect Level
PAH	Polycyclic Aromatic Hydrocarbon
PM	Particulate Matter
RfC	Reference Concentration
RfD	Reference Dose
SF	Slope Factor
TCEQ	Texas Commission on Environmental Quality
TDI	Tolerable Daily Intake
TEF	Toxic Equivalency Factor
TEQ	Toxicity Equivalence Quotient
TRV	Toxicological Reference Value
UR	Unit Risk
US EPA	United States Environmental Protection Agency
WHO	World Health Organization

EXECUTIVE SUMMARY

Overview of the Study

Toronto Pearson International Airport (Toronto Pearson) is located approximately 27 km northwest of the City of Toronto, in the City of Mississauga and is operated by the Greater Toronto Airports Authority (GTAA). The airport property borders on the City of Toronto, the City of Mississauga, and the City of Brampton. Toronto Pearson covers approximately 1,800 hectares and currently includes five runways, two main terminals (and several smaller satellite terminals), parking facilities, on-site public roads, a de-icing facility, a bus depot, emergency services, a cogeneration facility, and over 200 buildings. The airport handles approximately 35 million passengers and 450,000 aircraft movements annually. Almost one quarter of Canada's population lives within 160 km of the airport.

GTAA previously completed air quality emissions estimation and dispersion modelling in 1990/1991 and 2003/2004, as well as a human health risk assessment (HHRA) in 2003/2004. Many aspects of Toronto Pearson operations have changed since the last assessment, including new estimates of demand for air travel (commercial and personal), a constantly-changing aircraft fleet, newer and more efficient ground support equipment, modified operational guidelines, and new standard instrument departures. As a result, GTAA retained Golder Associates (Golder) to update to its emissions inventory and dispersion modelling to better quantify and assess the current and projected future air quality associated with operations of the airport. This was accomplished through a four phase air quality and human health risk study.

Golder provided the first three phases of the air quality assessment project, which included the development of an updated emission inventory for the airport property and the area extending in a 7.5 km radius around the airport property as well as the dispersion modelling for both on- and off-site sources to determine the cumulative effects of all sources at selected receptor sites. The air emissions inventory and dispersion modelling project was completed to quantify the current (2011) and likely future (2022 and 2032) air emission contributions from Toronto Pearson.

The fourth and final phase of the air quality study was to conduct a quantitative evaluation of health risks related to potential exposures to chemicals released during the operation of the airport. Intrinsik Environmental Sciences Inc. (Intrinsik), who completed the initial health evaluation in 2004 prior to the airport expansion as Cantox Environmental Inc., was retained to complete a human health risk assessment (HHRA). The HHRA provides health context and interpretation for the current and projected future air quality study information.

The quantification of potential chemical health risks was conducted through the use of the HHRA paradigm. The purpose of the current HHRA was to determine risk estimates based on three different exposure scenarios, including an assessment of existing background conditions in the absence of Toronto Pearson, an assessment of emissions from the Toronto Pearson alone, and a quantitative evaluation of the cumulative effects of the background conditions plus the airport alone. The three different exposure scenarios were assessed using the air emissions inventory and dispersion modelling information for the current time period (2011) and the two future time periods (2022 and 2032). The air quality and HHRA Study Domain has been defined as the area extending 7.5 km from Toronto Pearson and was selected in order to maintain consistency with the previous air quality report.

What is a Human Health Risk Assessment (HHRA)?

In general, an HHRA is a scientific study that evaluates the potential for the occurrence of adverse health effects from exposures of people to chemicals of concern (COC) present in surrounding environmental media (*e.g.*, air, soil, food, *etc*.), under existing or predicted exposure conditions arising from the operation of the Project under review.

HHRA procedures are based on the fundamental dose-response principle of toxicology. The response of an individual to a chemical exposure increases in proportion to the chemical concentration in critical target tissues where adverse effects may occur. The concentrations of chemicals in the target tissues (the dose) depend on the chemical concentrations in the environment where the receptor resides, works or visits.

All chemicals (both natural and man-made) have the potential to cause effects in people and the ecosystem. It is the chemical concentration, the route and amount of exposure, and the inherent toxicity of the chemical that determines the level of risk for adverse health effects to occur. Where technically and economically feasible, methods can be used to mitigate adverse effects. It is acknowledged that the various uncertainties associated with the HHRA process have the potential to influence estimates of exposure and risk. The methods and assumptions used in this HHRA were designed to be highly cautious (*i.e.,* health protective), and have a built-in tendency to overestimate, rather than underestimate, potential health risks.

The HHRA carried out for the Project followed the standard HHRA framework that is composed of the following general steps:

I. Problem formulation;
II. Exposure assessment;
III. Hazard assessment; and,
IV. Risk characterization.

The current HHRA focused on scenarios where reasonable linkages have been established between a chemical emission and its potential to influence human health with a focus on those relevant to the communities surrounding Toronto Pearson (*e.g.*, soil, home garden produce, and air quality). The HHRA was conducted according to widely accepted risk assessment methodologies and guidance documents published and endorsed by regulatory agencies including the Ontario Ministry of the Environment and Climate Change, Health Canada, and the United States Environmental Protection Agency to evaluate whether activities associated with Toronto Pearson might adversely impact health of individuals living, working or playing in the surrounding communities.

Who are the Sensitive Receptors in the Surrounding Area?

To assess potential risks related to the projected emissions from Toronto Pearson and regional background sources, key locations representative of the surrounding community were selected. At each of these receptor locations, potential exposure scenarios were developed and potential health impacts were evaluated for hypothetical individuals working or living at the chosen locations based upon predicted ground level airborne concentrations of the assessed chemicals.

Exposure scenarios were established using a select group of receptors (*i.e.*, representative individuals) that can be considered to be at greatest potential risk for adverse health effects associated with COCs. These scenarios were developed using conservative assumptions, as discussed throughout this report. In this context, conservative is taken to mean including the conditions of highest exposure that could be expected to be encountered by a person. The

assessment was prepared for the most adverse of conditions, and should exaggerate small effects.

For each exposure scenario, the most sensitive human receptors were considered. Characteristics of human receptors were selected to reflect the most sensitive life stage class (sex and age group), and the essential physical characteristics such as body weight, surface area, inhalation rate, and relative fitness.

The area surrounding Toronto Pearson is composed of a mixture of residential and commercial use. Therefore, a number of receptor locations representative of both residential and commercial receptor locations were selected for evaluation. Potential exposures and health risks were determined for eleven (11) specific locations in the area surrounding Toronto Pearson.

Representative Sensitive Receptor Locations	
Receptor Location	***Location Land Use***
Highway 427 and Dixon Road in Etobicoke	Commercial
Hotel Strip and Dixon Road in Etobicoke	Commercial
Longbourne Drive and Willowbridge Road in Etobicoke	Residential
Centennial Park Road in Etobicoke	Residential
Audubon Blvd. in Mississauga	Residential
County Court Road in Brampton	Residential
Cattrick Street in Malton	Residential
Bramalea Rd. and Avondale Rd. in Brampton	Residential
Elmcrest Rd. in Etobicoke	Residential
Kennedy Rd. and Grand Highland Way in Mississauga	Residential
Mavis Rd. and 401 in Mississauga	Residential

Additionally, a maximum point of impingement (MPOI) location was also considered. The MPOI refers to the location of the maximum concentration for a chemical that could occur anywhere within the Study Domain that is not on Toronto Pearson property. As a result, the MPOI is not a static location. For the purposes of the current assessment, the location land use of the MPOI was assumed to be industrial.

Sensitive Receptor Locations within the Study Domain

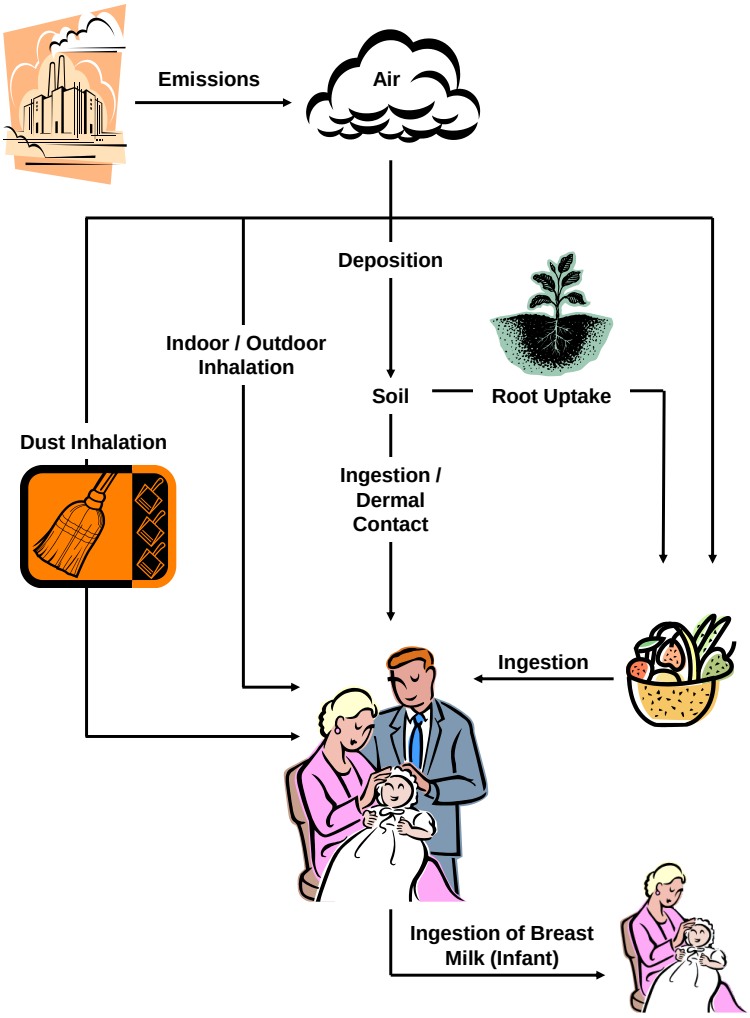
How were Potential Exposures Evaluated?

The HHRA included an inhalation assessment that evaluated acute (*i.e.,* short-term) and chronic (*i.e.,* long-term) health risks (*via* direct air inhalation) at each of the receptor locations noted in the figures above for all COCs. An individual's exposure (*via* inhalation) was assumed to equal the predicted ground-level air concentration (expressed as µg/m^3) for a particular chemical, duration and location. Health risk estimates (*via* inhalation) were subsequently calculated by directly comparing predicted ground-level air concentrations (*i.e.*, inhalation exposure) with the appropriate inhalation toxicity reference values, expressed as a concentration in air (µg/m^3).

In some cases, a number of the chemicals will settle over time and could accumulate in residential soils and home gardens within the Study Domain. These particular chemicals were also carried through a multimedia assessment, where the following additional exposure pathways were considered:

- **Inhalation:** Inhalation of air impacted by vapours and particulate emitted from the Project-related sources was evaluated.
- **Incidental Ingestion of Soil and Dust**: Through typical indoor and outdoor activities, individuals may accidentally ingest soil and/or dust particles. Children are typically more susceptible to this exposure pathway, as they spend more time in contact with the ground, and are more likely to put soiled articles, such as toys or hands, into their mouths.

- **Dermal Exposure to Soils and Dusts**: Dermal exposures of human receptors may occur in both indoor and outdoor environments, through direct dermal contact with chemically impacted soil and dust.
- **Ingestion of Locally Grown Produce**: Locally grown produce (such as vegetables and fruits grown in backyard gardens) may itself pose a source of exposure to some COCs. As chemicals are deposited from air-borne emissions, they may come into contact with leaves and fruit of crop plants. Deposition of chemicals onto soil may also result in an accumulation in plants through root uptake.
- **Ingestion of Breast Milk for Infants**: It is assumed that infants living in the surrounding area may be exposed to certain chemicals *via* their mother's breast milk. This exposure pathway was evaluated for only those COC such as polycyclic aromatic hydrocarbons that have the potential to "bio-accumulate".



Residential Exposure Scenario

Three cases were evaluated in the HHRA: Baseline, Airport Alone, and Cumulative Effects. For each of these cases, separate time periods were considered as part of the assessment, including current conditions (Year 2011) and two likely future conditions (Year 2022 and Year 2032).

- Baseline Case: included an assessment of existing and estimated background conditions in the absence of Toronto Pearson using recent regional air quality data for the following time periods:
  - Year 2011
  - Year 2022
  - Year 2032
- Airport Alone Case: included an assessment of emissions from Toronto Pearson alone during the following time periods:
  - Year 2011
  - Year 2022
  - Year 2032
- Cumulative Effects Case: included a quantitative evaluation of the cumulative effects of the Baseline Case ***plus*** the Airport Alone Case during the following time periods:
  - Year 2011
  - Year 2022
  - Year 2032

The Baseline Case included an assessment of existing and predicted background conditions (in the absence of Toronto Pearson) using recent regional air quality data. Existing criteria air contaminant (CAC) monitoring data were used to develop the 2011 Baseline Case, while Golder (2015) estimated future CAC concentrations for the 2022 and 2032 Baseline Cases. The CAC datasets for the 2022 and 2032 Baseline Cases were identical due to a lack of sufficient data to justify estimations beyond 2022. Existing volatile organic compound (VOC) monitoring data were used to develop each of the Baseline Cases.

The Airport Alone assessment evaluated the potential health impact related to the predicted ground-level air concentrations of each of the COCs contributed by each of the scenarios to off-site receptor locations in the surrounding community. The emphasis of the current HHRA was an evaluation of risks to human health from the Airport Alone Case.

The Cumulative Effects assessment evaluates the potential health impact related to the predicted ground-level air concentrations of each of the COCs contributed by the airport ***plus*** the existing background ambient concentrations of the COC based on the modelling of regional air quality within the Study Domain. The Cumulative Effects assessment was conducted to provide overall context related to regional conditions compared to the emissions specifically from the airport itself (*i.e.*, Airport Alone). Therefore, exposures to annual average concentrations of emissions from the Airport Alone operational scenario were compared against the Cumulative Effects Case (*i.e.,* Baseline Case emissions + Airport Alone emissions). Contributions from Toronto Pearson alone to background levels could not be evaluated for some chemicals due to limitations in the underlying Baseline Case dataset.

In order to ensure that the potential for adverse effects was not underestimated, conservative exposure assumptions were made through the HHRA. For example, residential receptors were assumed to never leave their designated receptor locations for their entire lifetime while being exposed to the maximum average air concentrations of chemicals of concern. Similarly, chemicals evaluated in the multi-media assessment were assumed to be 100% bioavailable *via* the oral route. While these assumptions are likely exaggerated, the conservative nature of these exposure scenarios ensures that the predicted chemical exposures were not underestimated.

What Chemicals were evaluated in the HHRA?

A current air emission inventory for the airport was developed by Golder (2015) using the US Federal Aviation Authority (FAA) Emissions and Dispersion Modelling System (EDMS). This airport-specific emissions inventory included modelled emissions from the airport property

related to aircraft, vehicular traffic, and other ancillary equipment for years 2011, 2022 and 2032.

Based on the chemical emissions from typical airports, a total volatile organic compounds (VOC) list consisting of 186 different VOCs was developed by Golder based on the output from the EDMS model. While these chemicals are associated with normal airport operations, many of these are emitted at negligible concentrations or are of low potential health concern based on their toxicological nature. To address this, a chemical screening approach was conducted such that the list of chemicals was reduced to those chemicals that are the most significant contributors to the predicted human health risk or combined into like-acting groups to facilitate evaluation.

Based on the percent composition of the VOCs in the list provided by Golder, VOCs that were determined to be emitted at negligible concentrations were removed from further evaluation in the assessment. Numerous VOCs that had predicted concentrations generally below 0.10% of total VOC emissions were removed based on percent-composition. However, despite the low predicted concentrations for some VOCs, a number were retained due to their toxicological properties. A total of 88 chemicals were excluded, representing less than three percent (3%) of the total VOC composition.

The remaining 98 VOCs were grouped together into 22 VOC groups based on the chemical and toxicological similarities of the chemicals. A "keystone" VOC, which was retained as a COC, was chosen to represent the VOC groupings based on its representative toxicity for the overall group. Each of the five (5) CACs identified by Golder were also retained as COCs for a total of 27 COCs.

Given that the primary source of COCs produced by Toronto Pearson operations are from air and vehicular traffic emissions to the atmosphere, the primary route of exposure for people is inhalation. As a result, all COCs were evaluated for exposures *via* the inhalation route. However, due to the physical-chemical properties of the individual evaluated chemicals, not all COCs emitted from the airport will persist or accumulate in the environment. Therefore, a screening was conducted to determine which COCs were to be evaluated for oral and dermal exposure pathways (*i.e.,* multi-media exposure assessment). Based on the screening, only one (1) COC was retained for the multi-media exposure assessment.

List of Selected Chemicals of Concern and Applicable Assessment

Chemicals of Concern	***Inhalation***	***Multi-Media***
Criteria Air Contaminants (CACs)		
Carbon monoxide	●	
Nitrogen dioxide (NO_2)	●	
Particulate matter - PM_{10}	●	
Particulate matter - $PM_{2.5}$	●	
Sulphur dioxide (SO_2)	●	
Volatile Organic Compounds (VOCs)		
Acetaldehyde	●	
Acetone	●	
Acrolein and related, as acrolein	●	
Aldehydes (other), as propionaldehyde	●	
Aliphatic alcohols, as methyl alcohol	●	
Alkanes/alkenes (other C1-C4)	●	
Alkanes/alkenes (other C5-C8)	●	
Alkanes/alkenes (other C>8-C10)	●	
Alkanes/alkenes (other C>10-C12)	●	
Alkanes/alkenes (other C>12-C16)	●	

Benzene and related, as benzene	●	
Butadiene, 1,3-	●	
Cycloalkanes and cycloalkenes, as cyclohexane	●	
Ethylbenzene and related, as ethylbenzene	●	
Formaldehyde and related, as formaldehyde	●	
Hexane, n-	●	
Naphthalene and related, as naphthalene	●	
Styrene	●	
Toluene and related,as toluene	●	
Xylenes, as total	●	
Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)		
PAHs as Benzo(a)pyrene Toxic Equivalents (BaP TEQ)	●	●

How were the Potential Risks Evaluated?

The risk characterization step integrates the exposure and hazard assessments to provide a conservative estimate of human health risk for the receptors assessed in the various exposure scenarios. Risk characterization involves comparing estimates of exposures (from the Exposure Assessment) with toxicity reference values (TRVs) published by various regulatory agencies (identified as part of the Hazard Assessment). This comparison (between predicted exposures and TRVs) can be expressed as a Concentration Ratio (CR) or Hazard Quotient (HQ) for non-carcinogenic chemicals and is calculated by dividing the predicted exposure by the regulatory TRV. In the case of carcinogenic chemicals, potential health risks are expressed as incremental lifetime cancer risks (ILCRs), and represent the incremental risk of an individual developing cancer over his or her lifetime due to exposures from a specific carcinogenic chemical.

One of the overarching goals of the HHRA is to ensure that the potential for adverse effects, or the risk, is not underestimated. In order to ensure this, the exposure and toxicological assumptions used to derive the risk estimates tended to be overprotective, or conservative. As a result, the human health risk estimates presented in the current report were considered conservative.

What were the Assessment Results and Overall Conclusions?

The results of the HHRA indicate that the predicted air emissions from some scenarios could potentially result in unacceptable health risks to the surrounding community. However, an exceedance of the acceptable risk levels does not necessarily indicate that an adverse health outcome will occur. As a result, further analyses were conducted to better understand why the exposure limits were exceeded.

The results of the acute inhalation assessment indicate that a limited number of short-term exceedances of the acceptable risk levels were predicted for SO_2, acrolein, and formaldehyde for at least one receptor location. Frequency analyses were conducted to determine how often the exposure limits were exceeded to provide a better understanding of the risk estimates. Based on these analyses, the predicted exceedances for these chemicals were highly intermittent in nature, and therefore were not considered to represent a significant health risk to the general population.

The results of the chronic inhalation assessment indicate that the predicted annual average air concentrations of acrolein, benzene, and formaldehyde exceeded the acceptable risk levels for at least one receptor location. As with the acute risks related to acrolein exposures, the chronic endpoint of concern for acrolein is specifically nasal irritation potentially leading to nasal lesions due to continuous long-term exposures to this irritant. Due to the absence of chronic human exposure data, laboratory animal data were used to derive the exposure limit used within the

assessment. Significant uncertainty factors that account for a great deal of conservatism in HHRA were applied to the animal test data for a relatively minor effect, such that the exposure limit derived is approximately 17,000 times lower than the test concentrations used in the laboratory study.

The estimated exposures for benzene and formaldehyde for years 2022 and 2032 resulted in ILCRs slightly greater than the MOECC acceptable regulatory-established cancer risk benchmark of 1-in-1,000,000. This suggests that the potential for an elevated level of risk above MOECC's acceptable ILCR may be present, the significance of which must be balanced against the high degree of conservatism incorporated in the risk assessment. For example, should the resident individual spend only half of their entire lifetime at the receptor location, the predicted ILCR for would be less than one-in-one million, or considered acceptable.

Further to this, the acceptable level of risk is an issue of policy rather than a scientific decision, and is set by regulatory agencies as opposed to risk assessors. Regulatory agencies have typically employed acceptable ILCR levels between 1-in-100,000 and 1-in-1,000,000. While the MOECC considers an ILCR of 1-in-1,000,000 to be acceptable for HHRAs in the Province of Ontario, Health Canada has specified that an ILCR of 1-in-100,000 is acceptable and is considered "essentially negligible". The highest ILCR predicted across all scenarios is less than this value specified by Health Canada.

For the multi-media assessment, none of the multi-media exposures (*i.e.*, soil, dust, home garden grown produce, and breast milk ingestion by infants) showed predicted risk levels that exceeded the relevant regulatory benchmark. Therefore, it is not anticipated that the deposition of chemicals from operations at Toronto Pearson would contribute to the development of adverse health effects in residents within the Study Domain.

In conclusion, the results of the HHRA indicate that the predicted air emissions could potentially result in unacceptable health risks to the surrounding community. However, an exceedance of the acceptable risk levels does not necessarily indicate that an adverse health will occur. Instead, the predicted exceedances for these chemicals were either based on highly intermittent events or on highly conservative exposure assumptions that are likely not representative of the general population. Therefore, it is not anticipated that the emissions from Toronto Pearson represent a significant health risk to the general population.

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HUMAN HEALTH RISK ASSESSMENT (HHRA) REPORT

1.0 INTRODUCTION

Toronto Pearson International Airport (Toronto Pearson) is located approximately 27 km northwest of the City of Toronto, in the City of Mississauga and is operated by the Greater Toronto Airports Authority (GTAA). The airport property borders on the City of Toronto, the City of Mississauga, and the City of Brampton. Toronto Pearson covers approximately 1,800 hectares and currently includes five runways, two main terminals (and several smaller satellite terminals), parking facilities, on-site public roads, a de-icing facility, a bus depot, emergency services (fire and ambulance), a cogeneration facility, and over 200 buildings, including administrative offices, hangers and garages, airline offices, and other supporting operations. The airport handles approximately 35 million passengers and 450,000 aircraft movements annually. Almost one quarter of Canada's population lives within 160 km of the airport.

Toronto Pearson has previously completed air quality emissions estimation and dispersion modelling in 1990/1991 and 2003/2004, and a human health risk assessment (HHRA) in 2003/2004 (with minor internal updates in 2010/2011). While noise issues continue to remain one of the predominant public concerns with respect to airports, Toronto Pearson is undertaking an update to its emissions inventory and dispersion modelling to better quantify and assess the current and projected future air quality associated with operations of the airport.

Many aspects of Toronto Pearson operations have changed since the last assessment, including new estimates of demand for air travel (commercial and personal), a constantly-changing aircraft fleet, newer and more efficient ground support equipment (GSE), modified operational guidelines, and new standard instrument departures (SIDs). The GTAA has also embarked on a plan for improving sustainability, which has involved reducing their airside vehicle fleet, decreasing fuel use (or replacing older equipment with newer), as well as other logistical improvements. All of these changes at Toronto Pearson demonstrate why it was necessary to complete an update of the emissions inventory, dispersion modelling, and HHRA.

To address these changes, Golder and Intrinsik partnered to complete a four phase air quality and human health risk study. Golder (2015) has provided the first three phases of the air quality assessment project, which included the development of an updated emission inventory for the airport property and the area extending in a 7.5 km radius around the airport property as well as the dispersion modelling for both on- and off-site sources to determine the cumulative effects of all sources at selected receptor sites. The air emissions inventory and dispersion modelling project was completed to quantify the current (2011) and likely future (2022 and 2032) air emission contributions from Toronto Pearson.

The fourth and final phase of the air quality study was to conduct a quantitative evaluation of health risks related to potential exposures to chemicals released during the operation of the airport. The quantification of potential chemical health risks was conducted through the use of the HHRA paradigm. The purpose of the current HHRA was to determine risk estimates based on three different exposure scenarios, including (1) an assessment of existing background conditions in the absence of Toronto Pearson; (2) an assessment of emissions from the Toronto Pearson alone; and, (3) a quantitative evaluation of the cumulative effects of the background conditions plus the airport alone. The three different exposure scenarios were assessed using the air emissions inventory and dispersion modelling information for the current year (2011) and the two future years (2022 and 2032). Golder (2015) provided 1-hour, 24-hour and annual average chemicals concentrations for the exposure scenarios described.

The current HHRA focused on scenarios where reasonable linkages have been established between a chemical emission and its potential to influence human health with a focus on those relevant to the communities surrounding Toronto Pearson (*e.g.*, soil, home garden produce, and air quality). The HHRA was conducted according to widely accepted risk assessment methodologies and guidance documents published and endorsed by regulatory agencies including the Ontario Ministry of the Environment and Climate Change (MOE, 2005; 2011), Health Canada (2010; 2012) and the United States Environmental Protection Agency (US EPA, 2005) to evaluate whether activities associated with Toronto Pearson might adversely impact health of individuals living, working or playing in the surrounding communities.

2.0 REVIEW OF STUDY METHODOLOGY AND ANALYSIS

2.1 Risk Assessment Framework

In general, a human health risk assessment, or HHRA, is a scientific study that evaluates the potential for the occurrence of adverse health effects from exposures of people (receptors) to chemicals of concern (COCs) present in surrounding environmental media (*e.g.*, air, soil, sediment, surface water, groundwater, food, *etc*.), under existing or predicted exposure conditions. HHRA procedures are based on the fundamental dose-response principle of toxicology. The response of an individual to a chemical exposure typically increases in proportion to the chemical concentration in critical target tissues where adverse effects may occur. The concentrations of chemicals in the target tissues (the dose) are determined by the degree of exposure, which is proportional to the chemical concentrations in the environment where the receptor resides, works or visits.

All chemicals (anthropogenic and natural) have the potential to cause effects in people and the ecosystem. However, it is the chemical concentration, the route of exposure, and the inherent toxicity of the chemical that determines the level of effect and potential for unacceptable risk to the exposed receptor. As illustrated in the diagram to the right, if all three components are present (*i.e.,* where the three circles intersect), the possibility of adverse risk exists.

The prediction of an individual's exposure to specific chemicals in the environment and the potential risks resulting from such exposures can be determined through the completion of a quantitative HHRA. The current HHRA follows the standard HHRA framework (see Figure 2-1) that is composed of the following steps:

i) Problem formulation;
ii) Exposure assessment;
iii) Hazard assessment; and,
iv) Risk characterization.

Typically, where potential adverse impacts are predicted through risk characterization, an additional step providing risk management and recommendations for mitigation measures to address these concerns can be added, if necessary. This risk management step is an integral to the EA process, to ensure the mitigation of any predicted potential health risks in the surrounding community, should they be identified.

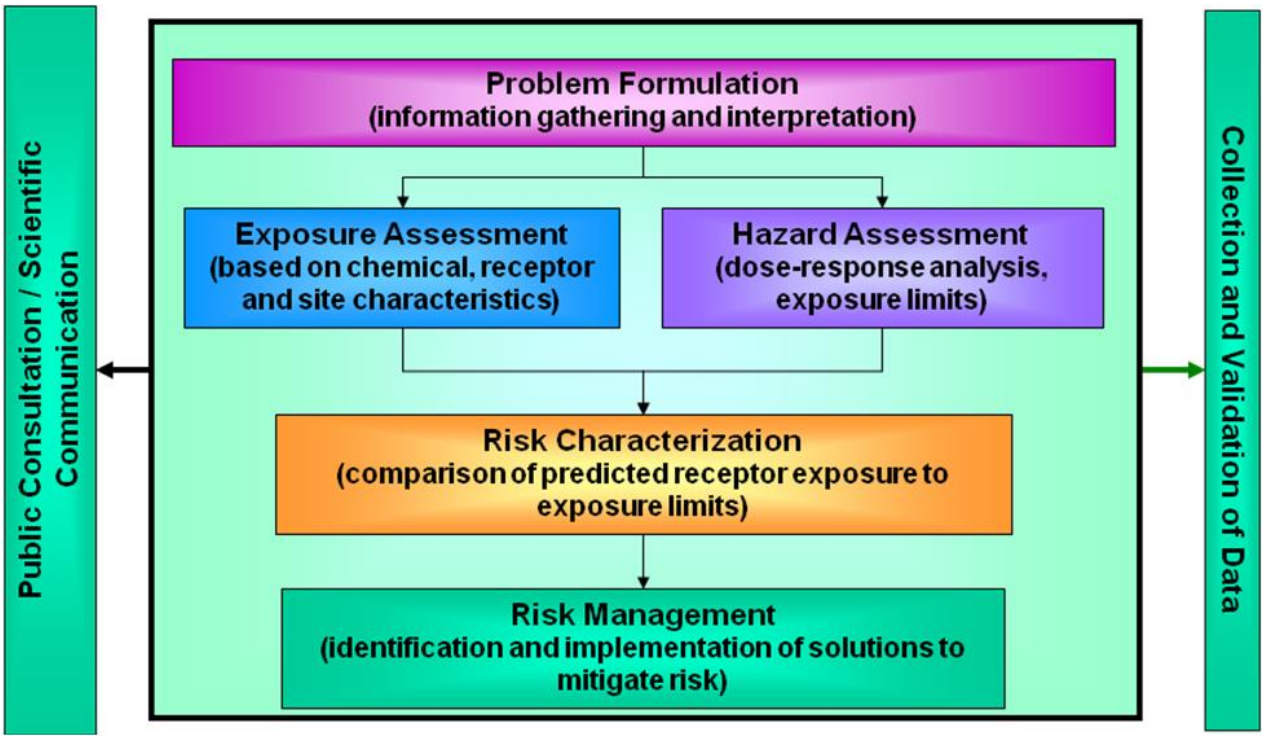


Figure 2-1 Overview of Standard HHRA Framework

2.1.1 Problem Formulation

The first step in the HHRA process is an information gathering and interpretation stage that plans and focuses the study on critical areas of concern for the Project. Problem formulation defines the nature and scope of the work to be conducted, permits practical boundaries to be placed on the overall scope of work and ensures that the assessment is directed at the key areas and issues of concern. This step is critical to the success of the HHRA as sound planning during the problem formulation step reduces the need for significant modifications once the HHRA has begun. The data gathered and evaluated in this step provides information into the physical layout and characteristics of the assessment area, possible exposure pathways, potential human receptors, COCs, and any other specific areas or issues of concern to be addressed.

The key tasks that comprise the problem formulation step of this HHRA include the following:

- **Site characterization**, which consists of a review of available project-specific data to identify factors affecting the availability of chemicals to potential receptors;
- **Chemical characterization**, which involves the identification of the COCs;
- **Receptor characterization** to identify "receptors of concern", which include those individuals with the greatest probability of exposure to chemicals from the proposed facility and those that have the greatest sensitivity to these chemicals; and,
- **Identification of exposure scenarios and pathways** takes into account chemical-specific parameters, such as solubility and volatility, characteristics of the site, such as physical geography, as well as the physiology and behaviour of the receptors.

The outcome of these tasks forms the basis of the approach taken in the HHRA.

2.1.2 Exposure Assessment

The exposure assessment evaluates data related to all chemicals, receptors and exposure pathways and routes identified during the problem formulation phase. As noted previously, the assessment of potential occurrences of adverse effects from chemicals is based on the dose-response concept that is fundamental to the responses of biological systems to chemicals (Filov *et al*., 1979; Amdur *et al.*, 1991). Since it is not usually practical to measure concentrations of chemicals at the actual site where the adverse response occurs within tissues and cells, these concentrations are estimated based on either the dose of the chemical that actually enters a receptor or, more commonly, by the concentrations in various environmental media that act as pathways for exposure. The degree of exposure of individuals to chemicals from the environment therefore depends on the interactions of a number of parameters, including:

- The concentrations of chemicals in various environmental media as determined by the magnitude of point sources as well as background or ambient concentrations;
- The characteristics of the chemicals of potential concern which affect environmental fate and persistence (*e.g.*, physical-chemical properties);
- The impact of site-specific characteristics, such as geology, geography and hydrogeology, on chemical behaviour;
- The physiological and behavioural characteristics of the receptors (*e.g.,* respiration rate, soils/dusts intake, time spent at various activities and in different environmental areas); and,
- The various physical, chemical and biological factors that determine the bioavailability of chemicals from various exposure pathways.

The primary objective of the exposure assessment was to predict, using a series of conservative assumptions, the rate of exposure of individuals living in the surrounding community (residential receptors) to the COCs through various exposure scenarios and pathways identified in the problem formulation step.

Given the nature of the aspects of Toronto Pearson under assessment, and that the primary source of COCs to the environment are *via* emissions to the atmosphere from airplanes and ground-support vehicles, the primary route of exposure for people is inhalation. However, for a subset of the COCs (*i.e.*, those considered persistent and/or bioaccumulative), there is the potential for deposition onto soils throughout the surrounding area, resulting in potential impacts to other exposure media (*e.g.*, soil, dust, locally grown produce, *etc*.). For these COCs, a multi-media assessment of potential risks related to oral and dermal exposures was conducted, in addition to the inhalation assessment.

For the inhalation exposure assessment, specific rates of exposure were not calculated. Rather, human exposures were conservatively assumed to be equal to ambient air concentrations (measured or modelled) of these substances (in $\mu g/m^3$). The inhalation assessment will evaluate health risks from acute and chronic exposures (*via* direct air inhalation only) for all of the COCs at each of the sensitive receptor locations in the surrounding community.

For the multi-media assessment, the rate of exposure of the selected receptors to the COCs *via* the various exposure scenarios, pathways, and routes identified in the problem formulation step is estimated. The overall objective is to predict, using a series of conservative assumptions, the rate of exposure (in µg chemical/kg body weight/day) to the COCs *via* the oral and dermal exposure routes identified in the problem formulation. As air exposures are evaluated as part of

the inhalation assessment, the multi-media assessment will focus on exposures arising from the oral and dermal pathways.

In order to evaluate potential exposures, it is necessary to characterize the physiological and behavioral characteristics of each receptor group. Several published sources were considered in the selection of these parameters, including:

- Federal Contaminated Sites Risk Assessment in Canada. PART I: Guidance on Human Health Risk Preliminary Quantitative Risk Assessment (PQRA) (Health Canada, 2012);
- Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario. Standards Development Branch, Ontario Ministry of the Environment. April 15th, 2011 (MOE, 2011);
- Compendium of Canadian Human Exposure Factors for Risk Assessment. O'Connor Associates Environmental Inc. 1155-2720 Queensview Dr., Ottawa, Ontario (Richardson, 1997);
- The US EPA Exposure Factors Handbook, 2011 Edition (Final). US Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F (US EPA, 2011);
- Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540//R/99/005. July, 2004 (US EPA, 2004); and,
- The US EPA Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (US EPA, 2005).

These sources have been used in numerous HHRAs and have been critically reviewed and accepted by regulatory agencies across Canada and the United States. The Compendium of Canadian Human Exposure Factors for Risk Assessment (Richardson, 1997), the MOE (2011) Rationale document, and Health Canada (2012) all rely on data from published and reliable Canadian sources, such as Health Canada, Statistics Canada, and the Canadian Fitness and Lifestyles Research Institute. Where insufficient data were available to appropriately characterize relevant activity patterns and/or behavioral/physiological characteristics, other sources such as the US EPA Exposure Factors Handbook (US EPA, 2011) were used.

2.1.3 Hazard Assessment

The hazard assessment involves identifying and understanding potential health outcomes that can result from exposure to each of the COCs and the conditions under which the outcomes might be observed. The hazard, or toxicity, assessment methodology is based on the fundamental dose response principle. That is, the response of biological systems to chemical exposures increases in proportion to the concentration of a chemical in critical target tissues where adverse health outcomes may occur.

2.1.3.1 Dose-Response Approaches

Two basic and quite different chemical categories are commonly recognized by regulatory agencies, depending on the compound's mode of toxic action, and applied when estimating toxicological criteria for humans (FDA, 1982; US EPA, 1989). These are the *threshold approach* (or the no-observed-adverse-effect levels [NOAELs]/benchmark dose with extrapolation/uncertainty factor approach) typically used to evaluate non-carcinogens, and the *non-threshold approach* (or the mathematical model-unit risk estimation approach), typically used for carcinogenic compounds.

Threshold Response Chemicals: For most effects, it is thought that there is a dose-response threshold below which no adverse effects would be expected to occur. This relationship is true for all chemicals that do not cause cancer by altering genetic material. Thresholds are generally assumed for non-carcinogenic effects because, for these types of effects, it is generally believed that homeostatic, compensating, and adaptive mechanisms must be overcome before toxicity is manifested. A NOAEL can be identified for threshold chemicals, which is the dose or amount of the chemical that results in no observable response in the most sensitive test species and test endpoint. The application of uncertainty or safety factors to the NOAEL provides an added level of protection, allowing for derivation of a *toxicity reference value* (TRV) or exposure limit that is expected to be safe to sensitive individuals following exposure for a prescribed period of time. Exposure limits derived for threshold-response chemicals are called reference concentrations (RfC), reference doses (RfD), acceptable daily intakes (ADI), tolerable daily intakes (TDI) or permissible daily intakes (PDI) and are generally derived by regulatory agencies such as Health Canada and the US EPA. These values indicate doses of chemicals that individuals can be exposed to on a daily basis over an entire lifetime without appreciable risk of the occurrence of adverse health effects.

Non-threshold Response Chemicals: This means that any exposure greater than zero is assumed to have a non-zero probability of causing some type of response or damage. This relationship is typically used for chemicals that can cause cancer by damaging genetic material. Under a "non-threshold" assumption, any exposure has some potential to cause damage, so it is necessary to define an "acceptable" level of risk associated with these types of exposures.

The acceptable level of risk is an issue of policy rather than a scientific decision (CCME, 2006), and is set by regulatory agencies as opposed to risk assessors. Regulatory agencies have typically employed acceptable incremental lifetime cancer risk (ILCR) levels (*i.e.*, over and above baseline) between 1-in-100,000 and 1-in-1,000,000. An ILCR represents the incremental risk of an individual within a given population developing cancer over his or her lifetime due to exposures from a specific carcinogenic compound.

- Health Canada has specified an ILCR of 1-in-100,000, which is considered "essentially negligible" (Health Canada, 2012).
- The Ontario MOECC considers an ILCR of 1-in-1,000,000 to be acceptable for human health risk assessments in the Province of Ontario.

ILCRs generally consider risks related to a particular Project (the Project alone, excluding any contribution from other background or pre-existing sources) in that the cancer risks are expressed on an incremental or additional basis as compared to cancer risks related to all sources. The current HHRA is being conducted in the Province of Ontario. As such, the ILCRs are reported relative to the Ontario acceptable ILCR of 1-in-1,000,000 (*i.e.*, one-in-one-million or 1×10^{-6}). This acceptable ILCR of 1-in-1,000,000 increases a person's lifetime cancer risk from 0.400000 (based on the existing 40% lifetime probability of developing cancer in Canada) to 0.400001.

Similar to an ILCR, the lifetime cancer risk (LCR) is an additional measure used to assess cancer. Unlike ILCRs, LCRs include the consideration of cancer risks from all sources including the particular facility under consideration. As such, LCRs are expressed on a total or all sources basis. MOECC has indicated that it may be appropriate to consider cancer risks in this manner, which has been done in the current assessment. The Ontario MOECC does not recommend an acceptable LCR for exposure to carcinogens associated with background or existing baseline conditions and, therefore, the LCR values (for "baseline" and "cumulative sources") are typically provided for reference only.

2.1.3.2 Exposure Limit Terminology

The terminology used to define threshold and non-threshold exposure limits differs according to the source/media and type of exposure and often varies between regulatory jurisdictions. The following terms are used to describe exposure limits in the current assessment.

Reference concentration (RfC): The US EPA defines a reference concentration as *"…an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.*" It can be derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. A reference concentration refers to the acceptable level of an airborne chemical for which the primary route of exposure is inhalation, and applies to either acute (*i.e.*, less than 24 hours) or chronic (*i.e.*, more than three months) exposure periods. The reference concentration is expressed as a concentration of the chemical in air (*i.e.,* micrograms per cubic metre, µg/m^3) and applies only to chemicals acting through a threshold mode of toxicological action.

For chemicals such as irritants and some combustion gases, short term or acute non-systemic toxicity is frequently observed at the points of entry into the body (*i.e.*, the respiratory tract, eyes, and skin, for airborne contaminants). In these cases, because the toxicity is enacted simply by direct contact between the receptor and the contaminated medium, the concentration in the air to which the receptor is exposed is the important measure of exposure, rather than the internal dose associated with multiple exposure pathways. For chemicals with these characteristics, short term RfCs are used to characterize health risk, and are intended to be protective of the general population.

Reference dose (RfD): The US EPA defines a reference dose as *"…an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime*". It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. The reference dose is most commonly expressed in terms of the total intake of the chemical per unit of body weight (*i.e.,* micrograms per kilogram of body weight per day, µg/kg bw/day) and applies only to chemicals acting through a threshold mode of toxicological action.

Inhalation unit risk (IUR): The US EPA defines a unit risk value as "*…the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/L in water, or 1 µg/m^3 in air".* The risks are referred to as "upper bound" because they are not likely to be underestimated and, in fact, may range from as low as zero to the upper bound value. A unit risk value of 3.0 x 10^{-5} per µg/m^3 would mean that under an upper worst-case estimate, three excess cancer cases would be expected to develop per one hundred thousand (100,000) people, if all 100,000 people were exposed every day for a lifetime to 1 µg of the chemical per m^3 of air.

Cancer slope factor (SF): The US EPA defines a cancer slope factor (SF) as *"…[a]n upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per mg/kg-day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100.*"

2.1.3.3 Exposure Duration

The toxicity of a chemical has been observed to vary between acute (short term) and chronic (long term) exposure. Thus, it is important to differentiate TRVs based on duration of exposure.

The two TRV durations used in the current HHRA can be described as follows:

- ***Acute:*** the amount or dose of a chemical that can be tolerated without evidence of adverse health effects on a short term basis. These benchmarks are routinely applied to conditions in which exposures extend from minutes through several hours or several days only (ATSDR, 2006). For the current HHRA, risks were evaluated based upon 1-hour and 24-hour exposure periods, where a relevant acute TRV for that time period is available.
- ***Chronic:*** the amount of a chemical that is expected to be without effect, even when exposure occurs continuously or regularly over extended periods, possibly lasting for periods of at least a year, and possibly extending over an entire lifetime (ATSDR, 2006).

As it would be inappropriate to establish a generic hierarchy of source agencies by which to select TRVs given the breadth of COCs evaluated in a typical HHRA, when TRVs for a one of the COCs were available from multiple regulatory agencies, all of the TRVs were reviewed and the professional judgment of experienced toxicologists was used to select the most appropriate TRV.

The most critical considerations in selecting TRVs were the source (it must have been derived by a reputable agency), the data used to derive the benchmark, the date the TRV was derived (it must be as up to date as possible), and its relevance in terms of duration and route of exposure. Both MOECC (MOE, 2005; 2011) and Health Canada (2010) provide lists of acceptable jurisdictions that maybe be used to determine toxicity reference values. The TRVs employed in the HHRA have been obtained from regulatory agencies such as:

- Ontario Ministry of the Environment and Climate Change (MOECC);
- Health Canada;
- Canadian Council of the Ministers of the Environment (CCME);
- World Health Organization (WHO);
- United States Environmental Protection Agency – Integrated Risk Information System (US EPA IRIS);
- Texas Commission on Environmental Quality (TCEQ);
- California Environmental Protection Agency (Cal EPA); and,
- Agency for Toxic Substances and Disease Registry (ATSDR).

Details on potential health outcomes associated with the COC, along with the basis of the TRVs, are outlined in toxicity profiles provided in Appendix A of this report.

2.1.4 Risk Characterization

The final step of a risk assessment is risk characterization. This involves the estimation, description, and evaluation of risk associated with exposure to COCs by comparing the estimated exposure to the appropriate regulatory benchmark or TRV for a specific chemical or group of compounds. Risk characterization involves the comparison of estimated exposures (identified in the exposure assessment) with regulatory benchmarks or TRVs (identified during the hazard/toxicity assessment) to identify potential human health risks. This comparison is typically expressed as a Concentration Ratio (CR) or Hazard Quotient (HQ) for non-carcinogenic chemicals and is calculated by dividing the predicted exposure by the regulatory benchmark/TRV. In the case of direct acting non-threshold carcinogenic chemicals, potential

risks are expressed as incremental lifetime cancer risks (ILCRs), and represents the incremental risk of an individual within a given population developing cancer over his or her lifetime due to exposures from a specific carcinogenic chemical of concern.

Separate assessments were completed for short term (acute) and long term (chronic) durations because the health outcomes produced by some COCs depend on the duration of exposure. It is important to distinguish between the health outcomes that might result from acute exposures *versus* effects that may occur following chronic exposures. In the chronic assessment, further distinction was made between inhalation alone (which included all emitted COCs) and multiple pathway exposures (*i.e.*, inhalation, oral and dermal together) since the pathway of exposure could also influence the potential health outcomes associated with each of the COCs.

In recognition of the influence of these exposure variables, risk estimates were segregated into:

- Acute inhalation (1-hour and 24-hour durations, or 8-hour durations in the case of carbon monoxide);
- Chronic inhalation (annual average durations); and,
- Chronic multi-media pathways (*i.e.,* oral and dermal exposures).

2.1.4.1 Concentration Ratios (CRs) and Hazard Quotients (HQs) for Non-Carcinogens

Concentration Ratios (CR)
CR values were used to evaluate the acute and chronic health risk from exposure to chemicals *via* inhalation. CR values were calculated by dividing the predicted ground-level air concentration (for 1-hour, 8-hour, 24-hour or annual average exposure durations) by the appropriate toxicity reference value (*i.e.*, RfC), according to the following example equation:

$$CR_{duration} = \frac{[Air]_{duration}}{RfC_{duration}}$$

Where:

$CR_{duration}$	=	the duration-specific *CR* (unitless), calculated for acute and chronic durations, as appropriate
$[Air]_{duration}$	=	the predicted ground-level air concentration (µg/m^3) for the specific time duration
$RfC_{duration}$	=	the RfC (µg/m^3) for the specific time duration

For a COC expected to be present in a single environmental media, such as the case with many gases which occur only or predominately in ambient air, a benchmark representing the entire exposure limit (*i.e.*, a CR value of 1.0) is considered appropriate. Therefore, a CR value of 1.0 (*i.e.*, 100% of the exposure limit) were used as acceptable CR value in the inhalation assessment. Acute and chronic CR values less than the selected benchmark (*i.e*., CR ≤1.0), indicate that predicted concentrations of COPC in air were less than the applicable inhalation exposure limit (*e.g*., RfC) and that adverse health effects would not be expected to occur.

When predicted risks are greater than the inhalation benchmark level (*i.e*., CR > 1.0), this indicates the potential for adverse health outcomes may exist. This outcome is referred to as an "exceedance" (*i.e.*, the predicted ground-level air concentration is greater than, or exceeds, the corresponding inhalation exposure limit for that averaging period). Re-evaluation of such CR estimates is important since both the exposure estimates and the toxicological criteria are based

on a series of conservative assumptions, particularly when considering the maximum "worst-case" exposure scenarios.

In general, interpretation of the CR values proceeded as follows:

CR ≤1:
Signifies that the estimated exposure is less than or equal to the TRV (*i.e.*, the assumed safe level of exposure). This situation is generally indicative of a negligible likelihood of inhalation health effects. Typically, a significant degree of conservatism (or protection) is incorporated during the derivation of a TRV and, therefore, if predicted exposures (under a worst case or highly conservative set of conditions) are less than a properly derived TRV, it can reasonably be concluded that predicted health risks are not of concern. An exception to this may be in the evaluation of certain criteria air contaminants where no threshold for effects has been identified.

CR >1:
Signifies that the exposure estimate exceeds the TRV. This suggests that the potential for an elevated level of risk may be present for a particular COC, and triggers an additional evaluation. The significance of a CR above 1 must be balanced against the degree of conservatism incorporated in the risk assessment (*e.g.,* an accounting of the number of assumptions used within the risk assessment that tend to overestimate, rather than underestimate, exposure and health risks).

Hazard Quotients (HQ)
Hazard Quotient (HQ) values were used to express risk resulting from chronic exposures to systemically acting, non-carcinogenic chemicals. This approach were used where the exposure to the chemical occurs through multiple pathways, and shows the additional risks related to the oral and dermal exposure pathways. HQ values were calculated by dividing the predicted exposure (*via* multiple pathways) by the appropriate toxicity reference value (RfD), according to the following example equation:

$$HQ = \frac{Exposure}{RfD}$$

Where:

HQ	=	the chronic Hazard Quotient (unitless), calculated for chronic exposures resulting from multiple pathways of exposure
Exposure	=	the chronic exposure estimate resulting from multiple pathways of exposure (µg/kg bodyweight/day
RfD	=	the chronic RfD (µg/kg bodyweight/day)

For chronic multi-media exposures, the CCME (2006) typically allocates 20% of the total exposure to any one environmental media during the derivation of its health-based soil quality criteria. This was based on the assumption that the source of exposure to a particular chemical may occur *via* five potential media: air, food, water, soil, and consumer products. A similar source attribution or allocation model has been adopted by the MOE (2011). This means that, in the absence of a multi-media assessment that takes into account multiple sources or media, the exposure limit should be apportioned for the single medium under consideration.

For the current assessment a benchmark of 0.2 was selected for the evaluation of the chronic multi-media assessment of airport alone emissions since not all potential exposure sources were considered (*i.e.*, the contribution of background sources of these chemicals were not quantified in the multi-media assessment). HQ values that are less than 0.2 represent a situation in which airport-related exposures (*e.g.*, facility and transport-related emissions) account for less than 20% of the oral exposure limit (*e.g.*, oral RfD). As a result, no adverse health risks are expected to be associated with the estimated level of exposure. When predicted health risks resulting from Project alone emissions were greater than the benchmark level (*i.e.*, HQ > 0.2), this may indicate the potential for adverse health outcomes among the most sensitive members of the population and triggers an additional evaluation. Re-evaluation of such HQs is important since both the exposure estimates and the TRV are based on a series of conservative assumptions, particularly when considering the maximum "worst-case" exposure scenarios.

In general, interpretation of the HQ values proceeded as follows:

HQ ≤0.2:
Signifies that the estimated exposure is less than or equal to 20% of the oral exposure limit (*i.e.*, the assumed safe level of exposure). This is generally indicative of a negligible likelihood of adverse human health effects. Typically an added assurance of protection is provided by the significant degree of conservatism (or protection) used during the development of regulatory exposure limits and predicted exposure estimates.

HQ >0.2:
Signifies that an exposure estimate exceeds 20% of the of the oral exposure limit. This generally suggests that the potential for an elevated level of health risk may exist for the specific COC and triggers an additional re-evaluation. The significance of an HQ above 0.2 must be balanced against the high degree of conservatism incorporated in the risk assessment (*e.g.*, an accounting of the number of assumptions used within the risk assessment that tend to overestimate, rather than underestimate, exposure and health risks)

2.1.4.2 Incremental Lifetime Cancer Risks (ILCRs) for Carcinogens

ILCR estimates were used to evaluate the increased cancer risk resulting from a lifetime of exposure to non-threshold genotoxic carcinogenic chemicals. ILCR estimates provide the incremental lifetime cancer risk resulting from contributions from Project emissions to the surrounding community.

Direct Air Inhalation
For carcinogenic chemicals evaluated as part of the inhalation assessment, ILCR estimates resulting from direct air inhalation were calculated as follows:

$$ILCR = [Air]_{Airport} \times IUR$$

Where:

ILCR	=	the incremental (or additional) lifetime cancer risk (unitless)
$[Air]_{Airport}$	=	the predicted annual average ground-level air concentration (µg/m^3) for the specific chemical arising from airport emissions
IUR	=	the chemical-specific inhalation unit risk value (µg/m^3)$^{-1}$

Multi-Media Exposure
For carcinogenic chemicals evaluated as part of the multi-media assessment, ILCR estimates resulting from a lifetime of exposure through multiple pathways were calculated as follows:

$$ILCR = LADD \times CSF$$

Where:

ILCR	=	the incremental lifetime cancer risk (unitless)
LADD	=	the incremental Lifetime Average Daily Dose *via* multiple pathways resulting from facility emissions (µg/kg bodyweight/day)
CSF	=	the chemical-specific cancer slope factor (µg/kg bodyweight/day)$^{-1}$

The resulting estimated incremental lifetime cancer risk can be compared to an acceptable risk level of cancer to determine if predicted exposures pose an unacceptable health risk. In the Province of Ontario, the acceptable ILCR is one-in-one million (or 1-in-1,000,000).

In general, interpretation of the ILCR values proceeded as follows:

ILCR ≤ 1.0 x 10^{-6} (1E-06):
Signifies that the estimated exposure results in an incremental lifetime cancer risk less than or equal to 1-in-1,000,000 (*i.e.*, within the accepted level of risk set by MOECC; Health Canada sets the level of essentially negligible risk at 1-in-100,000). This shows that negligible health risks are predicted. Added assurance of protection is provided by the high degree of conservatism (protection) incorporated in the derivation of the cancer-based unit risk and slope factor and the exposure estimate.

ILCR > 1.0 x 10^{-6} (1E-06):
Signifies the estimated exposure results in an incremental lifetime cancer risk greater than the MOECC acceptable regulatory-established cancer risk benchmark of 1-in-1,000,000. This suggests that the potential for an elevated level of risk above MOECC's acceptable ILCR (of 1-in-1,000,000) may be present for some COC, the significance of which must be balanced against the high degree of conservatism incorporated in the risk assessment.

2.1.5 Chemical Mixtures

Concurrent exposures to more than one chemical may result in toxicological interactions which produce health outcomes; this may also result in a combined toxicity which is equal to the sum of toxicities of the individual chemicals (additivity or independence), greater than the sum (synergism or potentiation) or less than the sum (antagonism). In general, toxicological interactions depend on the chemicals present, the levels of exposure to each, their mode of action and their concentrations. Most non-additive interactions can only be demonstrated at relatively high exposures, where clear adverse health outcomes are observed. Such interactions have not been observed or quantified at the relatively low rates of exposure typical of those associated with most environmental situations (NAS, 1983; Krewski and Thomas, 1992).

Because chemical exposures rarely occur in isolation, the potential health outcomes associated with mixtures of the COCs were assessed in the HHRA. The interaction between chemicals can take many forms, with additive interactions being assumed for the HHRA (Health Canada, 2012). Additive interactions apply to chemicals that are structurally similar, act toxicologically through similar mechanisms or affect the same target tissue in the body (*i.e.,* share common health outcome) (Health Canada, 2012).

The evaluation of risks related to chemical exposures in mixtures is an emerging science. There are currently no regulatory benchmarks or specific guidance (beyond those chemical groups that have established *toxicity equivalency factors* or TEFs) by which one could evaluate whether exposure to a given mixture could pose a health concern. While the MOECC has not developed specific guidance on chemical mixtures assessment beyond these chemical types, there is a requirement under the Provincial regulations to consider cumulative effects (*i.e.*, the additive or synergistic effects of chemical mixtures) when conducting risk assessments. Since discussions on acceptable benchmarks for chemical mixtures are emerging, MOECC has recommended that as a minimum, HQs and ILCRs are summed when toxicologically justified (*e.g.*, common modes of toxicological action) and when significant mixture interactions are identified (*i.e.*, independent modes of action at any level of disposition) that they be qualitatively discussed (MOE SDB, personal communication, 2010). However, this is considered a highly conservative approach, as the ILCR represents the incremental risk of an individual within a given population developing cancer over his or her lifetime due to exposures from a *specific* carcinogenic chemical, and has historically not been intended for use in evaluating the risk from a mixture of COCs. Therefore, only HQs for non-carcinogenic endpoints have been summed, where toxicologically justified, for illustrative purposes.

3.0 PROBLEM FORMULATION

The current assessment followed standard risk assessment methods, and was conducted in compliance with the risk assessment procedures endorsed by regulatory agencies including Health Canada, the CCME, and the US EPA, as well as guidance provided by the MOECC.

3.1 Overview of Problem

Toronto Pearson has previously completed air quality emissions estimation and dispersion modelling in 1990/1991 and 2003/2004, and an HHRA in 2003/2004 (with minor internal updates in 2010/2011). While noise issues continue to remain one of the predominant public concern with respect to airports, Toronto Pearson is undertaking an update to its emissions inventory, dispersion modelling and HHRA to better quantify and assess the current and projected future air quality associated with operations of the airport.

Many aspects of Toronto Pearson operations have changed since the last assessment, including new estimates of demand for air travel (commercial and personal), a constantly-changing aircraft fleet, newer and more efficient Ground Support Equipment (GSE), modified operational guidelines, and new Standard Instrument Departures (SIDs). The GTAA has also embarked on a plan for improving sustainability, which has involved reducing their airside vehicle fleet, decreasing fuel use (or replacing older equipment with newer), as well as other logistical improvements. All of these changes at Toronto Pearson demonstrate why an update of the emissions inventory, dispersion modelling, and HHRA was necessary.

To address these changes, Golder and Intrinsik partnered to complete a four phase air quality and human health risk study. These phases include:

- **Phase 1:** The creation of a current emission inventory for the airport property, including aircraft, using the U.S. Federal Aviation Authority's Emissions and Dispersion Modelling System (EDMS). This phase was completed by Golder (2015);
- **Phase 2:** The creation of a current emission inventory for an area extending in a 7.5 km radius around the airport property. Data to support this inventory may be obtained from the Ontario Ministry of the Environment. This phase was completed by Golder (2015);
- **Phase 3:** The completion of dispersion modelling for both on- and off-site sources to determine the combined impact (or cumulative effects) of all sources at selected receptor sites and compare results from two nearby Federal and Provincial ambient air monitoring stations. Cumulative effects from on- and off-site sources were determined at selected receptors and were compared to ambient air quality data (CACs and VOCs) from the Toronto Pearson air quality station and two local ambient air quality stations (Centennial Park 60413 and Brampton 60428). This phase was completed by Golder (2015); and,
- **Phase 4:** The completion of an HHRA based on the accumulated data. Ambient air quality data (select VOCs) were utilized for the evaluation of background and cumulative effects from on- and off-site sources from a local ambient air quality station (Centennial Park 60413) and an air quality station in Windsor, Ontario (60211). This phase was completed by Intrinsik (current report).

Figure 3-1 provides an aerial overview of the existing Toronto Pearson International Airport.

LEGEND

Approximate Site Boundary

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Imagery - ESRI World Imagery WMS, 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

600 300 0 600 1,200 1,800
SCALE 1:50,000 METRES

Aerial View of the Toronto Pearson International Airport Property (Golder, 2015)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	27 Feb. 2014		
GIS	ME	27 Feb. 2014		
CHECK	EH	27 Feb. 2014		
REVIEW	AB	27 Feb. 2014		

Figure 3-1

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudyPhase2_Report\January2015\Figure1_SiteLocationPlan.mxd

3.1.1 Assessment Scenarios Evaluated

To ensure that potential incremental and cumulative environmental effects from Toronto Pearson were adequately assessed, exposure and risk estimates were developed for several different assessment scenarios.

Three cases were evaluated in the HHRA: i) Baseline; ii) Airport Alone; and, iii) Cumulative Effects. For each of these cases, separate time periods were considered as part of the assessment, including current conditions (Year 2011) and two likely future conditions (Year 2022 and Year 2032).

- Baseline Case: included an assessment of existing and estimated background conditions in the absence of Toronto Pearson (*i.e.*, product of Phase 2 of the Study) using recent regional air quality data for the following time periods:
  - Year 2011
  - Year 2022
  - Year 2032
- Airport Alone Case: included an assessment of emissions from Toronto Pearson alone (*i.e.*, product of Phase 1 of the Study) during the following time periods:
  - Year 2011
  - Year 2022
  - Year 2032
- Cumulative Effects Case: included a quantitative evaluation of the cumulative effects of the Baseline Case plus the Airport Alone Case (*i.e.*, product of Phase 3 of the Study) during the following time periods:
  - Year 2011
  - Year 2022
  - Year 2032

The emissions inventories in the different assessment scenarios evaluated in the current HHRA (described in Section 3.3) were identical with only the individual chemical concentrations varying among the scenarios and time periods.

The Baseline Case included an assessment of existing background conditions, in the absence of Toronto Pearson (*i.e.*, product of Phase 2 of the Study) using recent regional air quality data. The results of this assessment are presented in Appendix E. Existing criteria air contaminant (CAC) monitoring data were used to develop the 2011 Baseline Case, while Golder (2015) estimated future CAC concentrations for the 2022 and 2032 Baseline Cases. The CAC datasets for the 2022 and 2032 Baseline Cases were identical due to a lack of sufficient data to justify estimations beyond 2022. Existing volatile organic compound (VOC) monitoring data were used to develop each of the Baseline Cases.

The Airport Alone Case included an assessment of emissions from Toronto Pearson alone (*i.e.*, product of Phase 1 of the Study) during years 2011, 2022, and 2032. The Airport Alone assessment evaluates the potential health impact related to the predicted ground-level air concentrations of each of the COCs contributed by each of the scenarios to off-site receptor locations in the surrounding community. The emphasis of the current HHRA was an evaluation of risks to human health from the Airport Alone Case.

The Cumulative Effects Case included a quantitative evaluation of the cumulative effects of the Baseline Case plus the Project Alone Case (*i.e.*¸ product of Phase 3 of the Study) during years 2011, 2022, and 2032. The cumulative effects assessment evaluates the potential health impact related to the predicted ground-level air concentrations of each of the COCs contributed by the airport ***plus*** the background ambient concentrations of the COC based on the modelling of regional air quality within the Study Domain. Therefore, exposures to annual average

concentrations of emissions from the Airport Alone operational scenario were compared against the Cumulative Effects Case (*i.e.,* Baseline Case emissions + Airport Alone emissions). Contributions from Toronto Pearson alone to background levels could not be evaluated for some chemicals due to limitations in the underlying Baseline Case dataset.

The maximum ground-level air concentrations predicted under the cumulative assessment may not necessarily represent realistic cumulative contributions, as the worst-case regional background contribution rarely occurs at the same time as the worst-case project scenario contribution given regional traffic and meteorological conditions. The results of this assessment are presented in Appendix E.

3.2 Site Characterization

Toronto Pearson International Airport is located approximately 27 km northwest of the City of Toronto, in the City of Mississauga and is operated by the GTAA. The airport property borders on the City of Toronto, the City of Mississauga, and the City of Brampton. Toronto Pearson covers approximately 1,800 hectares and currently includes five runways, two main terminals (and several smaller satellite terminals), parking facilities, on-site public roads, a de-icing facility, a bus depot, emergency services (fire and ambulance), a cogeneration facility, and over 200 buildings including administration, hangers and garages, airline offices and other supporting operations. The airport handles approximately 35 million passengers and 450,000 aircraft movements annually. Almost one quarter of Canada's population lives within 160 km of the airport.

The air quality and HHRA Study Domain has been defined as the area extending 7.5 km from Toronto Pearson and was selected in order to maintain consistency with the previous air quality report. The predominant land uses within the Study Domain are residential and commercial. Land use over the general area in which the Study Domain is located is shown in Figure 3-2.

592000 596000 600000 604000 608000 612000 616000 620000 624000 628000

4848000 4844000 4840000 4836000 4832000 4828000 4824000

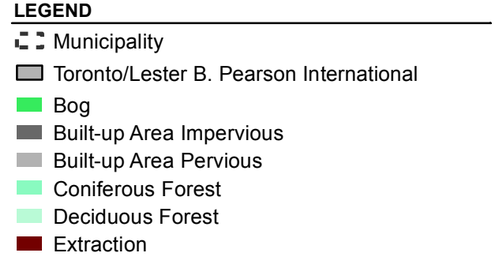
TOWN OF CALEDON
CITY OF VAUGHAN
CITY OF MARKHAM
CITY OF BRAMPTON
CITY OF MISSISSAUGA
CITY OF TORONTO
TOWN OF HALTON HILLS
TOWN OF MILTON
Lake Ontario

HIGHWAY 400
HIGHWAY 407
HIGHWAY 400 SOUTH
HIGHWAY 427 NORTH
HIGHWAY 409 WEST
HIGHWAY 401 COLLECTOR EAST
WILLIAM R ALLEN ROAD SOUTH
HIGHWAY 410
HIGHWAY 401 EAST
HIGHWAY 427 EXPRESSWAY SOUTH
F G GARDINER EXPRESSWAY WEST
HIGHWAY 401
HIGHWAY 403
QUEEN ELIZABETH WAY

N

LEGEND

- Municipality
- Toronto/Lester B. Pearson International
- Bog
- Built-up Area Impervious
- Built-up Area Pervious
- Coniferous Forest
- Deciduous Forest
- Extraction
- Forest
- Hedge Rows
- Marsh
- Mixed Forest
- Open Water
- Plantations - Tree Cultivated
- Swamp
- Tallgrass Woodland
- Transportation
- Undifferentiated



REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4
SCALE 1:120,000 KILOMETRES

Land Use Surrounding Toronto Pearson (Golder, 2015)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0	
DESIGN	ME	13 Jun. 2014	Figure 3-2		
GIS	ME	13 Jun. 2014			
CHECK	EH	13 Jun. 2014			
REVIEW	AB	13 Jun. 2014			

G:\Projects\2013\13-1151-0169_GTAA_Air_Quality_Study\GIS\MXDs\Reporting\AirQualityStudy\Phase2_Report\Figure3_LandUse.mxd

3.2.1 Sensitive Receptor Locations

Relying on predicted ground-level air concentrations at the maximum point of impingement (MPOI) from a project emission source to evaluate human health risks, particularly chronic risks, is considered a very conservative (*i.e.*, protective) approach. By definition, predicted ground-level air concentrations at all other locations are lower than those predicted at the MPOI. As such, the standard risk assessment approach is to also evaluate exposures and potential health risks at several specific sensitive receptor locations surrounding the project-specific emission sources.

To assess potential risks related to the projected emissions from Toronto Pearson and regional background sources, the Project Team selected key locations representative of the surrounding community. At each of these receptor locations, potential exposure scenarios were developed and potential health impacts were evaluated for individuals working or living at the chosen locations based upon predicted ground level airborne concentrations of the assessed chemicals.

It was not possible to consider exposures by all routes to every person (human receptor) within the area around Toronto Pearson who may be active at specific locations where there are predicted concentrations of COCs. On the other hand, it is important that the assessment is sufficiently comprehensive to ensure that overall risks have been adequately addressed. Accordingly, exposure scenarios were established using a select group of receptors (*i.e.*, representative individuals) that can be considered to be at greatest potential risk for adverse health effects associated with COCs. These scenarios were developed using conservative assumptions, as discussed throughout this report. In this context, conservative is taken to mean including the conditions of highest exposure that could be expected to be encountered by a person. The assessment was prepared for the most adverse of conditions, and should exaggerate small effects.

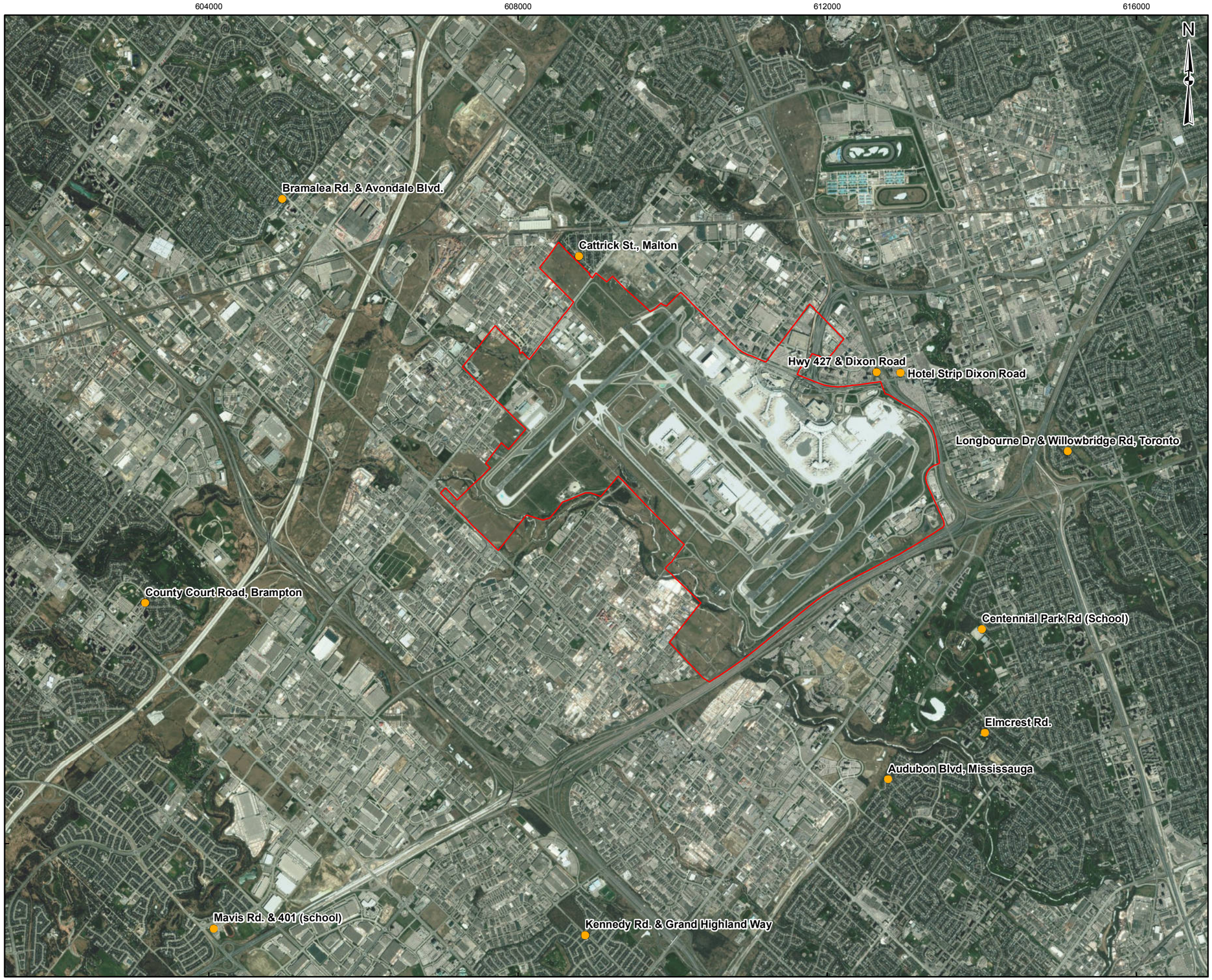
For each exposure scenario, the most sensitive human receptors were considered. Characteristics of human receptors were selected to reflect the most sensitive life stage class (sex and age group), and the essential physical characteristics such as body weight, surface area, inhalation rate, and relative fitness.

As noted previously, the area surrounding the Toronto Pearson is composed of a mixture of residential and commercial use. Therefore, a number of receptor locations representative of both residential and commercial receptor locations were selected for evaluation. Potential exposures and health risks were determined for twelve (12) specific locations in the area surrounding Toronto Pearson (Table 3-1; Figure 3-3)

Table 3-1 Sensitive Receptor Locations

Location ID	*Receptor Location*	*Location Land Use*
MPOI	Maximum Point of Impingement	Industrial
R1	Highway 427 and Dixon Road in Etobicoke	Commercial
R2	Hotel Strip and Dixon Road in Etobicoke	Commercial
R3	Longbourne Drive and Willowbridge Road in Etobicoke	Residential
R4	Centennial Park Road in Etobicoke	Residential
R5	Audubon Blvd. in Mississauga	Residential
R6	County Court Road in Brampton	Residential
R7	Cattrick Street in Malton	Residential
R8	Bramalea Rd. and Avondale Rd. in Brampton	Residential
R9	Elmcrest Rd. in Etobicoke	Residential
R10	Kennedy Rd. and Grand Highland Way in Mississauga	Residential
R11	Mavis Rd. and 401 in Mississauga	Residential

It should be noted that no specified location for the MPOI receptor location is shown on Figure 3-3, which includes the eleven (11) sensitive receptor locations (*i.e.,* R1 through R11). Instead, the MPOI Location ID refers to the location of the maximum concentration for a chemical that could occur anywhere shown on Figure 3-4 that is not on the Toronto Pearson property. This was accomplished by modelling gridded receptors within the 7.5 km study domain (in additional the specific receptor locations). All gridded receptors were modelled with local terrain elevations, based on terrain data provided by the MOECC. In addition, receptor locations were placed approximately every 50 metres along the fence line of the airport property. While the MPOI may be present anywhere within the Study Domain, the MPOI associated with Toronto Pearson emissions (*i.e.,* Airport Alone) was always found to be bordering the Toronto Pearson property line. Receptors within the Toronto Pearson property line were removed as per standard practice.



LEGEND

- Individual Receptors
- Approximate Site Boundary

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Imagery - ESRI World Imagery WMS, 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

1 0.5 0 1 2 3
SCALE 1:50,000 KILOMETRES

Air Quality Study Sensitive Receptor Locations (Golder, 2015)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	2014-09-15		
GIS	ME	2014-09-15		
CHECK	AB	2014-09-15		
REVIEW				

Figure 3-3

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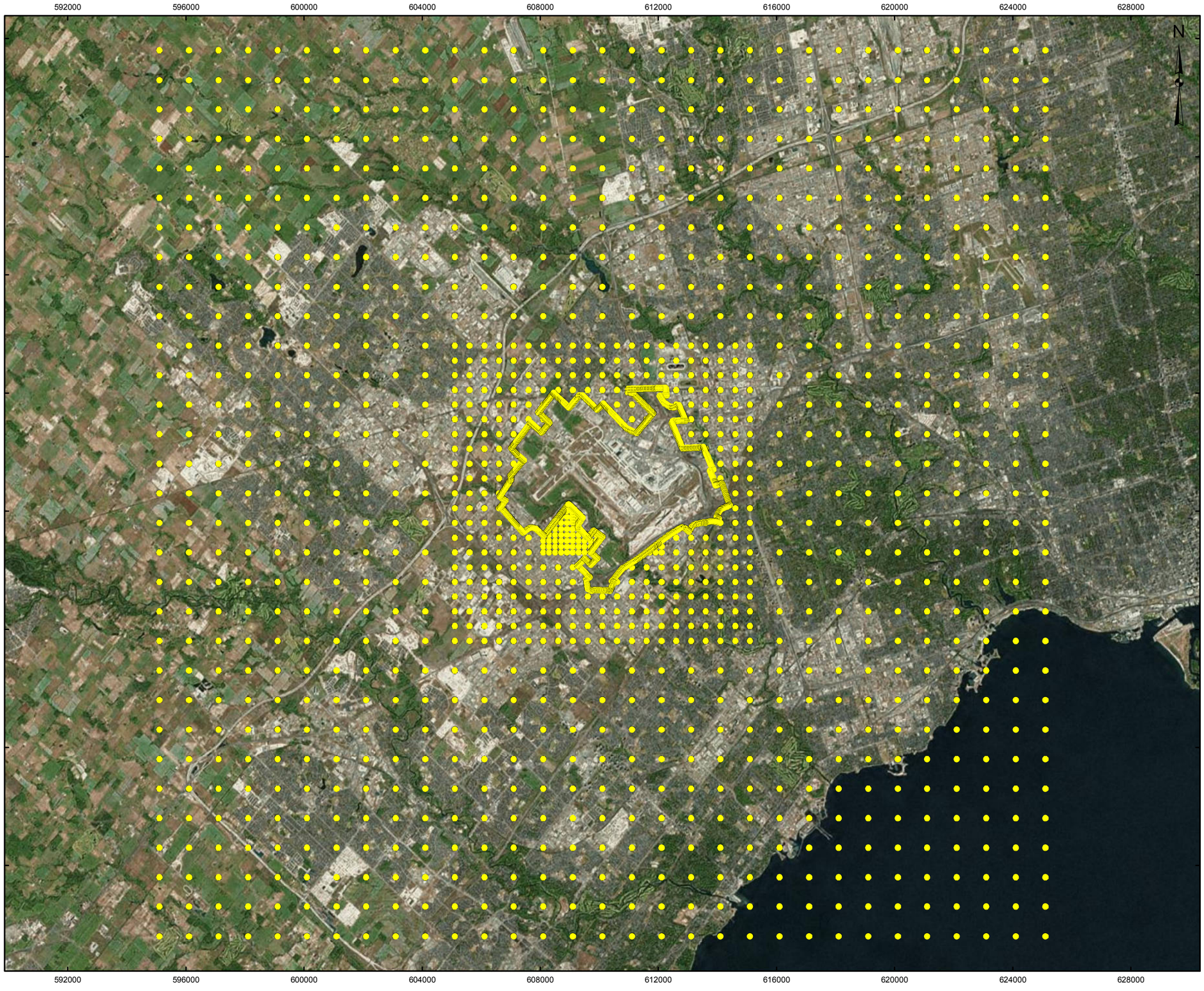

LEGEND

- Gridded Receptors

REFERENCE

Base Data - MNR LIO, obtained 2009
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2012
Imagery - ESRI World Imagery WMS, 2014
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

2 1 0 2 4 6
SCALE 1:130,000 KILOMETRES

Air Quality Study Gridded Receptor Locations (Golder, 2015)

Golder Associates
Mississauga, Ontario

PROJECT NO. 13-1151-0169			SCALE AS SHOWN	REV. 0.0
DESIGN	ME	27 Feb. 2014		
GIS	ME	5 Mar. 2014		
CHECK	EH	5 Mar. 2014		
REVIEW	AB	5 Mar. 2014		

Figure 3-4

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3.3 Identification of Chemicals of Concern (COC)

The chemicals of concern (COCs) described in the current assessment were selected based upon the predicted impacts of emissions from Toronto Pearson as well as from off-site, non-GTAA-related sources and activities (*i.e.,* background).

3.3.1 Toronto Pearson Chemical Inventory

A current air emission inventory for the airport was developed by Golder (2015) using the US Federal Aviation Authority (FAA) Emissions and Dispersion Modelling System (EDMS). This emissions inventory included modelled emissions from the airport property related to aircraft, vehicular traffic, and other ancillary equipment for years 2011, 2022 and 2032.

Emissions for the 2011 scenario were calculated based on the actual aircraft arrival and departure schedule for that year and emissions from roadways and parking facilities were calculated based on traffic counts and varied using EDMS default schedules (Golder, 2015). EDMS calculated total annual 2011 emissions for carbon monoxide (CO), total hydrocarbons, non-methane hydrocarbons, total volatile organic compounds (VOCs), total organic gases, nitrogen oxides (NO_x), sulphur dioxides (SO_x), particulate matter (as PM_{10} and $PM_{2.5}$), non-volatile particulate matter, volatile sulphates particulate matter, and volatile organic particulate matter.

Emissions for 2022 and 2032 were also calculated using EDMS based on the internal database for each aircraft type and operational mode. The 2011 Toronto Pearson schedule was used to determine peak and off-peak aircraft movement times by developing operational profiles for month of year, day of week and quarter hour of day. Anticipated 2022 and 2032 aircraft movements and types were then distributed throughout the calendar year based on the 2011 schedule. Aircraft movements were scaled up for the future year scenarios (2022 and 2032) using estimated future passenger counts, which are expected to increase *versus* 2011 (Golder, 2015).

Based on the emissions from Toronto Pearson, a total VOC list consisting of 186 VOCs for the 2011, 2022 and 2032 scenarios was developed by Golder based on outputs from EDMS. While these chemicals are associated with normal airport operations, many of these are emitted at negligible concentrations or are of low potential health concern based on their toxicological nature. To address this, a chemical screening approach was conducted such that the list of chemicals was reduced to those chemicals that are the most significant contributors to the predicted human health risk.

Based on the percent composition of the VOCs in the list provided by Golder, VOCs that were determined to be emitted at negligible concentrations were removed from further evaluation in the assessment. Numerous VOCs that had predicted concentrations generally below 0.10% of total VOC emissions were removed based on percent-composition. However, despite the low predicted concentrations for some VOCs, a number were retained due to their toxicological properties. A total of 88 chemicals were excluded, representing less than three percent (3%) of the total VOC composition.

The remaining 98 VOCs were grouped together into 22 VOC groups based on the chemical and toxicological similarities of the VOCs. A “keystone” VOC was chosen to represent the VOC groupings.

Table 3-2 presents the VOCs chosen as “keystone” VOCs and retained as COCs. All criteria air contaminants (CACs) identified by Golder were also retained as COCs for further evaluation. The selection process of the COCs is fully described in Appendix B.

Table 3-2 List of Chemicals of Concern (COCs) Selected for the HHRA
Criteria Air Contaminants (CACs)
Carbon monoxide (CO)
Nitrogen dioxide (NO_2)
Particulate matter - PM_{10}
Particulate matter - $PM_{2.5}$
Sulphur dioxide (SO_2)
Volatile Organic Compounds (VOCs)
Acetaldehyde
Acetone
Acrolein and related, as acrolein
Aldehydes (other), as propionaldehyde
Aliphatic alcohols, as methyl alcohol
Alkanes/alkenes (other C1-C4)
Alkanes/alkenes (other C5-C8)
Alkanes/alkenes (other C>8-C10)
Alkanes/alkenes (other C>10-C12)
Alkanes/alkenes (other C>12-C16)
Benzene and related, as benzene
Butadiene, 1,3-
Cycloalkanes and cycloalkenes, as cyclohexane
Ethylbenzene and related, as ethylbenzene
Formaldehyde and related, as formaldehyde
Hexane, n-
Naphthalene and related, as naphthalene
Styrene
Toluene and related,as toluene
Xylenes (total)
Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)
PAHs as Benzo(a)pyrene Toxic Equivalents (BaP TEQ)

3.3.2 Regional Background Chemical Inventory

COCs were identified based upon the predicted impacts of emissions from off-site, non-GTAA related sources and activities (*i.e.,* background). Regional emissions within the 7.5 km radius of the airport were quantified using Environment Canada’s 2006 SMOKE emissions inventory (Environment Canada, 2006) as well as transportation-related emissions provided by MOECC (Golder, 2015).

In order to realistically allocate the emissions determined by Environment Canada (2006) to the area within 7.5 km of Toronto Pearson, the Study Domain was divided into 516 1-km by 1-km grid cells. Emissions were apportioned to each cell according to the facilities, operations or land uses of each cell. Land use data were obtained from the Region of Peel. Each grid cell was treated as a separate area source and assigned emissions parameters (Golder, 2015). These data were assumed to be representative of regional background concentrations for the 2011 scenario.

The contaminants of interest included in the regional background emissions inventory for use within the HHRA included NO_2, SO_2, CO, $PM_{2.5}$, PM_{10}, which are collectively identified in the current assessment as the CACs. Regional background emissions data from SMOKE

(Environment Canada, 2006) were also available for total VOCs but this information was not utilized within the HHRA as the VOC data were unspeciated.

Utilizing air concentration trend information, Golder (2015) adjusted the estimated 2011 regional background emissions inventory for the CACs to predict for the future scenarios evaluated within the assessment (*i.e.,* 2022 and 2032).

Regional background VOC data from the National Air Pollution Surveillance Program (NAPS) of Environment Canada were used to support the Background Case and Cumulative Effects Case assessments (Appendix E). The data were largely collected from a local ambient air quality station (Centennial Park, NAPS 60413), which is located near receptor locations R4 and R9.

The station provided speciated ambient air quality data for those VOCs that were identified as COCs based on EDMS modelling described in Section 3.3.1. The data used in the HHRA were collected from the station in 2011.

However, ambient air data from the Centennial Park NAPS station were not available for all COCs, namely acetone, aliphatic alcohols, alkanes/alkenes with C>12-16, and the aldehydes, which encompasses a total of seven (7) COC groupings evaluated in the HHRA (*i.e.,* acetaldehyde, acetone, acrolein, aliphatic alcohols, alkanes/alkenes (other C>12-16), formaldehyde, and other aldehydes) (Section 3.3.1).

An air quality station from another large urban area, Windsor, Ontario (60211) was identified to have ambient air quality data representative of five (5) COC groups missing from the Centennial Park dataset (*i.e.,* acetaldehyde, acetone, acrolein, formaldehyde, and other aldehydes) (Section 3.3.1). These data, collected in 2010 were used in the Background Case and Cumulative Effects Case assessments.

While Windsor is an urbanized area, the density and intensity of other emissions sources within the Study Domain, such as the 400-series highways surrounding Toronto Pearson, are not likely adequately captured within the NAPS data used for the five (5) COC groups missing from the Centennial Park dataset. However, in the absence of more adequate data, this represents a source of uncertainty.

Suitable speciated ambient air quality data representative of the aliphatic alcohols and the alkanes/alkenes (other C>12-16) were not identified. As a result, Background Case and Cumulative Effects case estimated exposure point concentrations and risk estimates could not be calculated.

Ambient air concentrations collected from 2010 (Windsor) and 2011 (Centennial Park) were not adjusted to predict for the future scenarios evaluated within the assessment (*i.e.,* 2022 and 2032). Therefore, the ambient air concentrations for the VOCs evaluated for the Background Case assessment are identical for years 2011, 2022, and 2032. Based on regional air quality trends described by Golder (2015), which generally indicate improvements in air quality over the past 20 years, the assumption that Study Domain air quality will not change from 2011 through 2032 is likely conservative.

3.3.3 Chemical Screening to Determine Relevant Exposure Pathways

The following sections provide an overview of the screening approaches used to select the COCs evaluated for inhalation and multi-pathway (*i.e.,* oral and dermal) exposures in the current assessment.

3.3.3.1 Inhalation Exposures

Detailed screening of chemicals to select those COCs that pose the greatest concern from both a quantity and toxicological relevance point-of-view is a standard approach in risk assessment to ensure the most relevant COCs were selected for consideration. As described previously, this evaluation was conducted by evaluating the relative potency and abundance based on ground-level air concentrations at the MPOI and selected specific receptor locations in the community around the airport.

Given that the primary source of COCs produced by Toronto Pearson operations are from air and vehicular traffic emissions to the atmosphere, the primary route of exposure for people is inhalation.

3.3.3.2 Multi-Pathway Exposures

Due to the physical-chemical properties of the individual evaluated chemicals, not all COCs emitted from the airport will persist or accumulate in the environment. To identify the COCs that were considered in the multi-pathway risk assessment, the physical-chemical properties of each of the COCs were compared to accepted national and international criteria for the classification of persistent and bio-accumulative substances (Rodan *et al.,* 1999; Environment Canada, 2006).

The multimedia/multi-pathway screening approach used in the current assessment was adapted based upon the methodology presented in *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* document (US EPA, 2005), and is the standard approach in these types of assessments. The approach accounts for soil loss over time through both degradation and volatilization.

The characterization of persistence and bio-accumulation is provided in detail within Environment Canada's Existing Substances Program and the Health Canada and Environment Canada's Domestic Substances List Categorization, under the *Canadian Environmental Protection Act* (CEPA).

Persistence refers to the length of time a chemical resides in the environment and is measured by its half-life. This is the time required for the quantity of a chemical to diminish or degrade to half of its original amount within a particular environment or medium. For the purposes of this assessment, a chemical was considered persistent if its half-life in soil was greater than or equal to six months (≥182 days). The appropriate rate constants (or half-lives) for each of the potential COCs were taken from sources such as US EPA (2005) and Lymann *et al*. (1990), or obtained using EpiSuite from the US EPA (EpiSuite, 2007).

Bio-accumulation is a general term used to describe the process by which chemicals are accumulated in an organism directly from exposure to water, soil, or through consumption of food containing the substances. A chemical's potential to bio-accumulate is related to its octanol-water partition coefficient (K_{ow}). The K_{ow} refers to the ratio of distribution of a substance in octanol compared to that in water. For the purposes of this assessment, a chemical was considered bio-accumulative if its Log K_{ow} was greater than or equal to five.

Therefore, COCs retained for full multi-pathway assessment had:

- A half-life in soil greater than or equal to six months; and/or,
- An octanol-water partition coefficient (Log K_{ow}) greater than or equal to five.

The rationale behind this exercise was that if a chemical released to the air does not meet either of these criteria, only a limited opportunity exists for human exposure *via* secondary exposure pathways (*i.e.,* those other than inhalation), as the potential for that chemical to persist and/or accumulate in the environment is negligible. However, if a chemical meets one or both of these criteria, sufficient opportunity could be present for long term exposure.

3.3.3.3 Selected Chemicals of Concern and Exposure Pathways

Table 3-3 provides the list of the selected COCs and indicates whether they were assessed for both the inhalation only or multi-media pathway

Table 3-3 Final List of Selected Chemicals of Concern and Exposure Pathways

Chemicals of Concern	***Inhalation***	***Multi-Media***
Criteria Air Contaminants (CACs)		
Carbon monoxide	●	
Nitrogen dioxide (NO_2)	●	
Particulate matter - PM_{10}	●	
Particulate matter - $PM_{2.5}$	●	
Sulphur dioxide (SO_2)	●	
Volatile Organic Compounds (VOCs)		
Acetaldehyde	●	
Acetone	●	
Acrolein and related, as acrolein	●	
Aldehydes (other), as propionaldehyde	●	
Aliphatic alcohols, as methyl alcohol	●	
Alkanes/alkenes (other C1-C4)	●	
Alkanes/alkenes (other C5-C8)	●	
Alkanes/alkenes (other C>8-C10)	●	
Alkanes/alkenes (other C>10-C12)	●	
Alkanes/alkenes (other C>12-C16)	●	
Benzene and related, as benzene	●	
Butadiene, 1,3-	●	
Cycloalkanes and cycloalkenes, as cyclohexane	●	
Ethylbenzene and related, as ethylbenzene	●	
Formaldehyde and related, as formaldehyde	●	
Hexane, n-	●	
Naphthalene and related, as naphthalene	●	
Styrene	●	
Toluene and related,as toluene	●	
Xylenes, as total	●	
Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)		
PAHs as Benzo(a)pyrene Toxic Equivalents (BaP TEQ)	●	●

Therefore, all COCs were evaluated in the inhalation assessment and one (1) COC evaluated in the multi-media assessment.

3.4 Selection of Human Receptors and Exposure Scenarios

A human receptor is a hypothetical person (*e.g.*, infant, toddler, child, adolescent, or adult) who resides and/or works in the area being investigated and is, or could potentially be, exposed to the chemicals identified as being of potential concern. General physical and behavioural characteristics specific to the receptor type (*e.g.*, body weight, breathing rate, food consumption rate, *etc*.) were used to determine the amount of chemical exposure received by each receptor as part of the multi-media assessment. The potential risks associated with chemicals of concern were different depending on the receptor chosen for evaluation.

The HHRA must be sufficiently comprehensive to ensure inclusion of those receptors with the greatest potential for exposure to COCs, and those who have the greatest sensitivity, or potential for developing adverse health outcomes from these exposures. With this in mind, the selection of hypothetical, reasonable "worst-case" receptors, with somewhat exaggerated life style habits, were used to ensure a conservative (*i.e*., protective) assessment. For the current assessment, residential, industrial, and commercial receptors were considered depending on the receptor location within the surrounding community considered.

3.4.1 Exposure Scenarios

Residential Receptor Exposure Scenario

For the residential receptor locations, which are located at R3 through R11, an individual was hypothetically assumed to be born in Toronto and was conservatively assumed to live at that location of interest for their entire lifetime (*i.e.*, 80 years). Due to the residency time at a given receptor location (*i.e.*, conservatively assumed to be present 24-hours per day and 365 days per year), this group is considered to have the highest potential exposure and resultant health risk from chemicals emitted from the airport. Due to this conservatism, this receptor group will also account for those sensitive individuals who may be present at other land uses throughout the Study Domain (*e.g.*, hospitals, daycares, schools, retirement homes, *etc.*).

As per Health Canada (2012) guidance, the residential receptor was assumed to be represented by five discrete life stages:

1. Infant (birth to 6 months of age);
2. Preschool child/toddler (7 months to 4 years of age);
3. Child (5 to 11 years of age);
4. Adolescent (12 to 19 years of age); and,
5. Adult (≥ 20 years of age, assuming an 80 year lifespan).

The individual was assumed to be exposed *via* inhalation of ambient air to emissions from the proposed facility or project-related transportation source (and other nearby significant sources). The resident was also assumed to be exposed to COCs through contact with contaminated soil or home grown produce impacted by the deposition of the emitted COCs onto surface soils in the surrounding community. Predicted soil concentrations were conservatively assumed to be the maximum concentration that would be present after 30 years of deposition, taking into account degradation and soil loss over that time (US EPA, 2005).

Commercial Receptor Exposure Scenario

For the commercial receptor locations, which are located at R1 and R2, an adult (≥ 20 years of age) working within a commercial environment was hypothetically assumed to be present at one

of these receptor locations for 8 hours per day, 5 days per week, 52 weeks per year, for a working tenure of 35 years while being exposed to COCs in air.

For the sake of conservatism, each of the potential pathways and exposure assumptions typically associated with a residential scenario were evaluated in the multi-media assessment at all receptor locations. For example, when considering multimedia exposures (*i.e.*, non-inhalation), individuals at each of the assessed receptor locations were assumed to spend 24 hours per day, 7 days per week, for 50 weeks per year at this location. This is obviously an overestimation of potential exposures for the schools or other receptor locations (*e.g.*, hotels, commercial buildings, parks, *etc*.), as well as individuals exposed while at their workplace.

Industrial Receptor Exposure Scenario

For the MPOI, which was assumed to be an industrial receptor, an adult (≥ 20 years of age) working near the airport was hypothetically assumed to be present at or very near the fence line location 10 hours per day, 5 days per week, 48 weeks per year, for a working tenure of 35 years, while being exposed to COCs in air.

As with the commercial receptor scenario, each of the potential pathways and exposure assumptions typically associated with a residential scenario were evaluated in the multi-media assessment at all receptor locations, including the MPOI.

3.4.2 Exposure Pathways

The primary exposure pathway evaluated in the HHRA was the inhalation of the COCs by individuals living, working or playing in the surrounding community.

For those COCs evaluated by the multi-pathway assessment (*i.e.*, inhalation, oral and dermal exposures), the following additional exposure pathways were considered concurrently:

- **Inhalation:** Inhalation of air impacted by vapours and particulate emitted from the Project-related sources was evaluated.
- **Incidental Ingestion of Soil and Dust**: Through typical indoor and outdoor activities, individuals may accidentally ingest soil and/or dust particles. Children are typically more susceptible to this exposure pathway, as they spend more time in contact with the ground, and are more likely to put soiled articles, such as toys or hands, into their mouths.
- **Dermal Exposure to Soils and Dusts**: Dermal exposures of human receptors may occur in both indoor and outdoor environments, through direct dermal contact with chemically impacted soil and dust.
- **Ingestion of Locally Grown Produce**: Locally grown produce (such as vegetables and fruits grown in backyard gardens) may itself pose a source of exposure to some COCs. As chemicals are deposited from air-borne emissions, they may come into contact with leaves and fruit of crop plants. Deposition of chemicals onto soil may also result in an accumulation in plants through root uptake.
- **Ingestion of Breast Milk for Infants**: It is assumed that infants living in the surrounding area may be exposed to certain chemicals *via* their mother's breast milk. This exposure pathway was evaluated for only those COPC such as dioxins and furans that have the potential to “bio-accumulate”.

Figure 3-5 provides an overview of the residential exposure scenario, while Figure 3-6 illustrates the Conceptual Site Model (CSM) used in the assessment, and provides an overview of the sources of COCs and the exposure pathways associated with these sources.

As noted in the CSM, for the sake of conservatism, each of the potential pathways and exposure assumptions typically associated with a residential scenario were evaluated at all sensitive receptor locations. For example, when considering multimedia exposures (*i.e.*, non-inhalation), individuals at each of the assessed receptor locations were assumed to spend 24 hours per day, 7 days per week, for 52 weeks per year at this location. This is obviously an overestimation of potential exposures for the schools or other receptor locations (*e.g.*, hotels, commercial buildings, parks, *etc*.), as well as individuals exposed while at their workplace.

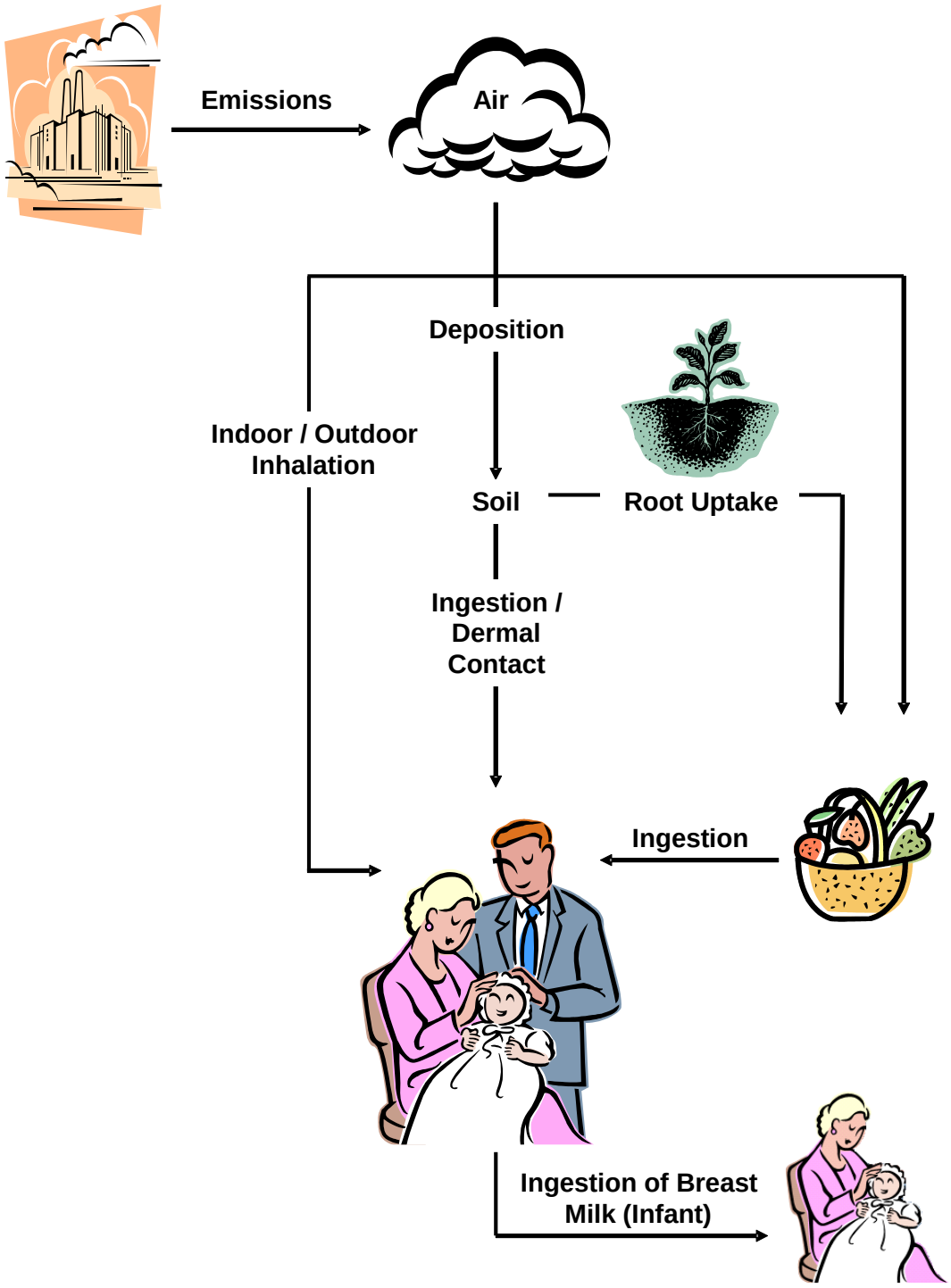

Figure 3-5 Residential Multi-Media Exposure Scenario

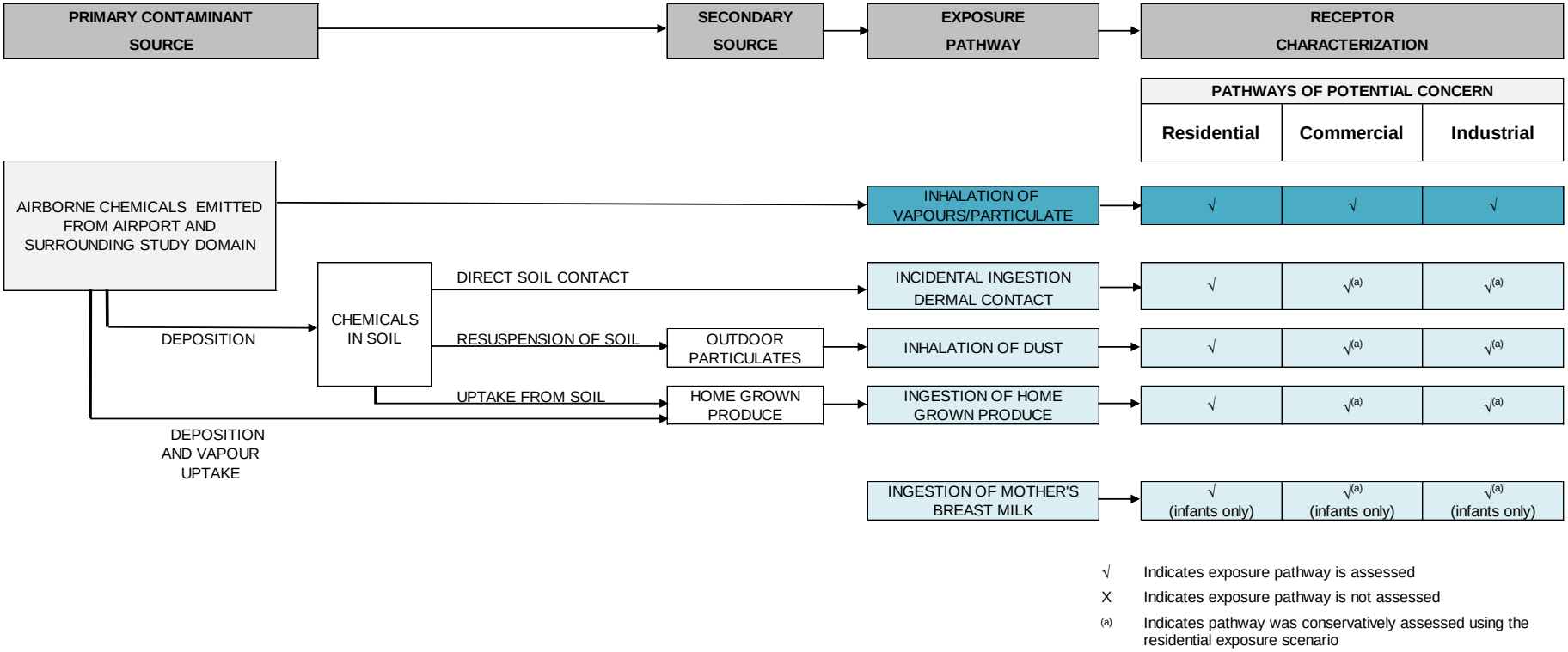

Figure 3-6 Conceptual Site Model (CSM) for Human Health Risk Assessment

4.0 EXPOSURE ASSESSMENT

The magnitude of exposure of human receptors to chemicals in the environment typically depends on the interactions of a number of parameters, including:

- The concentrations of chemicals in various environmental media (as determined by the quantities of chemicals entering the environment from various sources, their persistence, fate and behaviour in these media, and the normal ambient, or background concentrations that exist independent of a specific source);
- The physical-chemical characteristics of the chemicals of concern, which affect their environmental fate, transport, behaviour and persistence, and determine the degree or extent by which chemicals can be absorbed into the body;
- The influence of site-specific environmental characteristics, such as geology, soil type, topography, hydrology, hydrogeology, local meteorology and climatology, *etc*., on a chemical's fate, transport and behaviour within environmental media;
- The physiological and behavioural characteristics of the receptors (*e.g.,* respiration rate, soils/dusts intake rate, food ingestion rates, time spent at various activities and in different areas); and,
- The various exposure pathways for the transfer of the chemicals from the different environmental media to humans (*e.g.,* inhalation of indoor and outdoor air, soil particles and dusts; ingestion of food items, water, soils/dusts; skin penetration of various chemicals from dermal contact with soil/dust, water, sediments).

Exposure estimation in the multi-pathway assessment portion of the HHRA was conducted through the use of an integrated environmental risk assessment model developed by the Study Team. The model is spreadsheet based (Microsoft Excel™) but has a number of more advanced add-ons or features. Models of this type have been used on hundreds of peer-reviewed HHRAs in Canada, including those conducted for contaminated sites, landfills, smelters, refineries, incinerators, and a variety of other industrial facilities. The current model version incorporates the techniques and procedures for exposure modelling developed by various regulatory agencies and published scientific literature sources. Refer to Appendix D for a full description (*i.e.*, worked example) of the equations and parameters used in the HHRA.

4.1 Receptor Characterization

The general physical and behavioural characteristics (*e.g.*, body weight, breathing rate, food consumption rate, *etc*.) specific to each receptor type (*i.e.,* residential, agricultural) and age group (*i.e.*, infant, toddler, adolescent, *etc*.) are used, in part, to approximate the amount of chemical exposure received by each receptor. The HHRA must be sufficiently comprehensive to ensure that those receptors with the greatest potential for exposure to COC, and those that have the greatest sensitivity, or potential for developing adverse effects from these exposures, are included. With this in mind, the selection of hypothetical receptors, with somewhat exaggerated life style habits (to ensure a conservative assessment), were developed for consideration in the HHRA.

Due to differences in physiological characteristics and activity patterns between children and adults, the exposures received by a child and an adult will be different. Consequently, the potential health risks estimated for the same COC will differ depending on the receptor chosen for evaluation.

For COCs considered to be carcinogenic, it is common to evaluate exposure over a lifetime as development of cancer is a long-term process that may take many years to manifest. For this reason, a special type of receptor called a "lifetime" or "composite" receptor was used to evaluate potential carcinogenic risks. The "composite" or "lifetime" receptor is a compilation all relevant life stages for which exposure may occur. For a residential scenario, a composite receptor would be inclusive of all life stages from an infant up to and including an adult. Health risks associated with exposure to carcinogenic compounds are typically expressed as an estimate of excess or incremental lifetime cancer risk (ILCR) for a population or a hypothetical individual resulting from exposure to a particular source. Thus, risks associated with carcinogenic compounds are predicted using the average daily dose over a receptor's entire life span.

As previously indicated (Section 3.4), five age classes, as recommended by Health Canada (2012), were evaluated in the HHRA:

- Infant (0 to 6 months of age);
- Preschool child or toddler (7 months to 4 years of age);
- Child (5 years to 11 years of age);
- Adolescent or teen (12 to 19 years of age); and,
- Adult (20 years of age and over).

To evaluate potential exposures, it was necessary to characterize the physiological and behavioural characteristics of each receptor age group presented above.

4.2 Chemical Characterization

The second major component required to quantify potential human exposures is the characterization of chemical concentrations in various environmental media. More specifically, chemical characterization involves defining an exposure point concentration (EPC) for each COC under each relevant environmental media. An EPC is the chemical concentration in a particular environmental media (*e.g.,* soil, plants, air, water, *etc.*) that an individual may come into contact with over a prolonged duration.

4.2.1 Estimation of Ambient Ground-Level Air Concentrations

Ground-level air concentrations for each of the COCs at all sensitive receptor locations and years around Toronto Pearson were estimated by the Air Quality Assessment Team (Golder, 2015) for use in the HHRA. Ground-level air concentrations (or EPCs in air) used in the inhalation assessment follow the air quality scenarios described in Section 3.3.

Predicted 1-hour and 24-hour acute ground-level air contributions from Toronto Pearson at the MPOI and each sensitive receptor locations and year (*i.e.,* 2011, 2022, and 2032) are presented in Tables 4-1 through 4-6. Annual average ground-level air concentrations for each receptor location and year are provided in Tables 4-7 through 4-9.

As described in Section 3.4.1., the industrial and commercial worker scenarios (*i.e.,* MPOI, R1, and R2 receptor locations) were assumed to spend less than 100% of their time at the receptor location. In contrast, the residential receptor scenario (*i.e.,* R3 through R11 receptor locations) was assumed to spend 100% of their time at the same location. As a result, the predicted annual average air concentrations presented for the industrial and commercial worker scenarios

were adjusted, or time-weighted, based on the expected time spent at the receptor location, while the residential air concentrations were not adjusted.

These adjustments were completed because the chronic duration exposure limits described in the Hazard Assessment (Section 5.0) are protective of constant and long-term exposures to COCs in air (*i.e.,* 100% of time for at least one year). To account for less than constant exposure over a chronic duration, the modelled air concentrations of COCs are adjusted, or time-weighted, for the time that the receptor is anticipated to be present at the receptor location. For the industrial receptor, this means the air concentration was adjusted by a factor of 0.27 (*i.e.,* 10 hours/day, 5 days/week, 48 weeks/year), while for the commercial receptor, the air concentration was adjusted by a factor of 0.24 (*i.e.,* 8 hours/day, 5 days/week, 52 weeks/year). These adjustments are consistent with Health Canada (2012) guidance.

Background air concentrations, which included both regional (represented by regional monitoring data) and predicted local air emission sources, and cumulative air concentrations (*i.e.,* background plus Toronto Pearson contributions) are presented in Appendix E.

Table 4-1 Summary of 1-Hour Exposure Point Concentrations – 2011 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	5.08E+03	3.45E+03	3.56E+03	2.01E+03	1.09E+03	6.39E+02	7.26E+02	1.55E+03	8.39E+02	7.90E+02	3.04E+02	4.80E+02
Nitrogen dioxide (NO_2)	3.78E+02	1.75E+02	2.43E+02	1.37E+02	1.08E+02	9.01E+01	8.10E+01	1.90E+02	9.45E+01	9.24E+01	9.37E+01	1.04E+02
Coarse Particulate Matter (PM_{10})	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fine Particulate Matter ($PM_{2.5}$)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulphur Dioxide (SO_2)	1.68E+02	7.42E+01	9.20E+01	9.08E+01	3.23E+01	3.33E+01	1.45E+01	6.66E+01	1.71E+01	2.99E+01	1.61E+01	1.65E+01
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	1.10E+01	6.74E+00	6.90E+00	5.54E+00	2.79E+00	2.12E+00	1.52E+00	5.22E+00	1.55E+00	2.10E+00	1.05E+00	1.01E+00
Acetone	8.96E-01	5.47E-01	5.60E-01	4.50E-01	2.27E-01	1.72E-01	1.24E-01	4.24E-01	1.26E-01	1.71E-01	8.50E-02	8.25E-02
Acrolein and related	7.00E+00	4.28E+00	4.38E+00	3.52E+00	1.78E+00	1.35E+00	9.66E-01	3.31E+00	9.87E-01	1.34E+00	6.65E-01	6.45E-01
Aldehydes, other	7.31E+00	4.46E+00	4.57E+00	3.67E+00	1.85E+00	1.41E+00	1.01E+00	3.46E+00	1.03E+00	1.39E+00	6.94E-01	6.73E-01
Aliphatic alcohols	2.56E+01	1.57E+01	1.60E+01	1.29E+01	6.50E+00	4.94E+00	3.54E+00	1.21E+01	3.61E+00	4.89E+00	2.43E+00	2.36E+00
Alkanes/alkenes, other C1-4	1.02E+02	6.26E+01	6.41E+01	5.15E+01	2.60E+01	1.97E+01	1.41E+01	4.85E+01	1.44E+01	1.96E+01	9.72E+00	9.43E+00
Alkanes/alkenes, other C5-8	3.07E+01	1.88E+01	1.92E+01	1.54E+01	7.79E+00	5.91E+00	4.24E+00	1.45E+01	4.33E+00	5.86E+00	2.92E+00	2.83E+00
Alkanes/alkenes, other C>8-10	5.09E+01	3.11E+01	3.18E+01	2.56E+01	1.29E+01	9.80E+00	7.02E+00	2.41E+01	7.17E+00	9.71E+00	4.83E+00	4.68E+00
Alkanes/alkenes, other C>10-12	2.70E+00	1.65E+00	1.69E+00	1.36E+00	6.83E-01	5.19E-01	3.72E-01	1.28E+00	3.80E-01	5.15E-01	2.56E-01	2.48E-01
Alkanes/alkenes, other C>12-16	3.96E+00	2.42E+00	2.48E+00	1.99E+00	1.00E+00	7.63E-01	5.47E-01	1.88E+00	5.58E-01	7.56E-01	3.76E-01	3.65E-01
Benzene and related	8.15E+00	4.98E+00	5.10E+00	4.10E+00	2.07E+00	1.57E+00	1.12E+00	3.86E+00	1.15E+00	1.56E+00	7.73E-01	7.50E-01
Butadiene, 1,3-	4.29E+00	2.62E+00	2.68E+00	2.16E+00	1.09E+00	8.26E-01	5.92E-01	2.03E+00	6.04E-01	8.19E-01	4.07E-01	3.95E-01
Cycloalkanes and cycloalkenes	2.91E+00	1.78E+00	1.82E+00	1.46E+00	7.39E-01	5.61E-01	4.02E-01	1.38E+00	4.11E-01	5.56E-01	2.77E-01	2.68E-01

Table 4-1 Summary of 1-Hour Exposure Point Concentrations – 2011 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	6.55E+00	4.00E+00	4.10E+00	3.29E+00	1.66E+00	1.26E+00	9.03E-01	3.10E+00	9.22E-01	1.25E+00	6.21E-01	6.03E-01
Formaldehyde and related	4.01E+01	2.45E+01	2.51E+01	2.02E+01	1.02E+01	7.72E+00	5.53E+00	1.90E+01	5.65E+00	7.66E+00	3.81E+00	3.69E+00
Hexane, n-	9.90E-01	6.05E-01	6.19E-01	4.97E-01	2.51E-01	1.91E-01	1.37E-01	4.68E-01	1.39E-01	1.89E-01	9.39E-02	9.11E-02
Naphthalene and related	2.63E+00	1.61E+00	1.65E+00	1.32E+00	6.66E-01	5.06E-01	3.63E-01	1.24E+00	3.71E-01	5.02E-01	2.50E-01	2.42E-01
Styrene	7.49E-01	4.58E-01	4.69E-01	3.77E-01	1.90E-01	1.44E-01	1.03E-01	3.54E-01	1.06E-01	1.43E-01	7.11E-02	6.90E-02
Toluene and related	4.16E+00	2.54E+00	2.61E+00	2.09E+00	1.06E+00	8.02E-01	5.75E-01	1.97E+00	5.87E-01	7.95E-01	3.95E-01	3.83E-01
Xylenes	2.88E+00	1.76E+00	1.80E+00	1.45E+00	7.30E-01	5.54E-01	3.97E-01	1.36E+00	4.06E-01	5.50E-01	2.73E-01	2.65E-01
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-2	Summary of 1-Hour Exposure Point Concentrations – 2022 Airport Alone Assessment Scenario (µg/m³)											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	8.75E+03	4.64E+03	6.42E+03	2.09E+03	1.21E+03	1.11E+03	8.07E+02	2.38E+03	1.12E+03	9.23E+02	6.22E+02	5.92E+02
Nitrogen dioxide (NO_2)	3.04E+02	1.65E+02	1.86E+02	1.33E+02	1.49E+02	1.07E+02	1.10E+02	2.15E+02	1.38E+02	8.99E+01	1.02E+02	9.30E+01
Coarse Particulate Matter (PM_{10})	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fine Particulate Matter ($PM_{2.5}$)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulphur Dioxide (SO_2)	4.23E+02	1.63E+02	2.00E+02	1.04E+02	6.74E+01	5.94E+01	2.73E+01	1.38E+02	6.63E+01	4.99E+01	2.93E+01	2.14E+01
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	2.99E+01	1.86E+01	2.06E+01	8.95E+00	6.13E+00	6.20E+00	2.70E+00	1.11E+01	5.27E+00	4.57E+00	3.46E+00	2.25E+00
Acetone	2.51E+00	1.56E+00	1.73E+00	7.51E-01	5.14E-01	5.20E-01	2.27E-01	9.31E-01	4.42E-01	3.83E-01	2.90E-01	1.89E-01
Acrolein and related	1.96E+01	1.22E+01	1.35E+01	5.86E+00	4.01E+00	4.06E+00	1.77E+00	7.27E+00	3.45E+00	2.99E+00	2.26E+00	1.47E+00
Aldehydes, other	2.00E+01	1.24E+01	1.38E+01	5.97E+00	4.08E+00	4.13E+00	1.80E+00	7.40E+00	3.52E+00	3.04E+00	2.30E+00	1.50E+00
Aliphatic alcohols	7.19E+01	4.46E+01	4.96E+01	2.15E+01	1.47E+01	1.49E+01	6.49E+00	2.67E+01	1.27E+01	1.10E+01	8.30E+00	5.40E+00
Alkanes/alkenes, other C1-4	2.18E+02	1.35E+02	1.51E+02	6.53E+01	4.47E+01	4.52E+01	1.97E+01	8.10E+01	3.84E+01	3.33E+01	2.52E+01	1.64E+01
Alkanes/alkenes, other C5-8	4.09E+01	2.53E+01	2.82E+01	1.22E+01	8.37E+00	8.47E+00	3.69E+00	1.52E+01	7.20E+00	6.24E+00	4.72E+00	3.07E+00
Alkanes/alkenes, other C>8-10	1.41E+02	8.77E+01	9.75E+01	4.23E+01	2.89E+01	2.93E+01	1.28E+01	5.25E+01	2.49E+01	2.16E+01	1.63E+01	1.06E+01
Alkanes/alkenes, other C>10-12	6.39E+00	3.96E+00	4.41E+00	1.91E+00	1.31E+00	1.32E+00	5.77E-01	2.37E+00	1.13E+00	9.75E-01	7.38E-01	4.80E-01
Alkanes/alkenes, other C>12-16	1.11E+01	6.89E+00	7.66E+00	3.32E+00	2.27E+00	2.30E+00	1.00E+00	4.12E+00	1.96E+00	1.69E+00	1.28E+00	8.35E-01
Benzene and related	1.63E+01	1.01E+01	1.13E+01	4.88E+00	3.34E+00	3.38E+00	1.47E+00	6.05E+00	2.87E+00	2.49E+00	1.88E+00	1.23E+00
Butadiene, 1,3-	1.17E+01	7.28E+00	8.10E+00	3.51E+00	2.40E+00	2.43E+00	1.06E+00	4.36E+00	2.07E+00	1.79E+00	1.36E+00	8.82E-01
Cycloalkanes and cycloalkenes	1.31E+00	8.12E-01	9.03E-01	3.91E-01	2.68E-01	2.71E-01	1.18E-01	4.86E-01	2.31E-01	2.00E-01	1.51E-01	9.84E-02

Table 4-2 Summary of 1-Hour Exposure Point Concentrations – 2022 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	1.24E+01	7.72E+00	8.58E+00	3.72E+00	2.55E+00	2.58E+00	1.12E+00	4.62E+00	2.19E+00	1.90E+00	1.44E+00	9.35E-01
Formaldehyde and related	1.10E+02	6.81E+01	7.58E+01	3.29E+01	2.25E+01	2.28E+01	9.92E+00	4.08E+01	1.94E+01	1.68E+01	1.27E+01	8.26E+00
Hexane, n-	4.44E-01	2.75E-01	3.06E-01	1.33E-01	9.09E-02	9.20E-02	4.01E-02	1.65E-01	7.82E-02	6.77E-02	5.13E-02	3.34E-02
Naphthalene and related	7.38E+00	4.57E+00	5.09E+00	2.21E+00	1.51E+00	1.53E+00	6.66E-01	2.74E+00	1.30E+00	1.13E+00	8.52E-01	5.54E-01
Styrene	2.10E+00	1.30E+00	1.45E+00	6.28E-01	4.30E-01	4.35E-01	1.90E-01	7.79E-01	3.70E-01	3.21E-01	2.43E-01	1.58E-01
Toluene and related	6.76E+00	4.19E+00	4.67E+00	2.02E+00	1.38E+00	1.40E+00	6.11E-01	2.51E+00	1.19E+00	1.03E+00	7.81E-01	5.08E-01
Xylenes	3.85E+00	2.39E+00	2.65E+00	1.15E+00	7.88E-01	7.97E-01	3.47E-01	1.43E+00	6.78E-01	5.87E-01	4.44E-01	2.89E-01
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-3 Summary of 1-Hour Exposure Point Concentrations – 2032 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	9.44E+03	5.21E+03	7.06E+03	2.82E+03	1.69E+03	1.36E+03	8.40E+02	2.62E+03	1.28E+03	1.41E+03	7.27E+02	7.81E+02
Nitrogen dioxide (NO_2)	3.42E+02	1.84E+02	1.92E+02	1.42E+02	1.58E+02	9.84E+01	1.21E+02	1.96E+02	1.42E+02	8.65E+01	1.15E+02	1.21E+02
Coarse Particulate Matter (PM_{10})	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fine Particulate Matter ($PM_{2.5}$)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulphur Dioxide (SO_2)	3.95E+02	1.89E+02	2.29E+02	1.47E+02	8.71E+01	7.31E+01	2.99E+01	1.26E+02	7.20E+01	8.94E+01	3.55E+01	2.97E+01
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	3.59E+01	2.06E+01	2.38E+01	1.23E+01	8.21E+00	6.68E+00	2.93E+00	1.35E+01	6.19E+00	7.69E+00	3.18E+00	2.83E+00
Acetone	3.02E+00	1.73E+00	2.00E+00	1.03E+00	6.90E-01	5.61E-01	2.46E-01	1.13E+00	5.20E-01	6.46E-01	2.68E-01	2.38E-01
Acrolein and related	2.36E+01	1.35E+01	1.56E+01	8.08E+00	5.39E+00	4.38E+00	1.93E+00	8.86E+00	4.06E+00	5.05E+00	2.09E+00	1.86E+00
Aldehydes, other	2.40E+01	1.38E+01	1.59E+01	8.21E+00	5.48E+00	4.46E+00	1.96E+00	9.01E+00	4.13E+00	5.13E+00	2.13E+00	1.89E+00
Aliphatic alcohols	8.64E+01	4.96E+01	5.73E+01	2.96E+01	1.98E+01	1.61E+01	7.06E+00	3.25E+01	1.49E+01	1.85E+01	7.67E+00	6.82E+00
Alkanes/alkenes, other C1-4	2.60E+02	1.49E+02	1.72E+02	8.91E+01	5.95E+01	4.84E+01	2.12E+01	9.78E+01	4.48E+01	5.57E+01	2.31E+01	2.05E+01
Alkanes/alkenes, other C5-8	4.74E+01	2.72E+01	3.14E+01	1.63E+01	1.09E+01	8.82E+00	3.87E+00	1.78E+01	8.18E+00	1.02E+01	4.21E+00	3.74E+00
Alkanes/alkenes, other C>8-10	1.70E+02	9.76E+01	1.13E+02	5.83E+01	3.89E+01	3.16E+01	1.39E+01	6.39E+01	2.93E+01	3.64E+01	1.51E+01	1.34E+01
Alkanes/alkenes, other C>10-12	7.63E+00	4.38E+00	5.05E+00	2.61E+00	1.75E+00	1.42E+00	6.23E-01	2.87E+00	1.32E+00	1.63E+00	6.77E-01	6.02E-01
Alkanes/alkenes, other C>12-16	1.33E+01	7.67E+00	8.84E+00	4.58E+00	3.05E+00	2.48E+00	1.09E+00	5.02E+00	2.30E+00	2.86E+00	1.18E+00	1.05E+00
Benzene and related	1.92E+01	1.10E+01	1.27E+01	6.58E+00	4.39E+00	3.57E+00	1.57E+00	7.22E+00	3.31E+00	4.11E+00	1.70E+00	1.51E+00
Butadiene, 1,3-	1.41E+01	8.08E+00	9.33E+00	4.82E+00	3.22E+00	2.62E+00	1.15E+00	5.30E+00	2.43E+00	3.02E+00	1.25E+00	1.11E+00
Cycloalkanes and cycloalkenes	1.30E+00	7.49E-01	8.64E-01	4.47E-01	2.99E-01	2.43E-01	1.07E-01	4.91E-01	2.25E-01	2.79E-01	1.16E-01	1.03E-01

Table 4-3 Summary of 1-Hour Exposure Point Concentrations – 2032 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	1.47E+01	8.46E+00	9.76E+00	5.05E+00	3.37E+00	2.74E+00	1.20E+00	5.54E+00	2.54E+00	3.15E+00	1.31E+00	1.16E+00
Formaldehyde and related	1.32E+02	7.58E+01	8.74E+01	4.52E+01	3.02E+01	2.45E+01	1.08E+01	4.96E+01	2.27E+01	2.83E+01	1.17E+01	1.04E+01
Hexane, n-	4.43E-01	2.54E-01	2.94E-01	1.52E-01	1.01E-01	8.24E-02	3.62E-02	1.67E-01	7.64E-02	9.49E-02	3.93E-02	3.50E-02
Naphthalene and related	8.86E+00	5.09E+00	5.87E+00	3.04E+00	2.03E+00	1.65E+00	7.24E-01	3.33E+00	1.53E+00	1.90E+00	7.86E-01	7.00E-01
Styrene	2.53E+00	1.45E+00	1.67E+00	8.66E-01	5.78E-01	4.70E-01	2.06E-01	9.50E-01	4.35E-01	5.41E-01	2.24E-01	1.99E-01
Toluene and related	7.95E+00	4.56E+00	5.26E+00	2.72E+00	1.82E+00	1.48E+00	6.49E-01	2.99E+00	1.37E+00	1.70E+00	7.05E-01	6.27E-01
Xylenes	4.46E+00	2.56E+00	2.95E+00	1.53E+00	1.02E+00	8.30E-01	3.64E-01	1.68E+00	7.69E-01	9.55E-01	3.96E-01	3.52E-01
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-4 Summary of 24-Hour Exposure Point Concentrations – 2011 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	1.85E+03	1.16E+03	9.22E+02	3.14E+02	1.71E+02	1.61E+02	9.13E+01	2.11E+02	1.57E+02	1.77E+02	6.45E+01	6.00E+01
Nitrogen dioxide (NO_2)	3.66E+01	3.66E+01	2.97E+01	1.26E+01	9.51E+00	6.40E+00	8.04E+00	2.22E+01	9.39E+00	7.42E+00	4.38E+00	5.32E+00
Coarse Particulate Matter (PM_{10})	5.03E+00	2.37E+00	1.88E+00	7.23E-01	5.74E-01	3.10E-01	2.29E-01	5.17E-01	3.36E-01	3.59E-01	1.21E-01	2.32E-01
Fine Particulate Matter ($PM_{2.5}$)	4.67E+00	2.09E+00	1.79E+00	6.93E-01	5.57E-01	2.84E-01	2.20E-01	4.70E-01	3.25E-01	3.42E-01	1.11E-01	2.17E-01
Sulphur Dioxide (SO_2)	1.64E+01	9.46E+00	1.20E+01	4.21E+00	3.16E+00	2.04E+00	7.80E-01	4.49E+00	1.10E+00	1.73E+00	1.01E+00	7.43E-01
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	1.29E+00	9.32E-01	8.81E-01	2.94E-01	2.52E-01	1.56E-01	6.40E-02	2.25E-01	1.17E-01	1.28E-01	7.40E-02	8.44E-02
Acetone	1.04E-01	7.57E-02	7.16E-02	2.39E-02	2.05E-02	1.27E-02	5.20E-03	1.83E-02	9.51E-03	1.04E-02	6.01E-03	6.85E-03
Acrolein and related	8.17E-01	5.92E-01	5.60E-01	1.87E-01	1.60E-01	9.91E-02	4.06E-02	1.43E-01	7.43E-02	8.11E-02	4.70E-02	5.36E-02
Aldehydes, other	8.52E-01	6.18E-01	5.84E-01	1.95E-01	1.67E-01	1.03E-01	4.24E-02	1.49E-01	7.76E-02	8.46E-02	4.90E-02	5.59E-02
Aliphatic alcohols	2.99E+00	2.17E+00	2.05E+00	6.85E-01	5.85E-01	3.63E-01	1.49E-01	5.22E-01	2.72E-01	2.97E-01	1.72E-01	1.96E-01
Alkanes/alkenes, other C1-4	1.19E+01	8.66E+00	8.19E+00	2.74E+00	2.34E+00	1.45E+00	5.94E-01	2.09E+00	1.09E+00	1.19E+00	6.87E-01	7.84E-01
Alkanes/alkenes, other C5-8	3.58E+00	2.60E+00	2.46E+00	8.21E-01	7.01E-01	4.34E-01	1.78E-01	6.26E-01	3.26E-01	3.56E-01	2.06E-01	2.35E-01
Alkanes/alkenes, other C>8-10	5.93E+00	4.30E+00	4.07E+00	1.36E+00	1.16E+00	7.20E-01	2.95E-01	1.04E+00	5.40E-01	5.89E-01	3.41E-01	3.89E-01
Alkanes/alkenes, other C>10-12	3.14E-01	2.28E-01	2.16E-01	7.20E-02	6.16E-02	3.81E-02	1.56E-02	5.49E-02	2.86E-02	3.12E-02	1.81E-02	2.06E-02
Alkanes/alkenes, other C>12-16	4.62E-01	3.35E-01	3.17E-01	1.06E-01	9.05E-02	5.60E-02	2.30E-02	8.07E-02	4.21E-02	4.59E-02	2.66E-02	3.03E-02
Benzene and related	9.50E-01	6.89E-01	6.51E-01	2.18E-01	1.86E-01	1.15E-01	4.73E-02	1.66E-01	8.65E-02	9.43E-02	5.47E-02	6.23E-02
Butadiene, 1,3-	5.00E-01	3.63E-01	3.43E-01	1.15E-01	9.79E-02	6.07E-02	2.49E-02	8.74E-02	4.55E-02	4.97E-02	2.88E-02	3.28E-02
Cycloalkanes and cycloalkenes	3.40E-01	2.46E-01	2.33E-01	7.78E-02	6.65E-02	4.12E-02	1.69E-02	5.94E-02	3.09E-02	3.37E-02	1.96E-02	2.23E-02

Table 4-4 Summary of 24-Hour Exposure Point Concentrations – 2011 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	7.63E-01	5.53E-01	5.23E-01	1.75E-01	1.49E-01	9.26E-02	3.80E-02	1.33E-01	6.95E-02	7.58E-02	4.39E-02	5.01E-02
Formaldehyde and related	4.67E+00	3.39E+00	3.21E+00	1.07E+00	9.16E-01	5.67E-01	2.33E-01	8.17E-01	4.26E-01	4.64E-01	2.69E-01	3.07E-01
Hexane, n-	1.15E-01	8.37E-02	7.91E-02	2.64E-02	2.26E-02	1.40E-02	5.74E-03	2.02E-02	1.05E-02	1.15E-02	6.64E-03	7.57E-03
Naphthalene and related	3.07E-01	2.22E-01	2.10E-01	7.02E-02	6.00E-02	3.72E-02	1.53E-02	5.36E-02	2.79E-02	3.04E-02	1.76E-02	2.01E-02
Styrene	8.73E-02	6.33E-02	5.99E-02	2.00E-02	1.71E-02	1.06E-02	4.35E-03	1.53E-02	7.95E-03	8.67E-03	5.03E-03	5.73E-03
Toluene and related	4.86E-01	3.52E-01	3.33E-01	1.11E-01	9.51E-02	5.89E-02	2.42E-02	8.49E-02	4.42E-02	4.82E-02	2.80E-02	3.19E-02
Xylenes	3.36E-01	2.43E-01	2.30E-01	7.69E-02	6.57E-02	4.07E-02	1.67E-02	5.86E-02	3.06E-02	3.33E-02	1.93E-02	2.20E-02
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-5 Summary of 24-Hour Exposure Point Concentrations – 2022 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	2.25E+03	1.24E+03	1.34E+03	4.80E+02	2.17E+02	2.13E+02	1.24E+02	4.85E+02	1.69E+02	2.23E+02	8.85E+01	8.03E+01
Nitrogen dioxide (NO_2)	4.40E+01	3.33E+01	2.87E+01	1.69E+01	1.13E+01	9.72E+00	1.12E+01	2.98E+01	1.25E+01	9.14E+00	5.95E+00	9.54E+00
Coarse Particulate Matter (PM_{10})	8.63E+00	3.86E+00	4.15E+00	1.42E+00	7.17E-01	4.04E-01	4.40E-01	1.16E+00	6.50E-01	5.68E-01	2.57E-01	3.30E-01
Fine Particulate Matter ($PM_{2.5}$)	8.37E+00	3.32E+00	3.90E+00	1.37E+00	6.98E-01	3.88E-01	4.18E-01	1.10E+00	6.38E-01	5.24E-01	2.43E-01	3.12E-01
Sulphur Dioxide (SO_2)	3.43E+01	1.73E+01	1.41E+01	1.06E+01	6.30E+00	4.08E+00	1.74E+00	1.10E+01	2.99E+00	3.41E+00	1.92E+00	1.62E+00
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	2.95E+00	1.98E+00	1.51E+00	8.24E-01	5.16E-01	3.75E-01	1.49E-01	8.28E-01	2.34E-01	3.21E-01	1.83E-01	1.64E-01
Acetone	2.48E-01	1.66E-01	1.27E-01	6.91E-02	4.33E-02	3.15E-02	1.25E-02	6.95E-02	1.97E-02	2.69E-02	1.54E-02	1.38E-02
Acrolein and related	1.93E+00	1.30E+00	9.90E-01	5.40E-01	3.38E-01	2.46E-01	9.78E-02	5.42E-01	1.53E-01	2.10E-01	1.20E-01	1.08E-01
Aldehydes, other	1.97E+00	1.32E+00	1.01E+00	5.50E-01	3.44E-01	2.50E-01	9.95E-02	5.52E-01	1.56E-01	2.14E-01	1.22E-01	1.10E-01
Aliphatic alcohols	7.09E+00	4.76E+00	3.63E+00	1.98E+00	1.24E+00	9.01E-01	3.59E-01	1.99E+00	5.63E-01	7.71E-01	4.41E-01	3.95E-01
Alkanes/alkenes, other C1-4	2.15E+01	1.44E+01	1.10E+01	6.01E+00	3.76E+00	2.73E+00	1.09E+00	6.04E+00	1.71E+00	2.34E+00	1.34E+00	1.20E+00
Alkanes/alkenes, other C5-8	4.03E+00	2.70E+00	2.06E+00	1.13E+00	7.05E-01	5.12E-01	2.04E-01	1.13E+00	3.20E-01	4.39E-01	2.51E-01	2.25E-01
Alkanes/alkenes, other C>8-10	1.39E+01	9.36E+00	7.14E+00	3.89E+00	2.44E+00	1.77E+00	7.05E-01	3.91E+00	1.11E+00	1.52E+00	8.67E-01	7.77E-01
Alkanes/alkenes, other C>10-12	6.30E-01	4.23E-01	3.22E-01	1.76E-01	1.10E-01	8.00E-02	3.18E-02	1.77E-01	5.00E-02	6.85E-02	3.91E-02	3.51E-02
Alkanes/alkenes, other C>12-16	1.10E+00	7.35E-01	5.61E-01	3.06E-01	1.92E-01	1.39E-01	5.54E-02	3.07E-01	8.70E-02	1.19E-01	6.81E-02	6.10E-02
Benzene and related	1.61E+00	1.08E+00	8.24E-01	4.49E-01	2.81E-01	2.04E-01	8.14E-02	4.51E-01	1.28E-01	1.75E-01	1.00E-01	8.96E-02
Butadiene, 1,3-	1.16E+00	7.77E-01	5.93E-01	3.23E-01	2.02E-01	1.47E-01	5.86E-02	3.25E-01	9.19E-02	1.26E-01	7.20E-02	6.45E-02
Cycloalkanes and cycloalkenes	1.29E-01	8.66E-02	6.61E-02	3.60E-02	2.26E-02	1.64E-02	6.53E-03	3.62E-02	1.02E-02	1.40E-02	8.02E-03	7.19E-03

Table 4-5 Summary of 24-Hour Exposure Point Concentrations – 2022 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	1.23E+00	8.23E-01	6.28E-01	3.43E-01	2.15E-01	1.56E-01	6.21E-02	3.44E-01	9.74E-02	1.34E-01	7.63E-02	6.84E-02
Formaldehyde and related	1.08E+01	7.27E+00	5.55E+00	3.03E+00	1.89E+00	1.38E+00	5.48E-01	3.04E+00	8.60E-01	1.18E+00	6.73E-01	6.04E-01
Hexane, n-	4.38E-02	2.94E-02	2.24E-02	1.22E-02	7.65E-03	5.56E-03	2.21E-03	1.23E-02	3.47E-03	4.76E-03	2.72E-03	2.44E-03
Naphthalene and related	7.27E-01	4.88E-01	3.72E-01	2.03E-01	1.27E-01	9.24E-02	3.68E-02	2.04E-01	5.77E-02	7.92E-02	4.52E-02	4.05E-02
Styrene	2.07E-01	1.39E-01	1.06E-01	5.79E-02	3.62E-02	2.63E-02	1.05E-02	5.81E-02	1.64E-02	2.25E-02	1.29E-02	1.15E-02
Toluene and related	6.67E-01	4.48E-01	3.42E-01	1.86E-01	1.17E-01	8.48E-02	3.37E-02	1.87E-01	5.30E-02	7.26E-02	4.15E-02	3.72E-02
Xylenes	3.79E-01	2.55E-01	1.94E-01	1.06E-01	6.63E-02	4.82E-02	1.92E-02	1.06E-01	3.01E-02	4.13E-02	2.36E-02	2.11E-02
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-6 Summary of 24-Hour Exposure Point Concentrations – 2032 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	2.87E+03	1.42E+03	1.81E+03	5.95E+02	2.54E+02	2.26E+02	1.15E+02	6.48E+02	2.09E+02	2.46E+02	1.05E+02	1.08E+02
Nitrogen dioxide (NO_2)	4.57E+01	3.10E+01	3.08E+01	1.75E+01	1.43E+01	1.13E+01	9.85E+00	2.96E+01	1.49E+01	9.60E+00	6.70E+00	1.00E+01
Coarse Particulate Matter (PM_{10})	1.13E+01	4.50E+00	6.03E+00	1.91E+00	9.34E-01	4.58E-01	4.43E-01	1.48E+00	8.91E-01	6.54E-01	2.79E-01	3.61E-01
Fine Particulate Matter ($PM_{2.5}$)	1.09E+01	3.75E+00	5.61E+00	1.86E+00	9.12E-01	4.36E-01	4.29E-01	1.40E+00	8.76E-01	6.01E-01	2.62E-01	3.43E-01
Sulphur Dioxide (SO_2)	4.97E+01	2.00E+01	1.79E+01	1.08E+01	8.39E+00	5.08E+00	1.43E+00	1.33E+01	3.56E+00	4.25E+00	2.01E+00	1.75E+00
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	3.44E+00	2.24E+00	1.88E+00	9.90E-01	7.61E-01	4.54E-01	1.39E-01	1.06E+00	2.93E-01	3.79E-01	1.92E-01	1.56E-01
Acetone	2.89E-01	1.88E-01	1.58E-01	8.32E-02	6.40E-02	3.81E-02	1.17E-02	8.89E-02	2.46E-02	3.18E-02	1.61E-02	1.31E-02
Acrolein and related	2.26E+00	1.47E+00	1.24E+00	6.50E-01	5.00E-01	2.98E-01	9.11E-02	6.94E-01	1.92E-01	2.49E-01	1.26E-01	1.03E-01
Aldehydes, other	2.30E+00	1.50E+00	1.26E+00	6.61E-01	5.08E-01	3.03E-01	9.26E-02	7.06E-01	1.96E-01	2.53E-01	1.28E-01	1.04E-01
Aliphatic alcohols	8.28E+00	5.40E+00	4.53E+00	2.38E+00	1.83E+00	1.09E+00	3.34E-01	2.55E+00	7.05E-01	9.12E-01	4.61E-01	3.77E-01
Alkanes/alkenes, other C1-4	2.49E+01	1.62E+01	1.36E+01	7.17E+00	5.52E+00	3.29E+00	1.01E+00	7.66E+00	2.12E+00	2.74E+00	1.39E+00	1.13E+00
Alkanes/alkenes, other C5-8	4.54E+00	2.96E+00	2.49E+00	1.31E+00	1.01E+00	6.00E-01	1.83E-01	1.40E+00	3.87E-01	5.00E-01	2.53E-01	2.07E-01
Alkanes/alkenes, other C>8-10	1.63E+01	1.06E+01	8.92E+00	4.69E+00	3.61E+00	2.15E+00	6.57E-01	5.01E+00	1.39E+00	1.79E+00	9.08E-01	7.41E-01
Alkanes/alkenes, other C>10-12	7.31E-01	4.76E-01	4.00E-01	2.10E-01	1.62E-01	9.65E-02	2.95E-02	2.25E-01	6.23E-02	8.05E-02	4.07E-02	3.33E-02
Alkanes/alkenes, other C>12-16	1.28E+00	8.33E-01	7.00E-01	3.68E-01	2.83E-01	1.69E-01	5.16E-02	3.93E-01	1.09E-01	1.41E-01	7.13E-02	5.82E-02
Benzene and related	1.84E+00	1.20E+00	1.01E+00	5.29E-01	4.07E-01	2.43E-01	7.42E-02	5.66E-01	1.57E-01	2.03E-01	1.02E-01	8.37E-02
Butadiene, 1,3-	1.35E+00	8.79E-01	7.38E-01	3.88E-01	2.99E-01	1.78E-01	5.44E-02	4.15E-01	1.15E-01	1.49E-01	7.52E-02	6.14E-02
Cycloalkanes and cycloalkenes	1.25E-01	8.15E-02	6.84E-02	3.60E-02	2.77E-02	1.65E-02	5.04E-03	3.84E-02	1.06E-02	1.38E-02	6.97E-03	5.69E-03

Table 4-6 Summary of 24-Hour Exposure Point Concentrations – 2032 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	1.41E+00	9.19E-01	7.72E-01	4.06E-01	3.12E-01	1.86E-01	5.69E-02	4.34E-01	1.20E-01	1.55E-01	7.86E-02	6.42E-02
Formaldehyde and related	1.26E+01	8.24E+00	6.92E+00	3.64E+00	2.80E+00	1.67E+00	5.10E-01	3.89E+00	1.08E+00	1.39E+00	7.05E-01	5.75E-01
Hexane, n-	4.25E-02	2.77E-02	2.32E-02	1.22E-02	9.40E-03	5.60E-03	1.71E-03	1.31E-02	3.62E-03	4.68E-03	2.37E-03	1.93E-03
Naphthalene and related	8.49E-01	5.53E-01	4.65E-01	2.45E-01	1.88E-01	1.12E-01	3.43E-02	2.61E-01	7.23E-02	9.36E-02	4.73E-02	3.86E-02
Styrene	2.42E-01	1.58E-01	1.32E-01	6.97E-02	5.36E-02	3.19E-02	9.76E-03	7.44E-02	2.06E-02	2.67E-02	1.35E-02	1.10E-02
Toluene and related	7.62E-01	4.96E-01	4.17E-01	2.19E-01	1.69E-01	1.00E-01	3.07E-02	2.34E-01	6.49E-02	8.39E-02	4.24E-02	3.46E-02
Xylenes	4.27E-01	2.78E-01	2.34E-01	1.23E-01	9.46E-02	5.64E-02	1.72E-02	1.31E-01	3.64E-02	4.71E-02	2.38E-02	1.94E-02
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-7	Summary of Annual Average Exposure Point Concentrations – 2011 Airport Alone Assessment Scenario (µg/m³)											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	2.40E+01	2.08E+01	1.41E+01	1.30E+01	6.37E+00	3.49E+00	1.13E+00	9.13E+00	1.99E+00	3.85E+00	1.93E+00	1.23E+00
Nitrogen dioxide (NO_2)	2.17E+00	1.89E+00	1.49E+00	1.93E+00	1.18E+00	8.25E-01	3.57E-01	2.66E+00	5.01E-01	7.74E-01	4.79E-01	3.02E-01
Coarse Particulate Matter (PM_{10})	1.41E-01	1.11E-01	7.95E-02	8.55E-02	4.48E-02	2.57E-02	8.02E-03	6.33E-02	1.35E-02	2.77E-02	1.43E-02	8.67E-03
Fine Particulate Matter ($PM_{2.5}$)	1.27E-01	9.08E-02	6.86E-02	7.91E-02	4.14E-02	2.37E-02	7.34E-03	5.93E-02	1.24E-02	2.56E-02	1.32E-02	7.97E-03
Sulphur Dioxide (SO_2)	3.79E-01	2.62E-01	2.35E-01	3.18E-01	1.45E-01	9.47E-02	3.98E-02	3.67E-01	5.57E-02	9.33E-02	5.91E-02	3.82E-02
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	4.67E-02	4.05E-02	2.82E-02	2.87E-02	1.33E-02	7.66E-03	3.10E-03	2.39E-02	4.78E-03	8.22E-03	4.66E-03	3.01E-03
Acetone	3.80E-03	3.29E-03	2.29E-03	2.33E-03	1.08E-03	6.23E-04	2.51E-04	1.94E-03	3.88E-04	6.68E-04	3.78E-04	2.45E-04
Acrolein and related	2.97E-02	2.57E-02	1.79E-02	1.82E-02	8.46E-03	4.87E-03	1.97E-03	1.52E-02	3.03E-03	5.23E-03	2.96E-03	1.91E-03
Aldehydes, other	3.10E-02	2.68E-02	1.87E-02	1.90E-02	8.83E-03	5.08E-03	2.05E-03	1.59E-02	3.16E-03	5.45E-03	3.09E-03	1.99E-03
Aliphatic alcohols	1.09E-01	9.42E-02	6.56E-02	6.67E-02	3.10E-02	1.78E-02	7.20E-03	5.57E-02	1.11E-02	1.91E-02	1.08E-02	7.00E-03
Alkanes/alkenes, other C1-4	4.34E-01	3.76E-01	2.62E-01	2.66E-01	1.24E-01	7.12E-02	2.88E-02	2.22E-01	4.44E-02	7.64E-02	4.33E-02	2.80E-02
Alkanes/alkenes, other C5-8	1.30E-01	1.13E-01	7.86E-02	7.99E-02	3.71E-02	2.14E-02	8.62E-03	6.67E-02	1.33E-02	2.29E-02	1.30E-02	8.39E-03
Alkanes/alkenes, other C>8-10	2.16E-01	1.87E-01	1.30E-01	1.32E-01	6.15E-02	3.54E-02	1.43E-02	1.10E-01	2.20E-02	3.80E-02	2.15E-02	1.39E-02
Alkanes/alkenes, other C>10-12	1.14E-02	9.90E-03	6.90E-03	7.01E-03	3.26E-03	1.87E-03	7.57E-04	5.85E-03	1.17E-03	2.01E-03	1.14E-03	7.36E-04
Alkanes/alkenes, other C>12-16	1.68E-02	1.46E-02	1.01E-02	1.03E-02	4.79E-03	2.75E-03	1.11E-03	8.60E-03	1.72E-03	2.96E-03	1.67E-03	1.08E-03
Benzene and related	3.45E-02	2.99E-02	2.09E-02	2.12E-02	9.85E-03	5.66E-03	2.29E-03	1.77E-02	3.53E-03	6.08E-03	3.44E-03	2.22E-03
Butadiene, 1,3-	1.82E-02	1.58E-02	1.10E-02	1.12E-02	5.18E-03	2.98E-03	1.20E-03	9.31E-03	1.86E-03	3.20E-03	1.81E-03	1.17E-03
Cycloalkanes and cycloalkenes	1.24E-02	1.07E-02	7.46E-03	7.58E-03	3.52E-03	2.03E-03	8.18E-04	6.33E-03	1.26E-03	2.17E-03	1.23E-03	7.96E-04

Table 4-7 Summary of Annual Average Exposure Point Concentrations – 2011 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	2.77E-02	2.40E-02	1.68E-02	1.70E-02	7.91E-03	4.55E-03	1.84E-03	1.42E-02	2.84E-03	4.88E-03	2.77E-03	1.79E-03
Formaldehyde and related	1.70E-01	1.47E-01	1.03E-01	1.04E-01	4.85E-02	2.79E-02	1.13E-02	8.71E-02	1.74E-02	2.99E-02	1.69E-02	1.09E-02
Hexane, n-	4.19E-03	3.63E-03	2.53E-03	2.57E-03	1.20E-03	6.88E-04	2.78E-04	2.15E-03	4.29E-04	7.38E-04	4.18E-04	2.70E-04
Naphthalene and related	1.11E-02	9.66E-03	6.73E-03	6.84E-03	3.18E-03	1.83E-03	7.38E-04	5.71E-03	1.14E-03	1.96E-03	1.11E-03	7.18E-04
Styrene	3.17E-03	2.75E-03	1.92E-03	1.95E-03	9.05E-04	5.21E-04	2.10E-04	1.63E-03	3.24E-04	5.59E-04	3.16E-04	2.04E-04
Toluene and related	1.77E-02	1.53E-02	1.07E-02	1.08E-02	5.03E-03	2.90E-03	1.17E-03	9.04E-03	1.80E-03	3.11E-03	1.76E-03	1.14E-03
Xylenes	1.22E-02	1.06E-02	7.37E-03	7.49E-03	3.48E-03	2.00E-03	8.08E-04	6.25E-03	1.25E-03	2.15E-03	1.22E-03	7.86E-04
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	5.44E-04	3.89E-04	2.93E-04	3.39E-04	1.77E-04	1.01E-04	3.14E-05	2.54E-04	5.31E-05	1.10E-04	5.65E-05	3.41E-05

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-8 Summary of Annual Average Exposure Point Concentrations – 2022 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Commercial Land Use			***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	2.43E+01	2.11E+01	1.37E+01	1.48E+01	6.86E+00	3.98E+00	1.23E+00	1.50E+01	3.15E+00	4.02E+00	1.89E+00	1.14E+00
Nitrogen dioxide (NO_2)	2.26E+00	1.88E+00	1.51E+00	2.45E+00	1.74E+00	1.05E+00	4.30E-01	3.67E+00	8.88E-01	1.02E+00	5.88E-01	3.59E-01
Coarse Particulate Matter (PM_{10})	2.02E-01	1.37E-01	1.02E-01	1.16E-01	5.95E-02	3.48E-02	1.11E-02	1.02E-01	2.55E-02	3.56E-02	1.77E-02	1.03E-02
Fine Particulate Matter ($PM_{2.5}$)	1.82E-01	1.08E-01	8.55E-02	1.07E-01	5.45E-02	3.22E-02	1.04E-02	9.52E-02	2.36E-02	3.26E-02	1.63E-02	9.39E-03
Sulphur Dioxide (SO_2)	7.69E-01	4.17E-01	3.60E-01	6.18E-01	3.05E-01	1.79E-01	6.22E-02	8.05E-01	1.49E-01	1.72E-01	8.93E-02	5.45E-02
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	6.93E-02	5.61E-02	4.07E-02	5.72E-02	2.62E-02	1.56E-02	5.12E-03	6.61E-02	1.30E-02	1.54E-02	7.50E-03	4.49E-03
Acetone	5.81E-03	4.70E-03	3.41E-03	4.80E-03	2.20E-03	1.31E-03	4.30E-04	5.54E-03	1.09E-03	1.29E-03	6.29E-04	3.76E-04
Acrolein and related	4.54E-02	3.67E-02	2.66E-02	3.75E-02	1.71E-02	1.02E-02	3.36E-03	4.33E-02	8.51E-03	1.01E-02	4.91E-03	2.94E-03
Aldehydes, other	4.62E-02	3.74E-02	2.71E-02	3.81E-02	1.75E-02	1.04E-02	3.42E-03	4.41E-02	8.66E-03	1.03E-02	5.00E-03	2.99E-03
Aliphatic alcohols	1.66E-01	1.35E-01	9.77E-02	1.37E-01	6.29E-02	3.75E-02	1.23E-02	1.59E-01	3.12E-02	3.70E-02	1.80E-02	1.08E-02
Alkanes/alkenes, other C1-4	5.05E-01	4.09E-01	2.97E-01	4.17E-01	1.91E-01	1.14E-01	3.74E-02	4.82E-01	9.48E-02	1.12E-01	5.47E-02	3.27E-02
Alkanes/alkenes, other C5-8	9.46E-02	7.66E-02	5.55E-02	7.81E-02	3.58E-02	2.13E-02	7.00E-03	9.03E-02	1.78E-02	2.10E-02	1.02E-02	6.13E-03
Alkanes/alkenes, other C>8-10	3.27E-01	2.65E-01	1.92E-01	2.70E-01	1.24E-01	7.37E-02	2.42E-02	3.12E-01	6.14E-02	7.28E-02	3.54E-02	2.12E-02
Alkanes/alkenes, other C>10-12	1.48E-02	1.20E-02	8.68E-03	1.22E-02	5.59E-03	3.33E-03	1.09E-03	1.41E-02	2.77E-03	3.29E-03	1.60E-03	9.57E-04
Alkanes/alkenes, other C>12-16	2.57E-02	2.08E-02	1.51E-02	2.12E-02	9.71E-03	5.79E-03	1.90E-03	2.45E-02	4.82E-03	5.72E-03	2.78E-03	1.66E-03
Benzene and related	3.77E-02	3.06E-02	2.22E-02	3.12E-02	1.43E-02	8.50E-03	2.79E-03	3.60E-02	7.08E-03	8.40E-03	4.09E-03	2.44E-03
Butadiene, 1,3-	2.72E-02	2.20E-02	1.60E-02	2.24E-02	1.03E-02	6.12E-03	2.01E-03	2.59E-02	5.10E-03	6.04E-03	2.94E-03	1.76E-03
Cycloalkanes and cycloalkenes	3.03E-03	2.45E-03	1.78E-03	2.50E-03	1.14E-03	6.82E-04	2.24E-04	2.89E-03	5.68E-04	6.74E-04	3.28E-04	1.96E-04

Table 4-8	Summary of Annual Average Exposure Point Concentrations – 2022 Airport Alone Assessment Scenario (µg/m³)											
Chemicals of Concern	***Receptor Location of Concern***											
	Commercial Land Use			***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	2.88E-02	2.33E-02	1.69E-02	2.38E-02	1.09E-02	6.48E-03	2.13E-03	2.75E-02	5.40E-03	6.41E-03	3.12E-03	1.87E-03
Formaldehyde and related	2.54E-01	2.06E-01	1.49E-01	2.10E-01	9.61E-02	5.73E-02	1.88E-02	2.43E-01	4.77E-02	5.66E-02	2.75E-02	1.65E-02
Hexane, n-	1.03E-03	8.32E-04	6.03E-04	8.48E-04	3.88E-04	2.31E-04	7.60E-05	9.80E-04	1.93E-04	2.29E-04	1.11E-04	6.65E-05
Naphthalene and related	1.71E-02	1.38E-02	1.00E-02	1.41E-02	6.45E-03	3.84E-03	1.26E-03	1.63E-02	3.20E-03	3.80E-03	1.85E-03	1.11E-03
Styrene	4.86E-03	3.94E-03	2.85E-03	4.01E-03	1.84E-03	1.09E-03	3.60E-04	4.64E-03	9.12E-04	1.08E-03	5.26E-04	3.15E-04
Toluene and related	1.57E-02	1.27E-02	9.19E-03	1.29E-02	5.92E-03	3.52E-03	1.16E-03	1.49E-02	2.94E-03	3.48E-03	1.70E-03	1.01E-03
Xylenes	8.90E-03	7.21E-03	5.23E-03	7.35E-03	3.37E-03	2.00E-03	6.59E-04	8.50E-03	1.67E-03	1.98E-03	9.64E-04	5.77E-04
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	7.77E-04	4.61E-04	3.66E-04	4.58E-04	2.33E-04	1.38E-04	4.45E-05	4.07E-04	1.01E-04	1.40E-04	6.98E-05	4.02E-05

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

Table 4-9	Summary of Annual Average Exposure Point Concentrations – 2032 Airport Alone Assessment Scenario (µg/m³)											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	2.83E+01	2.46E+01	1.60E+01	1.76E+01	8.07E+00	4.62E+00	1.46E+00	1.81E+01	3.69E+00	4.73E+00	2.24E+00	1.35E+00
Nitrogen dioxide (NO_2)	2.52E+00	2.08E+00	1.71E+00	2.82E+00	2.01E+00	1.23E+00	4.95E-01	4.15E+00	8.26E-01	1.18E+00	6.78E-01	4.17E-01
Coarse Particulate Matter (PM_{10})	2.37E-01	1.61E-01	1.20E-01	1.38E-01	7.12E-02	4.11E-02	1.35E-02	1.24E-01	3.03E-02	4.23E-02	2.12E-02	1.20E-02
Fine Particulate Matter ($PM_{2.5}$)	1.92E-01	1.26E-01	1.00E-01	1.27E-01	6.51E-02	3.79E-02	1.26E-02	1.15E-01	2.79E-02	3.88E-02	1.95E-02	1.10E-02
Sulphur Dioxide (SO_2)	9.31E-01	5.06E-01	4.36E-01	7.54E-01	3.70E-01	2.15E-01	7.65E-02	9.85E-01	1.80E-01	2.13E-01	1.09E-01	6.50E-02
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	8.45E-02	6.59E-02	4.81E-02	6.98E-02	3.17E-02	1.85E-02	6.23E-03	8.18E-02	1.55E-02	1.86E-02	9.30E-03	5.45E-03
Acetone	7.10E-03	5.53E-03	4.04E-03	5.86E-03	2.66E-03	1.55E-03	5.23E-04	6.87E-03	1.30E-03	1.56E-03	7.82E-04	4.58E-04
Acrolein and related	5.55E-02	4.32E-02	3.16E-02	4.58E-02	2.08E-02	1.21E-02	4.09E-03	5.37E-02	1.02E-02	1.22E-02	6.11E-03	3.58E-03
Aldehydes, other	5.64E-02	4.40E-02	3.21E-02	4.66E-02	2.11E-02	1.23E-02	4.16E-03	5.46E-02	1.04E-02	1.24E-02	6.21E-03	3.64E-03
Aliphatic alcohols	2.03E-01	1.59E-01	1.16E-01	1.68E-01	7.62E-02	4.44E-02	1.50E-02	1.97E-01	3.74E-02	4.47E-02	2.24E-02	1.31E-02
Alkanes/alkenes, other C1-4	6.12E-01	4.77E-01	3.49E-01	5.05E-01	2.29E-01	1.34E-01	4.51E-02	5.92E-01	1.12E-01	1.34E-01	6.74E-02	3.95E-02
Alkanes/alkenes, other C5-8	1.12E-01	8.70E-02	6.36E-02	9.22E-02	4.18E-02	2.44E-02	8.22E-03	1.08E-01	2.05E-02	2.45E-02	1.23E-02	7.20E-03
Alkanes/alkenes, other C>8-10	4.00E-01	3.12E-01	2.28E-01	3.30E-01	1.50E-01	8.74E-02	2.95E-02	3.87E-01	7.35E-02	8.79E-02	4.40E-02	2.58E-02
Alkanes/alkenes, other C>10-12	1.80E-02	1.40E-02	1.02E-02	1.48E-02	6.73E-03	3.92E-03	1.32E-03	1.74E-02	3.30E-03	3.95E-03	1.98E-03	1.16E-03
Alkanes/alkenes, other C>12-16	3.14E-02	2.45E-02	1.79E-02	2.59E-02	1.18E-02	6.86E-03	2.32E-03	3.04E-02	5.78E-03	6.90E-03	3.46E-03	2.03E-03
Benzene and related	4.52E-02	3.52E-02	2.57E-02	3.73E-02	1.69E-02	9.87E-03	3.33E-03	4.37E-02	8.30E-03	9.93E-03	4.97E-03	2.91E-03
Butadiene, 1,3-	3.31E-02	2.58E-02	1.89E-02	2.74E-02	1.24E-02	7.24E-03	2.44E-03	3.21E-02	6.09E-03	7.28E-03	3.65E-03	2.14E-03
Cycloalkanes and cycloalkenes	3.07E-03	2.39E-03	1.75E-03	2.54E-03	1.15E-03	6.71E-04	2.26E-04	2.97E-03	5.64E-04	6.75E-04	3.38E-04	1.98E-04

Table 4-9 Summary of Annual Average Exposure Point Concentrations – 2032 Airport Alone Assessment Scenario (µg/m³)												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential Land Use***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Ethylbenzene and related	3.47E-02	2.70E-02	1.97E-02	2.86E-02	1.30E-02	7.57E-03	2.55E-03	3.35E-02	6.37E-03	7.62E-03	3.82E-03	2.24E-03
Formaldehyde and related	3.11E-01	2.42E-01	1.77E-01	2.56E-01	1.16E-01	6.78E-02	2.29E-02	3.01E-01	5.71E-02	6.82E-02	3.42E-02	2.00E-02
Hexane, n-	1.04E-03	8.13E-04	5.94E-04	8.61E-04	3.91E-04	2.28E-04	7.69E-05	1.01E-03	1.92E-04	2.29E-04	1.15E-04	6.73E-05
Naphthalene and related	2.09E-02	1.63E-02	1.19E-02	1.72E-02	7.82E-03	4.56E-03	1.54E-03	2.02E-02	3.83E-03	4.59E-03	2.30E-03	1.35E-03
Styrene	5.94E-03	4.63E-03	3.39E-03	4.91E-03	2.23E-03	1.30E-03	4.38E-04	5.75E-03	1.09E-03	1.31E-03	6.54E-04	3.83E-04
Toluene and related	1.87E-02	1.46E-02	1.07E-02	1.54E-02	7.01E-03	4.09E-03	1.38E-03	1.81E-02	3.44E-03	4.11E-03	2.06E-03	1.21E-03
Xylenes	1.05E-02	8.18E-03	5.98E-03	8.67E-03	3.93E-03	2.29E-03	7.74E-04	1.02E-02	1.93E-03	2.31E-03	1.16E-03	6.77E-04
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	8.21E-04	5.40E-04	4.30E-04	5.44E-04	2.79E-04	1.62E-04	5.39E-05	4.92E-04	1.19E-04	1.66E-04	8.35E-05	4.70E-05

NA Not applicable. Exposures to this chemical are not relevant for this exposure assessment scenario.

4.2.2 Estimation of Environmental Media Concentrations

The objective of the multi-media exposure assessment was to predict, using information from receptor and chemical characterization (Sections 4.1 and 4.2, respectively), chronic exposures (expressed as µg chemical/kg body weight/day) to COCs *via* the exposure pathways identified in the Problem Formulation (Section 3.1). This was accomplished using the maximum predicted annual ground-level air concentrations and deposition rates resulting from Toronto Pearson emissions alone (*i.e*., no other local and/or regional emission sources were considered) to predicted EPCs in various environmental media.

The potential deposition of airborne particulate-bound contaminants from the atmosphere (originating from the airport) onto ground-level surfaces (such as soil, home gardens, *etc*.) in the surrounding community is an important element of exposure. Deposition (both dry and wet) can be affected by a variety of different factors, the most important of which tend to be the characteristics of the atmosphere (*e.g.*, wind speed, temperature, atmospheric stability, *etc*.), the nature of the surface (*e.g.*, its surface roughness, porosity, *etc*.), and the properties of the depositing species (*e.g.*, reactivity, diameter and shape, solubility, *etc*.). This process can be achieved through "dry" deposition where the particles or gas molecules impact upon a surface, or through "wet" deposition where rain or other precipitation scavenges particles and gas molecules from the air and deposits them on surfaces. To address this particular exposure route, total deposition into the environment (*e.g*., soil) was estimated in total, wet, and dry deposition per year at each sensitive receptor location by the air quality assessment team.

The maximum predicted annual ground-level air concentrations (Tables 4-7 through 4-9) and annual deposition rates (Table 4-10) resulting from Toronto Pearson emissions alone (*i.e*., no other local and/or regional emission sources were considered) were used to predict EPCs in various environmental media. Chronic exposures to these media at the receptor locations were conservatively predicted under a residential exposure scenario regardless of current land use for the 'Airport Alone'. These exposures are presented for years 2011, 2022, and 2032 in Tables 4-11 through 4-13, respectively.

The methods, equations and assumptions used to predict concentrations in various environmental media were obtained from the US EPA (2005), Health Canada (2012), and MOE (2011). Refer to Appendix D for details concerning the derivation of EPCs in various environmental media.

Table 4-10	Deposition Rates for Benzo(a)pyrene TEQ – Airport Alone Assessment Scenarios (All Years)								
Receptor Location	***Annual Benzo(a)pyrene TEQ Deposition Rates (mg/m^2/yr)***								
	2011			***2022***			***2032***		
	Total	***Dry***	***Wet***	***Total***	***Dry***	***Wet***	***Total***	***Dry***	***Wet***
MPOI	4E-02	4E-02	2E-05	5E-02	5E-02	7E-05	6E-02	6E-02	8E-05
R1	4E-02	4E-02	2E-05	5E-02	5E-02	4E-05	6E-02	6E-02	5E-05
R2	3E-02	3E-02	1E-05	4E-02	4E-02	3E-05	4E-02	4E-02	4E-05
R3	7E-03	7E-03	4E-06	1E-02	1E-02	1E-05	1E-02	1E-02	1E-05
R4	4E-03	4E-03	2E-06	7E-03	7E-03	1E-05	8E-03	8E-03	1E-05
R5	3E-03	3E-03	1E-06	4E-03	4E-03	9E-06	5E-03	5E-03	1E-05
R6	9E-04	9E-04	5E-07	2E-03	2E-03	4E-06	2E-03	2E-03	5E-06
R7	5E-03	5E-03	3E-06	9E-03	9E-03	2E-05	1E-02	1E-02	3E-05
R8	2E-03	2E-03	9E-07	3E-03	3E-03	9E-06	3E-03	3E-03	1E-05
R9	3E-03	3E-03	1E-06	4E-03	4E-03	8E-06	5E-03	5E-03	1E-05
R10	1E-03	1E-03	8E-07	2E-03	2E-03	8E-06	3E-03	3E-03	9E-06
R11	9E-04	9E-04	5E-07	1E-03	1E-03	4E-06	1E-03	1E-03	5E-06

TEQ Toxic Equivalency Quotient

Table 4-11 Multi-Media Exposure Estimates for Benzo(a)pyrene TEQ – 2011 Airport Alone Assessment Scenario							
Receptor Location	***Receptor Group***	***Garden Produce***	***Breast Milk***	***Soil Ingestion***	***Dust Ingestion***	***Dermal Contact***	***Total Estimated Daily Intake***
MPOI	Composite	-	-	-	-	-	6.98E-08
	Adult	5.72E-08	-	5.90E-10	3.72E-13	6.56E-10	5.84E-08
	Teen	4.58E-08	-	6.99E-10	4.14E-13	6.90E-10	4.72E-08
	Child	1.02E-07	-	1.27E-09	6.98E-13	8.61E-10	1.05E-07
	Toddler	1.95E-07	-	1.01E-08	7.97E-13	1.13E-09	2.06E-07
	Infant	0.00E+00	6.94E-08	5.09E-09	4.25E-13	1.54E-09	7.60E-08
R1	Composite	-	-	-	-	-	6.28E-08
	Adult	5.13E-08	-	5.90E-10	3.72E-13	6.56E-10	5.25E-08
	Teen	4.11E-08	-	6.99E-10	4.14E-13	6.90E-10	4.25E-08
	Child	9.19E-08	-	1.27E-09	6.98E-13	8.61E-10	9.40E-08
	Toddler	1.75E-07	-	1.01E-08	7.97E-13	1.13E-09	1.86E-07
	Infant	0.00E+00	6.24E-08	5.09E-09	4.25E-13	1.54E-09	6.90E-08
R2	Composite	-	-	-	-	-	4.72E-08
	Adult	3.86E-08	-	4.42E-10	2.79E-13	4.92E-10	3.95E-08
	Teen	3.09E-08	-	5.24E-10	3.11E-13	5.18E-10	3.19E-08
	Child	6.92E-08	-	9.51E-10	5.24E-13	6.46E-10	7.08E-08
	Toddler	1.32E-07	-	7.58E-09	5.98E-13	8.48E-10	1.40E-07
	Infant	0.00E+00	4.70E-08	3.81E-09	3.19E-13	1.16E-09	5.19E-08
R3	Composite	-	-	-	-	-	1.20E-08
	Adult	9.86E-09	-	1.03E-10	6.51E-14	1.15E-10	1.01E-08
	Teen	7.91E-09	-	1.22E-10	7.25E-14	1.21E-10	8.15E-09
	Child	1.77E-08	-	2.22E-10	1.22E-13	1.51E-10	1.81E-08
	Toddler	3.37E-08	-	1.77E-09	1.40E-13	1.98E-10	3.57E-08
	Infant	0.00E+00	1.20E-08	8.90E-10	7.44E-14	2.70E-10	1.31E-08
R4	Composite	-	-	-	-	-	6.56E-09
	Adult	5.36E-09	-	5.90E-11	3.72E-14	6.56E-11	5.49E-09
	Teen	4.30E-09	-	6.99E-11	4.14E-14	6.90E-11	4.43E-09
	Child	9.61E-09	-	1.27E-10	6.98E-14	8.61E-11	9.82E-09
	Toddler	1.83E-08	-	1.01E-09	7.97E-14	1.13E-10	1.94E-08
	Infant	0.00E+00	6.52E-09	5.09E-10	4.25E-14	1.54E-10	7.18E-09
R5	Composite	-	-	-	-	-	4.29E-09
	Adult	3.49E-09	-	4.42E-11	2.79E-14	4.92E-11	3.58E-09
	Teen	2.79E-09	-	5.24E-11	3.11E-14	5.18E-11	2.90E-09
	Child	6.26E-09	-	9.51E-11	5.24E-14	6.46E-11	6.42E-09
	Toddler	1.19E-08	-	7.58E-10	5.98E-14	8.48E-11	1.28E-08
	Infant	0.00E+00	4.26E-09	3.81E-10	3.19E-14	1.16E-10	4.75E-09

Table 4-11 Multi-Media Exposure Estimates for Benzo(a)pyrene TEQ – 2011 Airport Alone Assessment Scenario

Receptor Location	*Receptor Group*	*Garden Produce*	*Breast Milk*	*Soil Ingestion*	*Dust Ingestion*	*Dermal Contact*	*Total Estimated Daily Intake*
R6	Composite	-	-	-	-	-	1.31E-09
	Adult	1.06E-09	-	1.33E-11	8.37E-15	1.48E-11	1.09E-09
	Teen	8.52E-10	-	1.57E-11	9.32E-15	1.55E-11	8.83E-10
	Child	1.91E-09	-	2.85E-11	1.57E-14	1.94E-11	1.96E-09
	Toddler	3.64E-09	-	2.27E-10	1.79E-14	2.54E-11	3.89E-09
	Infant	0.00E+00	1.30E-09	1.14E-10	9.57E-15	3.47E-11	1.45E-09
R7	Composite	-	-	-	-	-	8.84E-09
	Adult	7.25E-09	-	7.37E-11	4.65E-14	8.21E-11	7.40E-09
	Teen	5.81E-09	-	8.73E-11	5.18E-14	8.63E-11	5.98E-09
	Child	1.30E-08	-	1.58E-10	8.73E-14	1.08E-10	1.33E-08
	Toddler	2.47E-08	-	1.26E-09	9.96E-14	1.41E-10	2.62E-08
	Infant	0.00E+00	8.80E-09	6.36E-10	5.31E-14	1.93E-10	9.63E-09
R8	Composite	-	-	-	-	-	2.57E-09
	Adult	2.08E-09	-	2.95E-11	1.86E-14	3.28E-11	2.14E-09
	Teen	1.66E-09	-	3.49E-11	2.07E-14	3.45E-11	1.73E-09
	Child	3.73E-09	-	6.34E-11	3.49E-14	4.31E-11	3.84E-09
	Toddler	7.12E-09	-	5.06E-10	3.99E-14	5.65E-11	7.69E-09
	Infant	0.00E+00	2.55E-09	2.54E-10	2.13E-14	7.70E-11	2.88E-09
R9	Composite	-	-	-	-	-	4.45E-09
	Adult	3.63E-09	-	4.42E-11	2.79E-14	4.92E-11	3.72E-09
	Teen	2.90E-09	-	5.24E-11	3.11E-14	5.18E-11	3.01E-09
	Child	6.50E-09	-	9.51E-11	5.24E-14	6.46E-11	6.66E-09
	Toddler	1.24E-08	-	7.58E-10	5.98E-14	8.48E-11	1.32E-08
	Infant	0.00E+00	4.42E-09	3.81E-10	3.19E-14	1.16E-10	4.92E-09
R10	Composite	-	-	-	-	-	1.88E-09
	Adult	1.55E-09	-	1.47E-11	9.30E-15	1.64E-11	1.58E-09
	Teen	1.24E-09	-	1.75E-11	1.04E-14	1.73E-11	1.27E-09
	Child	2.77E-09	-	3.17E-11	1.75E-14	2.15E-11	2.82E-09
	Toddler	5.28E-09	-	2.53E-10	1.99E-14	2.83E-11	5.56E-09
	Infant	0.00E+00	1.87E-09	1.27E-10	1.06E-14	3.85E-11	2.04E-09
R11	Composite	-	-	-	-	-	1.36E-09
	Adult	1.11E-09	-	1.33E-11	8.37E-15	1.48E-11	1.14E-09
	Teen	8.88E-10	-	1.57E-11	9.32E-15	1.55E-11	9.19E-10
	Child	1.99E-09	-	2.85E-11	1.57E-14	1.94E-11	2.04E-09
	Toddler	3.79E-09	-	2.27E-10	1.79E-14	2.54E-11	4.04E-09
	Infant	0.00E+00	1.35E-09	1.14E-10	9.57E-15	3.47E-11	1.50E-09

TEQ Toxic Equivalency Quotient

[a] All exposures expressed as mg chemical per kg body weight per day (mg/kg/d).

Table 4-12 Multi-Media Exposure Estimates for Benzo(a)pyrene TEQ – 2022 Airport Alone Assessment Scenario

Receptor Location	*Receptor Group*	*Garden Produce*	*Breast Milk*	*Soil Ingestion*	*Dust Ingestion*	*Dermal Contact*	*Total Estimated Daily Intake*
MPOI	Composite	-	-	-	-	-	9.43E-08
	Adult	7.74E-08	-	7.37E-10	4.65E-13	8.21E-10	7.90E-08
	Teen	6.21E-08	-	8.73E-10	5.18E-13	8.63E-10	6.38E-08
	Child	1.39E-07	-	1.58E-09	8.73E-13	1.08E-09	1.41E-07
	Toddler	2.64E-07	-	1.26E-08	9.96E-13	1.41E-09	2.78E-07
	Infant	0.00E+00	9.38E-08	6.36E-09	5.31E-13	1.93E-09	1.02E-07
R1	Composite	-	-	-	-	-	7.64E-08
	Adult	6.23E-08	-	7.37E-10	4.65E-13	8.21E-10	6.39E-08
	Teen	4.99E-08	-	8.73E-10	5.18E-13	8.63E-10	5.16E-08
	Child	1.12E-07	-	1.58E-09	8.73E-13	1.08E-09	1.14E-07
	Toddler	2.13E-07	-	1.26E-08	9.96E-13	1.41E-09	2.27E-07
	Infant	0.00E+00	7.59E-08	6.36E-09	5.31E-13	1.93E-09	8.42E-08
R2	Composite	-	-	-	-	-	6.09E-08
	Adult	4.96E-08	-	5.90E-10	3.72E-13	6.56E-10	5.09E-08
	Teen	3.98E-08	-	6.99E-10	4.14E-13	6.90E-10	4.11E-08
	Child	8.90E-08	-	1.27E-09	6.98E-13	8.61E-10	9.11E-08
	Toddler	1.70E-07	-	1.01E-08	7.97E-13	1.13E-09	1.81E-07
	Infant	0.00E+00	6.05E-08	5.09E-09	4.25E-13	1.54E-09	6.71E-08
R3	Composite	-	-	-	-	-	1.67E-08
	Adult	1.37E-08	-	1.47E-10	9.30E-14	1.64E-10	1.40E-08
	Teen	1.09E-08	-	1.75E-10	1.04E-13	1.73E-10	1.13E-08
	Child	2.45E-08	-	3.17E-10	1.75E-13	2.15E-10	2.50E-08
	Toddler	4.67E-08	-	2.53E-09	1.99E-13	2.83E-10	4.95E-08
	Infant	0.00E+00	1.66E-08	1.27E-09	1.06E-13	3.85E-10	1.83E-08
R4	Composite	-	-	-	-	-	9.94E-09
	Adult	8.09E-09	-	1.03E-10	6.51E-14	1.15E-10	8.30E-09
	Teen	6.47E-09	-	1.22E-10	7.25E-14	1.21E-10	6.72E-09
	Child	1.45E-08	-	2.22E-10	1.22E-13	1.51E-10	1.49E-08
	Toddler	2.77E-08	-	1.77E-09	1.40E-13	1.98E-10	2.96E-08
	Infant	0.00E+00	9.87E-09	8.90E-10	7.44E-14	2.70E-10	1.10E-08
R5	Composite	-	-	-	-	-	5.77E-09
	Adult	4.70E-09	-	5.90E-11	3.72E-14	6.56E-11	4.82E-09
	Teen	3.76E-09	-	6.99E-11	4.14E-14	6.90E-11	3.90E-09
	Child	8.43E-09	-	1.27E-10	6.98E-14	8.61E-11	8.64E-09
	Toddler	1.61E-08	-	1.01E-09	7.97E-14	1.13E-10	1.72E-08
	Infant	0.00E+00	5.73E-09	5.09E-10	4.25E-14	1.54E-10	6.39E-09

Table 4-12 Multi-Media Exposure Estimates for Benzo(a)pyrene TEQ – 2022 Airport Alone Assessment Scenario							
Receptor Location	***Receptor Group***	***Garden Produce***	***Breast Milk***	***Soil Ingestion***	***Dust Ingestion***	***Dermal Contact***	***Total Estimated Daily Intake***
R6	Composite	-	-	-	-	-	2.40E-09
	Adult	1.94E-09	-	2.95E-11	1.86E-14	3.28E-11	2.00E-09
	Teen	1.55E-09	-	3.49E-11	2.07E-14	3.45E-11	1.62E-09
	Child	3.48E-09	-	6.34E-11	3.49E-14	4.31E-11	3.58E-09
	Toddler	6.64E-09	-	5.06E-10	3.99E-14	5.65E-11	7.20E-09
	Infant	0.00E+00	2.37E-09	2.54E-10	2.13E-14	7.70E-11	2.71E-09
R7	Composite	-	-	-	-	-	1.49E-08
	Adult	1.22E-08	-	1.33E-10	8.37E-14	1.48E-10	1.25E-08
	Teen	9.79E-09	-	1.57E-10	9.32E-14	1.55E-10	1.01E-08
	Child	2.19E-08	-	2.85E-10	1.57E-13	1.94E-10	2.24E-08
	Toddler	4.17E-08	-	2.27E-09	1.79E-13	2.54E-10	4.43E-08
	Infant	0.00E+00	1.48E-08	1.14E-09	9.57E-14	3.47E-10	1.63E-08
R8	Composite	-	-	-	-	-	4.28E-09
	Adult	3.48E-09	-	4.42E-11	2.79E-14	4.92E-11	3.58E-09
	Teen	2.79E-09	-	5.24E-11	3.11E-14	5.18E-11	2.89E-09
	Child	6.25E-09	-	9.51E-11	5.24E-14	6.46E-11	6.41E-09
	Toddler	1.19E-08	-	7.58E-10	5.98E-14	8.48E-11	1.28E-08
	Infant	0.00E+00	4.25E-09	3.81E-10	3.19E-14	1.16E-10	4.75E-09
R9	Composite	-	-	-	-	-	5.80E-09
	Adult	4.73E-09	-	5.90E-11	3.72E-14	6.56E-11	4.85E-09
	Teen	3.78E-09	-	6.99E-11	4.14E-14	6.90E-11	3.92E-09
	Child	8.48E-09	-	1.27E-10	6.98E-14	8.61E-11	8.69E-09
	Toddler	1.62E-08	-	1.01E-09	7.97E-14	1.13E-10	1.73E-08
	Infant	0.00E+00	5.76E-09	5.09E-10	4.25E-14	1.54E-10	6.43E-09
R10	Composite	-	-	-	-	-	2.90E-09
	Adult	2.36E-09	-	2.95E-11	1.86E-14	3.28E-11	2.43E-09
	Teen	1.89E-09	-	3.49E-11	2.07E-14	3.45E-11	1.96E-09
	Child	4.24E-09	-	6.34E-11	3.49E-14	4.31E-11	4.35E-09
	Toddler	8.09E-09	-	5.06E-10	3.99E-14	5.65E-11	8.65E-09
	Infant	0.00E+00	2.88E-09	2.54E-10	2.13E-14	7.70E-11	3.21E-09
R11	Composite	-	-	-	-	-	1.56E-09
	Adult	1.27E-09	-	1.47E-11	9.30E-15	1.64E-11	1.30E-09
	Teen	1.02E-09	-	1.75E-11	1.04E-14	1.73E-11	1.05E-09
	Child	2.28E-09	-	3.17E-11	1.75E-14	2.15E-11	2.33E-09
	Toddler	4.35E-09	-	2.53E-10	1.99E-14	2.83E-11	4.63E-09
	Infant	0.00E+00	1.55E-09	1.27E-10	1.06E-14	3.85E-11	1.71E-09

TEF Toxic Equivalency Quotient

[a] All exposures expressed as mg chemical per kg body weight per day (mg/kg/d).

Table 4-13 Multi-Media Exposure Estimates for Benzo(a)pyrene TEQ – 2032 Airport Alone Assessment Scenario							
Receptor Location	***Receptor Group***	***Garden Produce***	***Breast Milk***	***Soil Ingestion***	***Dust Ingestion***	***Dermal Contact***	***Total Estimated Daily Intake***
MPOI	Composite	-	-	-	-	-	1.05E-07
	Adult	8.60E-08	-	8.85E-10	5.58E-13	9.85E-10	8.79E-08
	Teen	6.89E-08	-	1.05E-09	6.21E-13	1.04E-09	7.10E-08
	Child	1.54E-07	-	1.90E-09	1.05E-12	1.29E-09	1.57E-07
	Toddler	2.94E-07	-	1.52E-08	1.20E-12	1.70E-09	3.11E-07
	Infant	0.00E+00	1.04E-07	7.63E-09	6.38E-13	2.31E-09	1.14E-07
R1	Composite	-	-	-	-	-	9.05E-08
	Adult	7.38E-08	-	8.85E-10	5.58E-13	9.85E-10	7.57E-08
	Teen	5.91E-08	-	1.05E-09	6.21E-13	1.04E-09	6.12E-08
	Child	1.32E-07	-	1.90E-09	1.05E-12	1.29E-09	1.36E-07
	Toddler	2.52E-07	-	1.52E-08	1.20E-12	1.70E-09	2.69E-07
	Infant	0.00E+00	8.99E-08	7.63E-09	6.38E-13	2.31E-09	9.99E-08
R2	Composite	-	-	-	-	-	6.63E-08
	Adult	5.42E-08	-	5.90E-10	3.72E-13	6.56E-10	5.55E-08
	Teen	4.34E-08	-	6.99E-10	4.14E-13	6.90E-10	4.48E-08
	Child	9.72E-08	-	1.27E-09	6.98E-13	8.61E-10	9.93E-08
	Toddler	1.85E-07	-	1.01E-08	7.97E-13	1.13E-09	1.96E-07
	Infant	0.00E+00	6.59E-08	5.09E-09	4.25E-13	1.54E-09	7.25E-08
R3	Composite	-	-	-	-	-	1.84E-08
	Adult	1.51E-08	-	1.47E-10	9.30E-14	1.64E-10	1.54E-08
	Teen	1.21E-08	-	1.75E-10	1.04E-13	1.73E-10	1.25E-08
	Child	2.71E-08	-	3.17E-10	1.75E-13	2.15E-10	2.76E-08
	Toddler	5.16E-08	-	2.53E-09	1.99E-13	2.83E-10	5.44E-08
	Infant	0.00E+00	1.83E-08	1.27E-09	1.06E-13	3.85E-10	2.00E-08
R4	Composite	-	-	-	-	-	1.16E-08
	Adult	9.44E-09	-	1.18E-10	7.44E-14	1.31E-10	9.69E-09
	Teen	7.56E-09	-	1.40E-10	8.28E-14	1.38E-10	7.84E-09
	Child	1.69E-08	-	2.54E-10	1.40E-13	1.72E-10	1.74E-08
	Toddler	3.23E-08	-	2.02E-09	1.59E-13	2.26E-10	3.46E-08
	Infant	0.00E+00	1.15E-08	1.02E-09	8.50E-14	3.08E-10	1.28E-08
R5	Composite	-	-	-	-	-	7.01E-09
	Adult	5.70E-09	-	7.37E-11	4.65E-14	8.21E-11	5.86E-09
	Teen	4.56E-09	-	8.73E-11	5.18E-14	8.63E-11	4.74E-09
	Child	1.02E-08	-	1.58E-10	8.73E-14	1.08E-10	1.05E-08
	Toddler	1.95E-08	-	1.26E-09	9.96E-14	1.41E-10	2.09E-08
	Infant	0.00E+00	6.96E-09	6.36E-10	5.31E-14	1.93E-10	7.79E-09

Table 4-13 Multi-Media Exposure Estimates for Benzo(a)pyrene TEQ – 2032 Airport Alone Assessment Scenario							
Receptor Location	***Receptor Group***	***Garden Produce***	***Breast Milk***	***Soil Ingestion***	***Dust Ingestion***	***Dermal Contact***	***Total Estimated Daily Intake***
R6	Composite	-	-	-	-	-	2.59E-09
	Adult	2.10E-09	-	2.95E-11	1.86E-14	3.28E-11	2.16E-09
	Teen	1.68E-09	-	3.49E-11	2.07E-14	3.45E-11	1.75E-09
	Child	3.76E-09	-	6.34E-11	3.49E-14	4.31E-11	3.87E-09
	Toddler	7.18E-09	-	5.06E-10	3.99E-14	5.65E-11	7.74E-09
	Infant	0.00E+00	2.56E-09	2.54E-10	2.13E-14	7.70E-11	2.90E-09
R7	Composite	-	-	-	-	-	1.74E-08
	Adult	1.42E-08	-	1.47E-10	9.30E-14	1.64E-10	1.46E-08
	Teen	1.14E-08	-	1.75E-10	1.04E-13	1.73E-10	1.18E-08
	Child	2.55E-08	-	3.17E-10	1.75E-13	2.15E-10	2.61E-08
	Toddler	4.86E-08	-	2.53E-09	1.99E-13	2.83E-10	5.15E-08
	Infant	0.00E+00	1.73E-08	1.27E-09	1.06E-13	3.85E-10	1.90E-08
R8	Composite	-	-	-	-	-	4.65E-09
	Adult	3.80E-09	-	4.42E-11	2.79E-14	4.92E-11	3.89E-09
	Teen	3.04E-09	-	5.24E-11	3.11E-14	5.18E-11	3.14E-09
	Child	6.81E-09	-	9.51E-11	5.24E-14	6.46E-11	6.97E-09
	Toddler	1.30E-08	-	7.58E-10	5.98E-14	8.48E-11	1.38E-08
	Infant	0.00E+00	4.62E-09	3.81E-10	3.19E-14	1.16E-10	5.12E-09
R9	Composite	-	-	-	-	-	7.09E-09
	Adult	5.77E-09	-	7.37E-11	4.65E-14	8.21E-11	5.92E-09
	Teen	4.62E-09	-	8.73E-11	5.18E-14	8.63E-11	4.79E-09
	Child	1.03E-08	-	1.58E-10	8.73E-14	1.08E-10	1.06E-08
	Toddler	1.97E-08	-	1.26E-09	9.96E-14	1.41E-10	2.11E-08
	Infant	0.00E+00	7.04E-09	6.36E-10	5.31E-14	1.93E-10	7.87E-09
R10	Composite	-	-	-	-	-	3.93E-09
	Adult	3.19E-09	-	4.42E-11	2.79E-14	4.92E-11	3.28E-09
	Teen	2.55E-09	-	5.24E-11	3.11E-14	5.18E-11	2.66E-09
	Child	5.72E-09	-	9.51E-11	5.24E-14	6.46E-11	5.88E-09
	Toddler	1.09E-08	-	7.58E-10	5.98E-14	8.48E-11	1.18E-08
	Infant	0.00E+00	3.90E-09	3.81E-10	3.19E-14	1.16E-10	4.40E-09
R11	Composite	-	-	-	-	-	1.69E-09
	Adult	1.39E-09	-	1.47E-11	9.30E-15	1.64E-11	1.42E-09
	Teen	1.11E-09	-	1.75E-11	1.04E-14	1.73E-11	1.15E-09
	Child	2.49E-09	-	3.17E-11	1.75E-14	2.15E-11	2.54E-09
	Toddler	4.74E-09	-	2.53E-10	1.99E-14	2.83E-11	5.02E-09
	Infant	0.00E+00	1.68E-09	1.27E-10	1.06E-14	3.85E-11	1.85E-09

TEQ Toxic Equivalency Quotient.

[a] All exposures expressed as mg chemical per kg body weight per day (mg/kg/d).

4.3 Exposure Analysis of Particulate Matter

The size of the airborne particles to which people are exposed is one of the most important aspects in determining the potential for health risk resulting from PM exposure. Size is directly related to where particles will be deposited in specific parts of the respiratory tract. Particles larger than about 10 microns (*μm*) in aerodynamic diameter (>PM_{10}) are deposited almost exclusively in the nose, throat, and upper respiratory tract, and tend to be coughed out over a very short period of time. This size range is considered outside the inhalable range for people, since these particles are too large to be deposited in the lung. Health effects associated with particles greater than PM_{10} are considered less critical compared to fractions less than 10 microns in size since they are less likely to be absorbed into the body *via* inhalation. Fine and ultrafine particles (<2.5 μm), on the other hand, are small enough to reach the alveoli (air spaces) deep in the lungs. In general, it may be assumed that the smaller the particle, the greater the potential to reach respiratory structures such as alveoli where blood-gas exchange occurs. Inhaled fine and ultrafine particles can also carry adsorbed chemical pollutants to the deeper lung structures. Smaller particles tend to be present in greater numbers, and they possess a greater total surface area than larger particles of the same mass.

The potential impacts of human exposure to the respirable fraction of PM (*i.e.*, $PM_{2.5}$ and PM_{10}) was emphasized in the current HHRA, rather than the broader size fraction represented by total suspended particulate (*i.e.*, TSP, comprising particles ranging up to 44 μm in size). The inhalable fraction (*i.e.*, PM_{10}) is also widely used to evaluate potential health issues, since this size of particle primarily affects tissues in the upper airways, but can also travel deep into the lung. When both sets of data are available (PM_{10} and $PM_{2.5}$), the $PM_{2.5}$ data tends to carry more weight in determining the potential for health risks because of the large body of scientific literature characterizing both the epidemiological and toxicological properties of the finer size fraction. Furthermore, the $PM_{2.5}$ size fraction is typically the most relevant size fraction for engine exhaust emissions, and as such is particularly relevant for an evaluation of an airport.

4.3.1 Uncertainties Related to Ultrafine Particulate Matter (UFP)

The potential health impact of ultrafine particulate matter (*i.e.*, UFP or $PM_{0.1}$) is an emerging area of scientific enquiry. As combustion emission byproducts and produced through secondary atmospheric transformations, ambient UFPs have many potential environmental sources whose relative contributions to ambient concentrations vary with location, season, and time-of-day. However, in urban areas, particularly in proximity to major roads, motor vehicle exhaust can be identified as the major contributor to UFP concentrations. In particular, diesel vehicles have been found to contribute substantially, sometimes in disproportion to their numbers in the vehicle fleet (HEI, 2013).

Recent studies have also suggested that major airports can be significant sources of UFP for the surrounding communities. Hudda *et al*. (2014) measured the spatial pattern of particle number concentrations downwind from the Los Angeles International Airport (LAX) and determined that UFP emissions from the airport were four-times background concentrations even at 10 kilometres downwind. Their study results suggested that airport emissions are a major source of ambient particulate in Los Angeles, at the same general magnitude as the entire urban freeway network (Hudda *et al*., 2014).

Perhaps more relevant to the current HHRA, Weichenthal *et al*. (2015) recently completed a land use regression model characterizing the spatial distribution of ambient UFP in the GTA. The results of their ambient UFP monitoring throughout the GTA and subsequent spatial

distribution modelling indicated that distance to the Pearson International airport was identified as an important predictor of ambient UFPs within the overall airshed (Weichenthal *et al*., 2015).

The unique physical properties of UFPs, their interactions with tissues and cells, and their potential for easy movement within the body beyond the lungs have lead researchers to suspect that UFPs may have specific or enhanced toxicity relative to other particle size fractions and may contribute to effects beyond the respiratory system. However, the considerable body of research that has been conducted has not been able to definitively confirm this possibility (HEI, 2013). To date, toxicological studies in animals, controlled human exposure studies, and epidemiologic studies have not provided consistent findings on the effects of exposures to ambient levels of UFPs, particularly in human populations. Most importantly, the current scientific evidence does not support a conclusion that exposures to UFPs alone can account in substantial ways for the adverse effects that have been associated with other ambient pollutants, such as $PM_{2.5}$ (HEI, 2013).

Currently there are no established regulatory benchmarks or standardized approaches to evaluation of the health impact related to exposures to this particulate matter fraction. As such, for the current assessment, the ultrafine fraction was considered as part of the evaluation of health impacts related to the $PM_{2.5}$ (*i.e.*, particulate matter less than 2.5 microns in size) group. However, the uncertainties related to both exposures and health impacts from UFPs, particularly as it pertains to emissions from large-scale airports, is something that should flagged for further consideration in the future once additional scientific information on this particle size fraction becomes available.

Therefore, only the PM_{10} and $PM_{2.5}$ size fractions were evaluated in the current assessment.

5.0 HAZARD ASSESSMENT

All chemicals have the potential to cause toxicological effects; however, it is the chemical concentration, the route of exposure, the duration of exposure, and the inherent toxicity of the chemical that determines the level of effect and hence the potential for adverse health effects. In this stage of the HHRA, toxicity reference values (TRVs) to be used to characterize health risks were selected for each COC.

When TRVs for a particular COC were available from multiple regulatory agencies, values were reviewed and the professional judgment of an experienced toxicologist and/or risk assessor was used to select the most appropriate TRV. A number of different considerations went into selecting a TRV for use in the HHRA, including:

- The source of the information. Is the TRV derived by a reputable regulatory agency?
- Is there sufficient documentation available concerning the derivation of the TRV (*e.g.,* study, endpoint, point of departure, uncertainty factors applied, *etc.*)?
- How current is the derivation of the TRV?
- How relevant is the TRV in terms of exposure route and duration of interest?

The TRVs employed in the current HHRA were obtained from reputable regulatory agencies including, but not limited to:

- Ontario Ministry of the Environment and Climate Change (MOECC);
- Health Canada;
- US EPA Integrated Risk Information System (US EPA IRIS);
- Agency for Toxic Substances and Disease Registry (ATSDR);
- Canadian Council of the Ministers of the Environment (CCME);
- World Health Organization (WHO);
- California Environmental Protection Agency (Cal EPA); and,
- Texas Commission on Environmental Quality (TCEQ).

A summary of the non-carcinogenic and carcinogenic TRVs used in the inhalation assessment (*i.e.,* 1-hour, 24-hour, and chronic duration) are summarized in Tables 5-1 through 5-3. A summary of the non-carcinogenic and carcinogenic TRVs used in the multi-media assessment (chronic duration) are presented in Table 5-4. Refer to Appendix A for further details concerning each TRV considered and, where necessary, the rationale used to select the specific TRV.

5.1 Acute Toxicity Reference Values

The acute (*i.e.*, 1-hour and 24-hour exposure durations) non-carcinogenic inhalation TRVs for each of the COCs (where they were available), as well as the key critical health outcomes and regulatory source for each TRV, are provided in Tables 5-1 and 5-2.

Table 5-1 Summary of Acute 1-Hour Inhalation TRVs and Benchmarks Selected for Use in the HHRA

Chemical of Concern	*Non-Carcinogenic Inhalation TRVs (µg/m³)*			
	Duration	*Value*	*Critical Effect*	*Source*
Criteria Air Contaminants (CACs)				
Carbon monoxide	1-Hour	40,000	Carboxyhaemoglobin blood levels less than or equal to 2.1% in the cardiovascular-sensitive population (human)	US EPA, 2011
Nitrogen dioxide (NO_2)	1-Hour	188	Respiratory irritation (human)	US EPA, 2010
Particulate matter - PM_{10}	NA	-	-	-
Particulate matter - $PM_{2.5}$	NA	-	-	-
Sulphur dioxide (SO_2)	1-Hour	196	Respiratory morbidity (human)	US EPA, 2010
Volatile Organic Compounds (VOCs)				
Acetaldehyde	1-Hour	470	Broncho-constriction, PC20>20% drop in FEV1 (human)	Cal EPA, 2008
Acetone	1-Hour	26,000	Neurological effects (human)	TCEQ, 2013
Acrolein and related, as acrolein	1-Hour	2.5	Eye Irritation (human)	Cal EPA, 2008
Aldehydes (other), as propionaldehyde	1-Hour	1,800[a]	Irritation of mucosal surfaces (human)	TCEQ, 2014 (Draft)
Aliphatic alcohols, as methyl alcohol	1-Hour	13,000	No clinical signs of irritation (human)	TCEQ, 2014
Alkanes/alkenes (other C1-C4), as butene, 2-	1-Hour	34,000	Decreases in maternal body weight (rat)	TCEQ, 2014
Alkanes/alkenes (other C5-C8), as pentane, all isomers	1-Hour	200,000	No clinical signs of toxicity (rat)	TCEQ, 2011
Alkanes/alkenes (other C>8-C10), as decane, n-	1-Hour	60,000	Health-based	MOE, 2012
Alkanes/alkenes (other C>10-C12)	NA	-	-	-
Alkanes/alkenes (other C>12-C16)	NA	-	-	-
Benzene and related, as benzene	Acute	27	Decreased early nucleated red cell counts (mouse)	Cal EPA, 2014
Butadiene, 1,3-	Acute	660	Lowered fetal weight (mouse)	Cal EPA, 2013
Cycloalkanes and cycloalkenes, as cyclohexane	NA	-	-	-
Ethylbenzene and related, as ethylbenzene	1-Hour	86,000	Ototoxicity (rat)	TCEQ, 2010
Formaldehyde and related, as formaldehyde	1-Hour	50	Eye and nose irritation (human)	TCEQ, 2008
Hexane, n-	NA	-	-	-
Naphthalene and related, as naphthalene	NA	-	-	-
Styrene	1-Hour	21,000	Eye and nose irritation (human)	Cal EPA, 2008
Toluene and related, as toluene	1-Hour	15,000	Eye and nose irritation; increased occurrence of headache, dizziness, and intoxication (human)	TCEQ, 2014
Xylenes, as total	1-Hour	7,400	Respiratory and neurological effects (human)	TCEQ, 2014
Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)				
PAHs as Benzo(a)pyrene Toxic Equivalents (BaP TEQ)	NA	-	-	-

NA Not available

[a] Chronic inhalation TRV selected for propionaldehyde is currently a draft value from TCEQ (2014).

Table 5-2 Summary of Acute 24-Hour Inhalation TRVs and Benchmarks Selected for Use in the HHRA

Chemical of Concern	*Non-Carcinogenic Inhalation TRVs (µg/m³)*			
	Duration	*Value*	*Critical Effect*	*Source*
Criteria Air Contaminants (CACs)				
Carbon monoxide	8-Hour	6,000	Carboxyhemoglobin blood level of less than 1%	Health Canada, 2006
Nitrogen dioxide (NO_2)	24-Hour	200	Respiratory tract irritation	MOE, 2012
Particulate matter - PM_{10}	24-Hour	50	Respiratory tract irritation	WHO, 2006
Particulate matter - $PM_{2.5}$	24-Hour	27	Respiratory tract irritation	CCME, 2012
Sulphur dioxide (SO_2)	24-Hour	275	Respiratory tract irritation	MOE, 2012
Volatile Organic Compounds (VOCs)				
Acetaldehyde	24-Hour	500	Tissue damage	MOE, 2012
Acetone	24-Hour	11,880	Eye, throat and nasal irritation and neurological effects (human)	MOE, 2012
Acrolein and related, as acrolein	24-Hour	0.4	Eye, throat and nasal irritation (hamster, rat, and rabbit)	MOE, 2012
Aldehydes (other), as propionaldehyde	NA	-	-	-
Aliphatic alcohols, as methyl alcohol	24-Hour	4,000	Developmental abnormalities (mouse)	MOE, 2012
Alkanes/alkenes (other C1-C4), as propylene	24-Hour	4,000	Changes and inflammation of nasal mucosa (mouse and rat)	MOE, 2012
Alkanes/alkenes (other C5-C8), as n-hexane (mixture)	24-Hour	2,500	Neurological effects (human)	MOE, 2012
Alkanes/alkenes (other C>8-C10), as 1-decene	24-Hour	60,000	Health-based	MOE, 2012
Alkanes/alkenes (other C>10-C12)	NA	-	-	-
Alkanes/alkenes (other C>12-C16)	NA	-	-	-
Benzene and related, as benzene	24-Hour	29	Reduced lymphocyte proliferation following mitogen stimulation	ATSDR, 2007
Butadiene, 1,3-	Acute	15	Decreased fetal weight (mouse)	US EPA, 2002
Cycloalkanes and cycloalkenes, as cyclohexane	24-Hour	6,100	Reduced pup weights (rat)	MOE, 2012
Ethylbenzene and related, as ethylbenzene	24-Hour	1,000	Health-based	MOE, 2012
Formaldehyde and related, as formaldehyde	24-Hour	65	Respiratory and eye irritation (human)	MOE, 2012
Hexane, n-	24-Hour	2,500	Neurological effects (human)	MOE, 2012
Naphthalene and related, as naphthalene	24-Hour	22.5	Health-based	MOE, 2012
Styrene	24-Hour	400	Health-based	MOE, 2012
Toluene and related, as toluene	Acute	3,800	Neurological effects (human)	ATSDR, 2000
Xylenes, as total	24-Hour	730	Neurological effects (human)	MOE, 2012
Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)				
PAHs as Benzo(a)pyrene Toxic Equivalents (BaP TEQ)	NA	-	-	-

NA Not available

It should be noted that the typical regulatory approach in Canada to evaluating ambient air concentrations of the criteria air contaminants is through a comparison to Canada Wide Standards (CWS) or National Ambient Air Quality Objectives (NAAQOs). These standards and objectives typically provide the benchmark by which emissions from a proposed project are evaluated for acceptability, from both a federal and provincial compliance point-of-view. However, it should be noted that the NAAQOs for NOx and SO_2 are not specifically health risk-based. Many of these standards and objectives are dated (*i.e.*, established in 1974/5), do not include the most recent scientific health-based knowledge, and are impacted by policy decisions

in their derivation. As such, any discussion on the effect of air pollution cannot rely on the attainment of such “standards” to guarantee that health within exposed population will be protected. As a result, alternate health-based benchmarks were selected for use.

5.2 Chronic Toxicity Reference Values

5.2.1 Inhalation Exposures

The chronic non-carcinogenic and carcinogenic inhalation TRVs for each of the COCs (where they were available), as well as the key critical health outcomes and regulatory source for each TRV, are provided in Table 5-3.

Table 5-3 Summary of Chronic-Duration Inhalation TRVs and Benchmarks Selected for Use in the HHRA

Chemical of Concern	Non-Carcinogenic Inhalation TRVs ($\mu g/m^3$)			Carcinogenic Inhalation Unit Risk ($(\mu g/m^3)^{-1}$)		
	Value	*Critical Effect*	*Source*	*Value*	*Critical Effect*	*Source*
Criteria Air Contaminants (CACs)						
Carbon monoxide	-	-	-	NA	-	-
Nitrogen dioxide (NO_2)	40	Adverse health effects (human)	WHO, 2006	NA	-	-
Particulate matter - PM_{10}	20	Lowest levels at which total, cardiopulmonary and lung cancer mortality has been shown to increase (human)	WHO, 2006	NA	-	-
Particulate matter - $PM_{2.5}$	8.8	Cardiopulmonary and lung cancer mortality increase (human)	CCME, 2012	NA	-	-
Sulphur dioxide (SO_2)	29	Respiratory inflammation (human)	Health Canada, 2006	NA	-	-
Volatile Organic Compounds (VOCs)						
Acetaldehyde	140	Degeneration of olfactory epithelium (rat)	Cal EPA, 2008	$2.7x10^{-6}$	Nasal tumour incidence (rat)	Cal EPA, 2011
Acetone	16,000	Neurological effects (human)	TCEQ, 2013	NA	-	-
Acrolein and related, as acrolein	0.02	Nasal lesions (rat)	US EPA IRIS, 2003	NA	-	-
Aldehydes (other), as propionaldehyde	8	Atrophy of olfactory epithelium (rat)	US EPA IRIS, 2012	NA	-	-
Aliphatic alcohols, as methyl alcohol	4,000	Developmental abnormalities (mouse)	Cal EPA, 2008	NA	-	-
Alkanes/alkenes (other C1-C4), as propylene	3,000	Changes and inflammation of nasal cavity (rat)	Cal EPA, 2008	NA	-	-
Alkanes/alkenes (other C5-C8), as CCME aliphatic C6-C8	18,400	Neurological effects	MOE, 2011; CCME, 2008	NA	-	-
Alkanes/alkenes (other C>8-C10), as CCME aliphatic C>8-C10	1,000	Hepatic and hematological changes	MOE, 2011; CCME, 2008	NA	-	-
Alkanes/alkenes (other C>10-C12), as CCME aliphatic C>10-C12	1,000	Hepatic and hematological changes	MOE, 2011; CCME, 2008	NA	-	-
Alkanes/alkenes (other C>12-C16), as CCME aliphatic C>12-C16	1,000	Hepatic and hematological changes	MOE, 2011; CCME, 2008	NA	-	-
Benzene and related, as benzene	3	Statistically significant decreased counts of B-lymphocytes (human)	Cal EPA, 2014	$2.9x10^{-5}$	Leukemia incidence (occupational exposure)	Cal EPA, 2011
Butadiene, 1,3-	2	Ovarian atrophy (rat)	US EPA IRIS, 2002	$5.0x10^{-7}$	Leukemia incidence data (human)	TCEQ, 2008
Cycloalkanes and cycloalkenes, as cyclohexane	6,000	Reproductive and developmental effects (rat)	US EPA IRIS, 2003	NA	-	-

Table 5-3 Summary of Chronic-Duration Inhalation TRVs and Benchmarks Selected for Use in the HHRA

Chemical of Concern	Non-Carcinogenic Inhalation TRVs (µg/m^3)			Carcinogenic Inhalation Unit Risk ((µg/m^3)$^{-1}$)		
	Value	*Critical Effect*	*Source*	*Value*	*Critical Effect*	*Source*
Ethylbenzene and related, as ethylbenzene	260	Nephropathy (rat)	ATSDR, 2010	NA	-	-
Formaldehyde and related, as formaldehyde	9	Nasal obstruction and discomfort, lower airway discomfort, eye irritation (human)	Cal EPA, 2014	6.0×10^{-6}	Nasal squamous carcinoma incidence (rat)	Cal EPA, 2011
Hexane, n-	670	Neurological effects (human)	TCEQ, 2007	NA	-	-
Naphthalene and related, as naphthalene	3.7	Non-neoplastic lesions in nasal olfactory epithelium and respiratory epithelium (rat)	MOE, 2011; ATSDR, 2005	NA	-	-
Styrene	470	Neurological effects (human)	TCEQ, 2008	NA	-	-
Toluene and related, as toluene	5,000	Neurological effects (human)	MOE, 2011; US EPA IRIS, 2005	NA	-	-
Xylenes, as total	100	Neurological effects (rat)	US EPA IRIS, 2003	NA	-	-
Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)						
PAHs as Benzo(a)pyrene Toxic Equivalents (BaP TEQ)	-	-	-	1.1×10^{-3}	Respiratory tract tumour (hamster)	MOE, 2011; Cal EPA, 2011

NA Not available. No TRV or benchmark is available for this endpoint.

5.2.2 Multi-Pathway Exposures

The chronic non-carcinogenic and carcinogenic oral/dermal TRVs, as well as the key critical health outcomes and regulatory source for each TRV, are provided in Table 5-4. Refer to the toxicological profile for each of the COCs provided in Appendix A of this report for a detailed discussion of the relevant background information supporting the selected TRV.

Table 5-4 Summary of Chronic-Duration Oral TRVs and Benchmarks Selected for Use in the HHRA

Chemical of Concern	Non-Carcinogenic Oral TRVs (µg/kg/d)			Carcinogenic Oral Slope Factors $((\mu g/kg/d)^{-1})$		
	Value	*Critical Effect*	*Source*	*Value*	*Critical Effect*	*Source*
Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)						
PAHs as Benzo(a)pyrene Toxic Equivalents (BaP TEQ)	-	-	-	$7.3x10^{-3}$	Gastric tumours (mouse, rat)	US EPA IRIS, 1994

NA Not available. No TRV or benchmark is available for this endpoint.

5.3 Chemical Mixtures and Additive Risks

Because chemical exposures rarely occur in isolation, the potential health effects associated with mixtures of COC was considered. The interaction between chemicals can take many forms and as such, Health Canada (2012) recommends that additive interactions be assumed when chemicals (within a given mixture) are structurally similar, act toxicologically through similar mechanisms or affect the same target tissue in the body (*i.e.*, share a common effect).

There are currently no Ontario or Canada regulatory benchmarks (beyond those chemical groups that have established toxic equivalent factors such as the carcinogenic PAHs) by which one can evaluate whether exposure to a given mixture from, or in isolation from, multiple sources could pose a health concern. Health effects from mixtures are typically assessed by assuming additive effects of chemicals with similar exposure characteristics (*e.g.*, acute exposure; chronic exposure) and similar toxic effects (*e.g.*, respiratory irritants, nasal irritants, reproductive effects) (Health Canada, 2012). In other words, risk estimates for each chemical in a mixture were summed for illustrative, rather than regulatory compliance purposes. Those chemicals with unique toxicological endpoints were not included in any mixture.

For the evaluation of chemical mixtures in the HHRA, the health endpoint of the TRVs used in the HHRA provided the basis for the inclusion of an individual chemical in a chemical mixture. Table 5-5 presents those chemicals included in mixtures associated with acute and chronic non-cancer endpoints *via* inhalation.

An ILCR represents the incremental risk of an individual within a given population developing cancer over his or her lifetime due to exposures from a *specific* carcinogenic chemical. Therefore, it was not deemed appropriate to present the carcinogenic risk from a mixture of COCs (other than the carcinogenic PAHs). As a result, only CRs for non-carcinogenic endpoints have been summed where toxicologically justified for illustrative purposes.

Table 5-5 Potential Additive Interactions of the Chemicals of Concern		
Exposure Characteristics	***Potential Non-Carcinogenic Health Endpoint of Mixture***	***Chemicals of Concern***
Acute air exposure	Eye irritants	Acetone, acrolein, propionaldehyde, formaldehyde, styrene, and toluene
	Respiratory irritants	Acetaldehyde, acetone, alkanes/alkenes (other C1-C4), formaldehyde, NO_2, $PM_{2.5}$, PM_{10}, SO_2, styrene, toluene, and xylenes
	Neurological effects	Acetone, alkanes/alkenes (other C5-C8), n-hexane, toluene, and xylenes
	Reproductive/developmental effects	1,3-Butadiene, cyclohexane, and methyl alcohol
Chronic air exposure	Respiratory irritants	Acetaldehyde, acrolein, alkanes/alkenes (other C1-C4), formaldehyde, naphthalene, and propionaldehyde
	Respiratory effects	NO_2, $PM_{2.5}$, PM_{10}, and SO_2
	Liver effects	Alkanes/alkenes (other C>8-C10), alkanes/alkenes (other C>10-C12), and alkanes/alkenes (other C>12-C16),
	Neurological effects	Acetone, alkanes/alkenes (other C5-C8), n-hexane, styrene, toluene, and xylenes
	Reproductive/ developmental effects	1,3-Butadiene, cyclohexane, and methyl alcohol
	Hematological effects	Alkanes/alkenes (other C>8-C10), alkanes/alkenes (other C>10-C12), alkanes/alkenes (other C>12-C16), and benzene

5.3.1 Toxicity Equivalence Factors for Carcinogenic PAHs

The primary source of PAHs within Toronto Pearson is from jet engine emissions. However, the air dispersion modelling conducted by Golder (2015) using EDMS did not predict emissions of specific PAH compounds. In order to estimate the concentrations of specific PAH compounds emitted from the airport, a relationship between fine particulate matter ($PM_{2.5}$) and PAH compound concentrations was determined based on information from Cavallo *et al.* (2006).

Cavallo *et al*. (2006) characterized civil airport occupational exposures to PAHs through environmental monitoring of 23 PAHs, including the 16 priority PAHs, in three working areas of an airport. A PAHs exposure assessment was carried out based upon data accumulated from air samples collected during 24 h of 5 working days at the airport apron, airport building, and terminal/ office area of Leonardo DaVinci Airport in Rome, Italy (Cavallo *et al*., 2006).

The concentrations of 23 PAHs (*i.e.,* naphthalene, 2-methylnaphthalene, 1-methylnaphthalene, biphenyl, 2,6-dimetilnaphthalene, acenaphthylene, acenaphthene, 2,3,5-trimethylnaphthalene, fluorene, phenanthrene, anthracene, 1-methylphenanthrene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b+j+k] fluoranthene, benzo[e]pyrene, benzo[a]pyrene, perylene, indeno[1,2,3- cd]pyrene, dibenzo[ah]anthracene, benzo[ghi]perylene) were measured. The limit of detection (LOD) was 0.0001 µg/m^3. Total air exposure to each PAH was calculated, on each sampling day, by adding particulate (found on quartz filter) and vapour (found on PUF and XAD-2) measurements, which were reported as mean concentration (µg/m^3). Total air exposure estimate for occupational exposure was reported as mean concentration (µg/m^3) of 5

working days (Cavallo et al., 2006). The proportions of the 23 speciated PAHs and $PM_{2.5}$ were assumed to be consistent between Toronto Pearson and Leonardo DaVinci (Cavallo *et al*., 2006).

As indicated in Health Canada (2012), as well as most other regulatory guidance, the assessment of risks related to exposures to carcinogenic PAHs is primarily conducted through the use of potency or toxicity equivalence factors (PEF or TEF). TEFs allow large groups of compounds with a common mechanism of action such as PAHs to be assessed when limited data is available for all but one of the compounds (*i.e.*, benzo(a)pyrene). Through this approach, exposures to each of the carcinogenic PAHs are adjusted by their carcinogenic potency relative to benzo(a)pyrene. These potency-adjusted exposures can then be summed to provide an overall exposure to the group of carcinogenic PAHs, based on benzo(a)pyrene as the primary surrogate (*i.e.*, B[a]P-TEQ equivalent). However, as it would greatly over-estimate predicted carcinogenic risk estimates to assume all emitted PAHs were equivalent to benzo(a)pyrene, it is important to adjust the total PAH concentration to account for the relative potency of each of the individual PAHs included in the Total PAH estimate.

The information from Cavallo *et al*. (2006) was used to calculate the contribution of each of the individual PAHs emitted for both vapour and particulate phase aspects. By adjusting the relative percentage of each of the individual PAHs by its benzo(a)pyrene-TEF, one can calculate a specific TEQ adjustment factor for that specific PAH. By summing all of the individual TEQ adjustment factors, one can calculate a TEQ adjustment factor for the overall Total PAH group based on the jet engine PAH emission fingerprint. If one then multiplies the Total PAH group estimated air concentration for a given receptor by this TEQ group adjustment factor, this will result in an overall estimate PAH concentration that has been adjusted for benzo(a)pyrene potency.

Table 5-6 provides the approach used to calculate the overall TEQ adjustment factor based on the PAH emission profile provided by Cavallo et al. (2006). TEF Potency values recommended by Health Canada (2012) were selected when available. TEFs recommended by RIVM (2001) and WHO (1998) were considered in the absence of equivalence factors from Health Canada.

Table 5-6 PAH Benzo(a)pyrene Toxicity Equivalency Factors

Carcinogenic PAHs	***B[a]P-TEF***	***Source***
Acenaphthene	0.001	RIVM, 2001
Acenaphthylene	0.01	RIVM, 2001
Anthracene	0[a]	-
Benzo[a]anthracene	0.1	Health Canada, 2010
Benzo[a]pyrene	1	Health Canada, 2010
Benzo[b+j+k]fluoranthene	0.1	Health Canada, 2010
Benzo[e]pyrene	0.01	WHO, 1998
Benzo[ghi]perylene	0.01	Health Canada, 2010
Biphenyl	0[a]	-
Chrysene	0.01	Health Canada, 2010
Dimethylnaphthalene, 2,6-	0[a]	-
Fluoranthene	0.001	Health Canada, 2010
Fluorene	0[a]	-
Indeno[1,2,3-cd]pyrene	0.1	Health Canada, 2010
Methylnaphthalene, 1-	0[a]	-
Methylnaphthalene, 2-	0[a]	-

Table 5-6 PAH Benzo(a)pyrene Toxicity Equivalency Factors		
Methylphenanthrene, 1-	0[a]	-
Naphthalene	0[a]	-
Phenanthrene	0.001	Health Canada, 2010
Pyrene	0.001	RIVM, 2001
Trimethylnaphthalene, 2,3,5-	0[a]	-

[a] A PAH with a TEF of 0 was not considered to be a carcinogenic PAH, given the absence of B(a)P TEFs from Health Canada (2010), RIVM (2001), and WHO (1998)

6.0 RISK CHARACTERIZATION

The risk characterization step integrates the exposure and hazard assessments to provide estimates of human health risk. The following sections provide the worst-case acute and chronic human health risk estimates for the Airport Alone conditions for each receptor location and year evaluated.

Acute and chronic inhalation risk estimates (expressed as concentration ratios (CRs) and incremental lifetime risks (ILCRs)) are presented in Sections 6.1 and 6.2, respectively. Chronic health risks associated with oral and dermal exposures *via* multiple pathways and environmental media (*i.e.*, soil, dust, home garden produce, *etc.*) are presented in Section 6.3.

6.1 Acute Inhalation Assessment

As presented in Section 2.1.4.1, CR values were used to evaluate acute and chronic health risks resulting from exposures to COC *via* inhalation. CR values were calculated by dividing the predicted ground-level air concentration (Section 4.2.1) by the appropriate health-based regulatory benchmark (*i.e.,* TRV) (Sections 5.1 and 5.2).

In general, a CR value less than or equal to one (CR value ≤1) represents a situation where the predicted ground-level air concentration is less than a corresponding health-based TRV. Considering the various assumptions used that attempt to over predict rather than under predict ground-level air concentrations and the typical uncertainty factors applied during the development of a health-based TRV, a CR value less than or equal to one (CR value ≤ 1) at the receptor location is a strong indicator of negligible health risks resulting from exposure to a particular COC.

A CR value greater than one (CR value > 1) is indicative of a scenario whereby the predicted ground level air concentration is greater than the corresponding health-based TRV, suggesting that there is the potential for an adverse health effect. The significance of the exceedance must be balanced against the degree of conservatism incorporated in the derivation of the TRVs as well as the predicted ground-level concentrations.

6.1.1 Acute 1-Hour Inhalation Risk Estimates

Tables 6-1 through 6-3 present the acute 1-hour inhalation risk estimates *(*expressed as CR values) for 2011, 2022, and 2032, respectively. Risk estimates for the Background Case and Cumulative Effects Case are presented in Appendix E.

Table 6-1 Summary of 1-Hour Concentration Ratios – 2011 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	1.3E-01	8.6E-02	8.9E-02	5.0E-02	2.7E-02	1.6E-02	1.8E-02	3.9E-02	2.1E-02	2.0E-02	7.6E-03	1.2E-02
Nitrogen dioxide (NO_2)	**2.0E+00**	9.3E-01	**1.3E+00**	7.3E-01	5.7E-01	4.8E-01	4.3E-01	1.0E+00	5.0E-01	4.9E-01	5.0E-01	5.5E-01
Coarse Particulate Matter (PM_{10})	-	-	-	-	-	-	-	-	-	-	-	-
Fine Particulate Matter ($PM_{2.5}$)	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	8.6E-01	3.8E-01	4.7E-01	4.6E-01	1.6E-01	1.7E-01	7.4E-02	3.4E-01	8.7E-02	1.5E-01	8.2E-02	8.4E-02
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	2.3E-02	1.4E-02	1.5E-02	1.2E-02	5.9E-03	4.5E-03	3.2E-03	1.1E-02	3.3E-03	4.5E-03	2.2E-03	2.2E-03
Acetone	3.4E-05	2.1E-05	2.2E-05	1.7E-05	8.7E-06	6.6E-06	4.8E-06	1.6E-05	4.9E-06	6.6E-06	3.3E-06	3.2E-06
Acrolein and related	**2.8E+00**	**1.7E+00**	**1.8E+00**	**1.4E+00**	7.1E-01	5.4E-01	3.9E-01	**1.3E+00**	3.9E-01	5.3E-01	2.7E-01	2.6E-01
Aldehydes, other	4.1E-03	2.5E-03	2.5E-03	2.0E-03	1.0E-03	7.8E-04	5.6E-04	1.9E-03	5.7E-04	7.7E-04	3.9E-04	3.7E-04
Aliphatic alcohols	2.0E-03	1.2E-03	1.2E-03	9.9E-04	5.0E-04	3.8E-04	2.7E-04	9.3E-04	2.8E-04	3.8E-04	1.9E-04	1.8E-04
Alkanes/alkenes, other C1-4	3.0E-03	1.8E-03	1.9E-03	1.5E-03	7.6E-04	5.8E-04	4.2E-04	1.4E-03	4.2E-04	5.8E-04	2.9E-04	2.8E-04
Alkanes/alkenes, other C5-8	1.5E-04	9.4E-05	9.6E-05	7.7E-05	3.9E-05	3.0E-05	2.1E-05	7.3E-05	2.2E-05	2.9E-05	1.5E-05	1.4E-05
Alkanes/alkenes, other C>8-10	8.5E-04	5.2E-04	5.3E-04	4.3E-04	2.1E-04	1.6E-04	1.2E-04	4.0E-04	1.2E-04	1.6E-04	8.0E-05	7.8E-05
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-1 Summary of 1-Hour Concentration Ratios – 2011 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Benzene and related	3.0E-01	1.8E-01	1.9E-01	1.5E-01	7.6E-02	5.8E-02	4.2E-02	1.4E-01	4.3E-02	5.8E-02	2.9E-02	2.8E-02
Butadiene, 1,3-	6.5E-03	4.0E-03	4.1E-03	3.3E-03	1.6E-03	1.3E-03	9.0E-04	3.1E-03	9.2E-04	1.2E-03	6.2E-04	6.0E-04
Cycloalkanes and cycloalkenes	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene and related	7.6E-05	4.6E-05	4.8E-05	3.8E-05	1.9E-05	1.5E-05	1.1E-05	3.6E-05	1.1E-05	1.5E-05	7.2E-06	7.0E-06
Formaldehyde and related	8.0E-01	4.9E-01	5.0E-01	4.0E-01	2.0E-01	1.5E-01	1.1E-01	3.8E-01	1.1E-01	1.5E-01	7.6E-02	7.4E-02
Hexane, n-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene and related	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	3.6E-05	2.2E-05	2.2E-05	1.8E-05	9.0E-06	6.9E-06	4.9E-06	1.7E-05	5.0E-06	6.8E-06	3.4E-06	3.3E-06
Toluene and related	2.8E-04	1.7E-04	1.7E-04	1.4E-04	7.0E-05	5.3E-05	3.8E-05	1.3E-04	3.9E-05	5.3E-05	2.6E-05	2.6E-05
Xylenes	3.9E-04	2.4E-04	2.4E-04	2.0E-04	9.9E-05	7.5E-05	5.4E-05	1.8E-04	5.5E-05	7.4E-05	3.7E-05	3.6E-05
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Table 6-2 Summary of 1-Hour Concentration Ratios – 2022 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	2.2E-01	1.2E-01	1.6E-01	5.2E-02	3.0E-02	2.8E-02	2.0E-02	6.0E-02	2.8E-02	2.3E-02	1.6E-02	1.5E-02
Nitrogen dioxide (NO_2)	**1.6E+00**	8.8E-01	9.9E-01	7.1E-01	7.9E-01	5.7E-01	5.9E-01	**1.1E+00**	7.3E-01	4.8E-01	5.4E-01	4.9E-01
Coarse Particulate Matter (PM_{10})	-	-	-	-	-	-	-	-	-	-	-	-
Fine Particulate Matter ($PM_{2.5}$)	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	**2.2E+00**	8.3E-01	1.0E+00	5.3E-01	3.4E-01	3.0E-01	1.4E-01	7.0E-01	3.4E-01	2.5E-01	1.5E-01	1.1E-01
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	6.4E-02	3.9E-02	4.4E-02	1.9E-02	1.3E-02	1.3E-02	5.8E-03	2.4E-02	1.1E-02	9.7E-03	7.4E-03	4.8E-03
Acetone	9.7E-05	6.0E-05	6.7E-05	2.9E-05	2.0E-05	2.0E-05	8.7E-06	3.6E-05	1.7E-05	1.5E-05	1.1E-05	7.3E-06
Acrolein and related	**7.8E+00**	**4.9E+00**	**5.4E+00**	**2.3E+00**	**1.6E+00**	**1.6E+00**	7.1E-01	**2.9E+00**	**1.4E+00**	**1.2E+00**	9.1E-01	5.9E-01
Aldehydes, other	1.1E-02	6.9E-03	7.6E-03	3.3E-03	2.3E-03	2.3E-03	1.0E-03	4.1E-03	2.0E-03	1.7E-03	1.3E-03	8.3E-04
Aliphatic alcohols	5.5E-03	3.4E-03	3.8E-03	1.7E-03	1.1E-03	1.1E-03	5.0E-04	2.1E-03	9.7E-04	8.4E-04	6.4E-04	4.2E-04
Alkanes/alkenes, other C1-4	6.4E-03	4.0E-03	4.4E-03	1.9E-03	1.3E-03	1.3E-03	5.8E-04	2.4E-03	1.1E-03	9.8E-04	7.4E-04	4.8E-04
Alkanes/alkenes, other C5-8	2.0E-04	1.3E-04	1.4E-04	6.1E-05	4.2E-05	4.2E-05	1.8E-05	7.6E-05	3.6E-05	3.1E-05	2.4E-05	1.5E-05
Alkanes/alkenes, other C>8-10	2.4E-03	1.5E-03	1.6E-03	7.0E-04	4.8E-04	4.9E-04	2.1E-04	8.7E-04	4.2E-04	3.6E-04	2.7E-04	1.8E-04
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-2 Summary of 1-Hour Concentration Ratios – 2022 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Benzene and related	6.0E-01	3.7E-01	4.2E-01	1.8E-01	1.2E-01	1.3E-01	5.5E-02	2.2E-01	1.1E-01	9.2E-02	7.0E-02	4.5E-02
Butadiene, 1,3-	1.8E-02	1.1E-02	1.2E-02	5.3E-03	3.6E-03	3.7E-03	1.6E-03	6.6E-03	3.1E-03	2.7E-03	2.1E-03	1.3E-03
Cycloalkanes and cycloalkenes	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene and related	1.4E-04	9.0E-05	1.0E-04	4.3E-05	3.0E-05	3.0E-05	1.3E-05	5.4E-05	2.5E-05	2.2E-05	1.7E-05	1.1E-05
Formaldehyde and related	**2.2E+00**	**1.4E+00**	**1.5E+00**	6.6E-01	4.5E-01	4.6E-01	2.0E-01	8.2E-01	3.9E-01	3.4E-01	2.5E-01	1.7E-01
Hexane, n-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene and related	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	1.0E-04	6.2E-05	6.9E-05	3.0E-05	2.0E-05	2.1E-05	9.0E-06	3.7E-05	1.8E-05	1.5E-05	1.2E-05	7.5E-06
Toluene and related	4.5E-04	2.8E-04	3.1E-04	1.3E-04	9.2E-05	9.3E-05	4.1E-05	1.7E-04	7.9E-05	6.9E-05	5.2E-05	3.4E-05
Xylenes	5.2E-04	3.2E-04	3.6E-04	1.6E-04	1.1E-04	1.1E-04	4.7E-05	1.9E-04	9.2E-05	7.9E-05	6.0E-05	3.9E-05
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Table 6-3 Summary of 1-Hour Concentration Ratios – 2032 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	2.4E-01	1.3E-01	1.8E-01	7.1E-02	4.2E-02	3.4E-02	2.1E-02	6.6E-02	3.2E-02	3.5E-02	1.8E-02	2.0E-02
Nitrogen dioxide (NO_2)	**1.8E+00**	9.8E-01	1.0E+00	7.5E-01	8.4E-01	5.2E-01	6.5E-01	1.0E+00	7.6E-01	4.6E-01	6.1E-01	6.5E-01
Coarse Particulate Matter (PM_{10})	-	-	-	-	-	-	-	-	-	-	-	-
Fine Particulate Matter ($PM_{2.5}$)	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	**2.0E+00**	9.6E-01	**1.2E+00**	7.5E-01	4.4E-01	3.7E-01	1.5E-01	6.4E-01	3.7E-01	4.6E-01	1.8E-01	1.5E-01
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	7.6E-02	4.4E-02	5.1E-02	2.6E-02	1.7E-02	1.4E-02	6.2E-03	2.9E-02	1.3E-02	1.6E-02	6.8E-03	6.0E-03
Acetone	1.2E-04	6.7E-05	7.7E-05	4.0E-05	2.7E-05	2.2E-05	9.5E-06	4.4E-05	2.0E-05	2.5E-05	1.0E-05	9.2E-06
Acrolein and related	**9.4E+00**	**5.4E+00**	**6.2E+00**	**3.2E+00**	**2.2E+00**	**1.8E+00**	7.7E-01	**3.5E+00**	**1.6E+00**	**2.0E+00**	8.4E-01	7.4E-01
Aldehydes, other	1.3E-02	7.6E-03	8.8E-03	4.6E-03	3.0E-03	2.5E-03	1.1E-03	5.0E-03	2.3E-03	2.9E-03	1.2E-03	1.1E-03
Aliphatic alcohols	6.6E-03	3.8E-03	4.4E-03	2.3E-03	1.5E-03	1.2E-03	5.4E-04	2.5E-03	1.1E-03	1.4E-03	5.9E-04	5.2E-04
Alkanes/alkenes, other C1-4	7.6E-03	4.4E-03	5.1E-03	2.6E-03	1.8E-03	1.4E-03	6.2E-04	2.9E-03	1.3E-03	1.6E-03	6.8E-04	6.0E-04
Alkanes/alkenes, other C5-8	2.4E-04	1.4E-04	1.6E-04	8.1E-05	5.4E-05	4.4E-05	1.9E-05	8.9E-05	4.1E-05	5.1E-05	2.1E-05	1.9E-05
Alkanes/alkenes, other C>8-10	2.8E-03	1.6E-03	1.9E-03	9.7E-04	6.5E-04	5.3E-04	2.3E-04	1.1E-03	4.9E-04	6.1E-04	2.5E-04	2.2E-04
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-3 Summary of 1-Hour Concentration Ratios – 2032 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Benzene and related	7.1E-01	4.1E-01	4.7E-01	2.4E-01	1.6E-01	1.3E-01	5.8E-02	2.7E-01	1.2E-01	1.5E-01	6.3E-02	5.6E-02
Butadiene, 1,3-	2.1E-02	1.2E-02	1.4E-02	7.3E-03	4.9E-03	4.0E-03	1.7E-03	8.0E-03	3.7E-03	4.6E-03	1.9E-03	1.7E-03
Cycloalkanes and cycloalkenes	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene and related	1.7E-04	9.8E-05	1.1E-04	5.9E-05	3.9E-05	3.2E-05	1.4E-05	6.4E-05	3.0E-05	3.7E-05	1.5E-05	1.4E-05
Formaldehyde and related	**2.6E+00**	**1.5E+00**	**1.7E+00**	9.0E-01	6.0E-01	4.9E-01	2.2E-01	9.9E-01	4.5E-01	5.7E-01	2.3E-01	2.1E-01
Hexane, n-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene and related	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	1.2E-04	6.9E-05	8.0E-05	4.1E-05	2.8E-05	2.2E-05	9.8E-06	4.5E-05	2.1E-05	2.6E-05	1.1E-05	9.5E-06
Toluene and related	5.3E-04	3.0E-04	3.5E-04	1.8E-04	1.2E-04	9.9E-05	4.3E-05	2.0E-04	9.1E-05	1.1E-04	4.7E-05	4.2E-05
Xylenes	6.0E-04	3.5E-04	4.0E-04	2.1E-04	1.4E-04	1.1E-04	4.9E-05	2.3E-04	1.0E-04	1.3E-04	5.3E-05	4.8E-05
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

With the exception of four (4) COCs (*i.e.,* NO_2, SO_2, acrolein, and formaldehyde) all 1-hour acute CR estimates for years 2011, 2022, and 2032 were less than a value of one (1.0) under the 'Airport Alone' scenario, indicating that contributions from the airport for those remaining COCs are not expected to result in adverse acute inhalation health effects.

For the 2011 'Airport Alone' operational scenario, acute 1-hour CR estimates were greater than a value of one (CR > 1.0) for NO_2 and acrolein at the MPOI and the two (2) commercial receptor locations, and for acrolein at two (2) of the residential receptor locations.

For the 2022 Airport Alone operational scenario, acute 1-hour CR estimates were greater than a value of one (CR > 1.0) for the four (4) COCs at the MPOI, acrolein and formaldehyde at the two (2) commercial receptor locations, for NO_2 at one (1) of the residential receptor locations and for acrolein at six (6) of the residential receptor locations.

For the 2032 Airport Alone operational scenario, acute 1-hour CR estimates were greater than a value of one (CR > 1.0) for the four (4) COCs at the MPOI, SO_2, acrolein and formaldehyde at the two (2) commercial receptor locations, and for acrolein at six (6) of the residential receptor locations.

The 2032 Airport Alone scenario represents the worst case operational scenario with respect to emissions produced from Toronto Pearson, as it is anticipated that air traffic will be greater than the earlier years evaluated. While the maximum predicted air concentrations of SO_2, acrolein, and formaldehyde from the 2032 scenario produced a CR > 1.0 for at least one location, the actual number of occurrences where the predicted air concentration was greater than the TRV must also be considered.

Frequency analyses of the predicted 1-hour concentrations for SO_2, acrolein, and formaldehyde were conducted for two (2) receptor locations, R2 and R7, which generally represented the commercial and residential receptor locations, respectively, with the highest exposures to Toronto Pearson-sourced emissions. The maximum 1-hour concentration for each COC was determined using predicted 1-hour concentrations over a total of 5 years or 43,848 1-hour periods.

SO_2

The maximum predicted 1-hour SO_2 concentration resulting from Toronto Pearson emissions in 2032 exceeded the US EPA (2010) 1-hour NAAQS of 100 µg/m^3 at the MPOI and the commercial receptor locations.

A frequency analysis indicated that the 1-hour SO_2 concentrations predicted at commercial receptor location R2 under the 2032 Airport Alone Case exceeded the 1-hour US EPA (2010) REL of 100 µg/m^3 approximately 4 times out of the total 43,848 hours modelled (Golder, 2015). As a result, the 1-hr REL for SO_2 was exceeded approximately 0.009% of the time at location R2.

The US EPA (2010) 1-hour NAAQS of 100 µg/m^3 used to characterize acute health risks within the HHRA is intended to be the 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years. Given that there were only predicted exceedances 0.009% of the 5-year period considered, the predicted SO_2 concentrations as a whole for the 2032 scenario are not

actually considered an exceedance the US EPA (2010) NAAQS value. As such, it is unlikely that the predicted air concentrations of SO_2 within the Study Domain would result in a substantive health risk.

Acrolein

The maximum predicted 1-hour acrolein concentration resulting from Toronto Pearson emissions in 2032 exceeded the Cal EPA (2008) 1-hour REL of 2.5 µg/m^3 at the MPOI, the commercial receptor locations, and some residential receptor locations.

A frequency analysis indicated that the 1-hour acrolein concentrations predicted at commercial receptor location R2 under the 2032 Airport Alone Case exceeded the 1-hour Cal EPA (2008) REL of 2.5 µg/m^3 approximately 231 times out of the total 43,848 hours modelled (Golder, 2015). As a result, the 1-hr REL for acrolein would be exceeded approximately 0.5% of the time at location R2. Similarly, at residential receptor location R7 (2032 Airport Alone), it was predicted that concentration of acrolein would exceed the Cal EPA (2008) REL approximately 130 times out of the total 43,848 hours modelled (Golder, 2015), or approximately 0.3% of the time at location R7.

The Cal EPA (2008) 1-hour REL of 2.5 µg/m^3 used to characterize acute health risks within the HHRA, was designed to be protective of sensitive individuals within a population from eye irritation, which is considered a subjective effect. Additionally, the Cal EPA RELs are air concentrations at which intermittent one-hour exposures would not be expected to result in any effects, and therefore, an exceedance of this value will not necessarily result in the indicated effect.

The Cal EPA (2008) 1-hour REL was derived using the conclusions of clinical studies by Darley *et al.* (1960) and Weber-Tschopp *et al.* (1977). Darley *et al.* (1960) observed mild eye irritation in healthy volunteers exposed for five minutes to concentrations of acrolein in air of 140 µg/m^3. In a clinical study by Weber-Tschopp *et al.* (1977), which provides one of the most comprehensive descriptions of acute outcomes of acrolein in humans, three experiments were performed using male and female student volunteers. These involved:

- Continuous exposure at constantly increasing acrolein concentrations;
- Short exposures to successively increasing acrolein concentrations; and
- A single hour of exposure to a constant concentration.

The investigators concluded that the average threshold of acute outcome for acrolein is 210 µg/m^3 (eye irritation).

There is a 56-fold margin of safety between the 1-hour REL air concentration of acrolein (*i.e.,* 2.5 µg/m^3) selected and the lowest concentration at which mild eye irritation has been observed in humans (140 µg/m^3). As such, it is unlikely that the airport-sourced concentrations of acrolein within the Study Domain would result in a significant risk of eye and nose irritation to members of the general population.

Formaldehyde

The maximum predicted 1-hour formaldehyde concentration resulting from Toronto Pearson emissions in 2032 exceeded the TCEQ (2008) 1-hour ReV of 50 µg/m^3 at the MPOI and commercial receptor locations.

A frequency analysis indicated that the 1-hour formaldehyde concentrations predicted for commercial receptor location R2 under the 2032 Airport Alone Case exceeded the 1-hour TCEQ (2008) ReV of 50 µg/m^3 approximately 10 times out of the total 43,848 hours modelled (Golder, 2015). As a result, the 1-hr ReV for formaldehyde would be exceeded approximately 0.02% of the time at location R2.

The TCEQ (2008) 1-hour ReV of 50 µg/m^3 used to characterize acute health risks within the HHRA was designed to be protective of sensitive individuals within a population from eye and nose irritation. The TCEQ acute ReVs are air concentrations at which intermittent 1-hour exposures would not be expected to result in any effects, and therefore, an exceedance of this value will not necessarily result in the indicated effect.

The TCEQ (2008) 1-hour ReV was derived using the conclusions of clinical studies by Pazdrak *et al*. (1993) and Krakowiak *et al.* (1998), which performed experiments using human volunteers with known or suspected sensitivities to formaldehyde. The volunteers were continually exposed to formaldehyde in air for a duration of two hours, which is longer than the 1-hour durations considered in the HHRA. The investigators concluded that lowest concentration of formaldehyde that elicited an effect was 500 µg/m^3, which resulted in mild and reversible nasal and eye irritation. There is a 10-times margin of safety between the TCEQ (2008) ReV (50 µg/m^3) and the lowest concentration at which the mild nose and eye irritation was observed in humans (500 µg/m^3). The predicted concentrations of formaldehyde for all scenarios are well below 500 µg/m^3. As such, it is unlikely that the predicted air concentrations of formaldehyde within the Study Domain would result in a significant risk of eye and nose irritation to members of the general population.

6.1.2 Acute 24-Hour Inhalation Risk Estimates

Tables 6-4 through 6-6 present the acute 24-hour inhalation risk estimates *(*expressed as CR values) for 2011, 2022, and 2032, respectively. Risk estimates for the Background Case and Cumulative Effects Case are presented in Appendix E.

Table 6-4 Summary of 24-Hour Concentration Ratios – 2011 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)[a]	3.1E-01	1.9E-01	1.5E-01	5.2E-02	2.9E-02	2.7E-02	1.5E-02	3.5E-02	2.6E-02	3.0E-02	1.1E-02	1.0E-02
Nitrogen dioxide (NO_2)	1.8E-01	1.8E-01	1.5E-01	6.3E-02	4.8E-02	3.2E-02	4.0E-02	1.1E-01	4.7E-02	3.7E-02	2.2E-02	2.7E-02
Coarse Particulate Matter (PM_{10})	1.0E-01	4.7E-02	3.8E-02	1.4E-02	1.1E-02	6.2E-03	4.6E-03	1.0E-02	6.7E-03	7.2E-03	2.4E-03	4.6E-03
Fine Particulate Matter ($PM_{2.5}$)	1.7E-01	7.8E-02	6.6E-02	2.6E-02	2.1E-02	1.1E-02	8.1E-03	1.7E-02	1.2E-02	1.3E-02	4.1E-03	8.0E-03
Sulphur Dioxide (SO_2)	6.0E-02	3.4E-02	4.4E-02	1.5E-02	1.1E-02	7.4E-03	2.8E-03	1.6E-02	4.0E-03	6.3E-03	3.7E-03	2.7E-03
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	2.6E-03	1.9E-03	1.8E-03	5.9E-04	5.0E-04	3.1E-04	1.3E-04	4.5E-04	2.3E-04	2.6E-04	1.5E-04	1.7E-04
Acetone	8.8E-06	6.4E-06	6.0E-06	2.0E-06	1.7E-06	1.1E-06	4.4E-07	1.5E-06	8.0E-07	8.7E-07	5.1E-07	5.8E-07
Acrolein and related	**2.0E+00**	**1.5E+00**	**1.4E+00**	4.7E-01	4.0E-01	2.5E-01	1.0E-01	3.6E-01	1.9E-01	2.0E-01	1.2E-01	1.3E-01
Aldehydes, other	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic alcohols	7.5E-04	5.4E-04	5.1E-04	1.7E-04	1.5E-04	9.1E-05	3.7E-05	1.3E-04	6.8E-05	7.4E-05	4.3E-05	4.9E-05
Alkanes/alkenes, other C1-4	3.0E-03	2.2E-03	2.0E-03	6.8E-04	5.8E-04	3.6E-04	1.5E-04	5.2E-04	2.7E-04	3.0E-04	1.7E-04	2.0E-04
Alkanes/alkenes, other C5-8	1.4E-03	1.0E-03	9.8E-04	3.3E-04	2.8E-04	1.7E-04	7.1E-05	2.5E-04	1.3E-04	1.4E-04	8.2E-05	9.4E-05
Alkanes/alkenes, other C>8-10	9.9E-05	7.2E-05	6.8E-05	2.3E-05	1.9E-05	1.2E-05	4.9E-06	1.7E-05	9.0E-06	9.8E-06	5.7E-06	6.5E-06
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-
Benzene and related	3.3E-02	2.4E-02	2.2E-02	7.5E-03	6.4E-03	4.0E-03	1.6E-03	5.7E-03	3.0E-03	3.3E-03	1.9E-03	2.1E-03
Butadiene, 1,3-	3.3E-02	2.4E-02	2.3E-02	7.6E-03	6.5E-03	4.0E-03	1.7E-03	5.8E-03	3.0E-03	3.3E-03	1.9E-03	2.2E-03

Table 6-4 Summary of 24-Hour Concentration Ratios – 2011 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	5.6E-05	4.0E-05	3.8E-05	1.3E-05	1.1E-05	6.8E-06	2.8E-06	9.7E-06	5.1E-06	5.5E-06	3.2E-06	3.7E-06
Ethylbenzene and related	7.6E-04	5.5E-04	5.2E-04	1.7E-04	1.5E-04	9.3E-05	3.8E-05	1.3E-04	6.9E-05	7.6E-05	4.4E-05	5.0E-05
Formaldehyde and related	7.2E-02	5.2E-02	4.9E-02	1.6E-02	1.4E-02	8.7E-03	3.6E-03	1.3E-02	6.5E-03	7.1E-03	4.1E-03	4.7E-03
Hexane, n-	4.6E-05	3.3E-05	3.2E-05	1.1E-05	9.0E-06	5.6E-06	2.3E-06	8.1E-06	4.2E-06	4.6E-06	2.7E-06	3.0E-06
Naphthalene and related	1.4E-02	9.9E-03	9.3E-03	3.1E-03	2.7E-03	1.7E-03	6.8E-04	2.4E-03	1.2E-03	1.4E-03	7.8E-04	8.9E-04
Styrene	2.2E-04	1.6E-04	1.5E-04	5.0E-05	4.3E-05	2.6E-05	1.1E-05	3.8E-05	2.0E-05	2.2E-05	1.3E-05	1.4E-05
Toluene and related	1.3E-04	9.3E-05	8.8E-05	2.9E-05	2.5E-05	1.6E-05	6.4E-06	2.2E-05	1.2E-05	1.3E-05	7.4E-06	8.4E-06
Xylenes	4.6E-04	3.3E-04	3.2E-04	1.1E-04	9.0E-05	5.6E-05	2.3E-05	8.0E-05	4.2E-05	4.6E-05	2.6E-05	3.0E-05
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

[a] Carbon monoxide risk estimates are representative of an 8-hour exposure duration.

Table 6-5 Summary of 24-Hour Concentration Ratios – 2022 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)[a]	3.8E-01	2.1E-01	2.2E-01	8.0E-02	3.6E-02	3.6E-02	2.1E-02	8.1E-02	2.8E-02	3.7E-02	1.5E-02	1.3E-02
Nitrogen dioxide (NO_2)	2.2E-01	1.7E-01	1.4E-01	8.5E-02	5.7E-02	4.9E-02	5.6E-02	1.5E-01	6.3E-02	4.6E-02	3.0E-02	4.8E-02
Coarse Particulate Matter (PM_{10})	1.7E-01	7.7E-02	8.3E-02	2.8E-02	1.4E-02	8.1E-03	8.8E-03	2.3E-02	1.3E-02	1.1E-02	5.1E-03	6.6E-03
Fine Particulate Matter ($PM_{2.5}$)	3.1E-01	1.2E-01	1.4E-01	5.1E-02	2.6E-02	1.4E-02	1.5E-02	4.1E-02	2.4E-02	1.9E-02	9.0E-03	1.2E-02
Sulphur Dioxide (SO_2)	1.2E-01	6.3E-02	5.1E-02	3.9E-02	2.3E-02	1.5E-02	6.3E-03	4.0E-02	1.1E-02	1.2E-02	7.0E-03	5.9E-03
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	5.9E-03	4.0E-03	3.0E-03	1.6E-03	1.0E-03	7.5E-04	3.0E-04	1.7E-03	4.7E-04	6.4E-04	3.7E-04	3.3E-04
Acetone	2.1E-05	1.4E-05	1.1E-05	5.8E-06	3.6E-06	2.6E-06	1.1E-06	5.8E-06	1.7E-06	2.3E-06	1.3E-06	1.2E-06
Acrolein and related	**4.8E+00**	**3.2E+00**	**2.5E+00**	**1.3E+00**	8.5E-01	6.1E-01	2.4E-01	**1.4E+00**	3.8E-01	5.3E-01	3.0E-01	2.7E-01
Aldehydes, other	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic alcohols	1.8E-03	1.2E-03	9.1E-04	4.9E-04	3.1E-04	2.3E-04	9.0E-05	5.0E-04	1.4E-04	1.9E-04	1.1E-04	9.9E-05
Alkanes/alkenes, other C1-4	5.4E-03	3.6E-03	2.8E-03	1.5E-03	9.4E-04	6.8E-04	2.7E-04	1.5E-03	4.3E-04	5.9E-04	3.3E-04	3.0E-04
Alkanes/alkenes, other C5-8	1.6E-03	1.1E-03	8.3E-04	4.5E-04	2.8E-04	2.0E-04	8.2E-05	4.5E-04	1.3E-04	1.8E-04	1.0E-04	9.0E-05
Alkanes/alkenes, other C>8-10	2.3E-04	1.6E-04	1.2E-04	6.5E-05	4.1E-05	3.0E-05	1.2E-05	6.5E-05	1.8E-05	2.5E-05	1.4E-05	1.3E-05
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-
Benzene and related	5.5E-02	3.7E-02	2.8E-02	1.5E-02	9.7E-03	7.0E-03	2.8E-03	1.6E-02	4.4E-03	6.0E-03	3.4E-03	3.1E-03
Butadiene, 1,3-	7.7E-02	5.2E-02	4.0E-02	2.2E-02	1.3E-02	9.8E-03	3.9E-03	2.2E-02	6.1E-03	8.4E-03	4.8E-03	4.3E-03

Table 6-5 Summary of 24-Hour Concentration Ratios – 2022 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	2.1E-05	1.4E-05	1.1E-05	5.9E-06	3.7E-06	2.7E-06	1.1E-06	5.9E-06	1.7E-06	2.3E-06	1.3E-06	1.2E-06
Ethylbenzene and related	1.2E-03	8.2E-04	6.3E-04	3.4E-04	2.1E-04	1.6E-04	6.2E-05	3.4E-04	9.7E-05	1.3E-04	7.6E-05	6.8E-05
Formaldehyde and related	1.7E-01	1.1E-01	8.5E-02	4.7E-02	2.9E-02	2.1E-02	8.4E-03	4.7E-02	1.3E-02	1.8E-02	1.0E-02	9.3E-03
Hexane, n-	1.8E-05	1.2E-05	9.0E-06	4.9E-06	3.1E-06	2.2E-06	8.9E-07	4.9E-06	1.4E-06	1.9E-06	1.1E-06	9.8E-07
Naphthalene and related	3.2E-02	2.2E-02	1.7E-02	9.0E-03	5.7E-03	4.1E-03	1.6E-03	9.1E-03	2.6E-03	3.5E-03	2.0E-03	1.8E-03
Styrene	5.2E-04	3.5E-04	2.7E-04	1.4E-04	9.1E-05	6.6E-05	2.6E-05	1.5E-04	4.1E-05	5.6E-05	3.2E-05	2.9E-05
Toluene and related	1.8E-04	1.2E-04	9.0E-05	4.9E-05	3.1E-05	2.2E-05	8.9E-06	4.9E-05	1.4E-05	1.9E-05	1.1E-05	9.8E-06
Xylenes	5.2E-04	3.5E-04	2.7E-04	1.5E-04	9.1E-05	6.6E-05	2.6E-05	1.5E-04	4.1E-05	5.7E-05	3.2E-05	2.9E-05
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

[a] Carbon monoxide risk estimates are representative of an 8-hour exposure duration.

Table 6-6 Summary of 24-Hour Concentration Ratios – 2032 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)[a]	4.8E-01	2.4E-01	3.0E-01	9.9E-02	4.2E-02	3.8E-02	1.9E-02	1.1E-01	3.5E-02	4.1E-02	1.8E-02	1.8E-02
Nitrogen dioxide (NO_2)	2.3E-01	1.5E-01	1.5E-01	8.8E-02	7.1E-02	5.6E-02	4.9E-02	1.5E-01	7.5E-02	4.8E-02	3.4E-02	5.0E-02
Coarse Particulate Matter (PM_{10})	2.3E-01	9.0E-02	1.2E-01	3.8E-02	1.9E-02	9.2E-03	8.9E-03	3.0E-02	1.8E-02	1.3E-02	5.6E-03	7.2E-03
Fine Particulate Matter ($PM_{2.5}$)	4.0E-01	1.4E-01	2.1E-01	6.9E-02	3.4E-02	1.6E-02	1.6E-02	5.2E-02	3.2E-02	2.2E-02	9.7E-03	1.3E-02
Sulphur Dioxide (SO_2)	1.8E-01	7.3E-02	6.5E-02	3.9E-02	3.1E-02	1.8E-02	5.2E-03	4.8E-02	1.3E-02	1.5E-02	7.3E-03	6.4E-03
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	6.9E-03	4.5E-03	3.8E-03	2.0E-03	1.5E-03	9.1E-04	2.8E-04	2.1E-03	5.9E-04	7.6E-04	3.8E-04	3.1E-04
Acetone	2.4E-05	1.6E-05	1.3E-05	7.0E-06	5.4E-06	3.2E-06	9.8E-07	7.5E-06	2.1E-06	2.7E-06	1.4E-06	1.1E-06
Acrolein and related	**5.6E+00**	**3.7E+00**	**3.1E+00**	**1.6E+00**	**1.2E+00**	7.4E-01	2.3E-01	**1.7E+00**	4.8E-01	6.2E-01	3.1E-01	2.6E-01
Aldehydes, other	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic alcohols	2.1E-03	1.3E-03	1.1E-03	6.0E-04	4.6E-04	2.7E-04	8.4E-05	6.4E-04	1.8E-04	2.3E-04	1.2E-04	9.4E-05
Alkanes/alkenes, other C1-4	6.2E-03	4.1E-03	3.4E-03	1.8E-03	1.4E-03	8.2E-04	2.5E-04	1.9E-03	5.3E-04	6.9E-04	3.5E-04	2.8E-04
Alkanes/alkenes, other C5-8	1.8E-03	1.2E-03	9.9E-04	5.2E-04	4.0E-04	2.4E-04	7.3E-05	5.6E-04	1.5E-04	2.0E-04	1.0E-04	8.3E-05
Alkanes/alkenes, other C>8-10	2.7E-04	1.8E-04	1.5E-04	7.8E-05	6.0E-05	3.6E-05	1.1E-05	8.3E-05	2.3E-05	3.0E-05	1.5E-05	1.2E-05
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-
Benzene and related	6.3E-02	4.1E-02	3.5E-02	1.8E-02	1.4E-02	8.4E-03	2.6E-03	2.0E-02	5.4E-03	7.0E-03	3.5E-03	2.9E-03
Butadiene, 1,3-	9.0E-02	5.9E-02	4.9E-02	2.6E-02	2.0E-02	1.2E-02	3.6E-03	2.8E-02	7.7E-03	9.9E-03	5.0E-03	4.1E-03

Table 6-6 Summary of 24-Hour Concentration Ratios – 2032 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	2.0E-05	1.3E-05	1.1E-05	5.9E-06	4.5E-06	2.7E-06	8.3E-07	6.3E-06	1.7E-06	2.3E-06	1.1E-06	9.3E-07
Ethylbenzene and related	1.4E-03	9.2E-04	7.7E-04	4.1E-04	3.1E-04	1.9E-04	5.7E-05	4.3E-04	1.2E-04	1.6E-04	7.9E-05	6.4E-05
Formaldehyde and related	1.9E-01	1.3E-01	1.1E-01	5.6E-02	4.3E-02	2.6E-02	7.8E-03	6.0E-02	1.7E-02	2.1E-02	1.1E-02	8.8E-03
Hexane, n-	1.7E-05	1.1E-05	9.3E-06	4.9E-06	3.8E-06	2.2E-06	6.9E-07	5.2E-06	1.4E-06	1.9E-06	9.5E-07	7.7E-07
Naphthalene and related	3.8E-02	2.5E-02	2.1E-02	1.1E-02	8.4E-03	5.0E-03	1.5E-03	1.2E-02	3.2E-03	4.2E-03	2.1E-03	1.7E-03
Styrene	6.0E-04	3.9E-04	3.3E-04	1.7E-04	1.3E-04	8.0E-05	2.4E-05	1.9E-04	5.2E-05	6.7E-05	3.4E-05	2.8E-05
Toluene and related	2.0E-04	1.3E-04	1.1E-04	5.8E-05	4.4E-05	2.6E-05	8.1E-06	6.2E-05	1.7E-05	2.2E-05	1.1E-05	9.1E-06
Xylenes	5.9E-04	3.8E-04	3.2E-04	1.7E-04	1.3E-04	7.7E-05	2.4E-05	1.8E-04	5.0E-05	6.4E-05	3.3E-05	2.7E-05
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

[a] Carbon monoxide risk estimates are representative of an 8-hour exposure duration.

With the exception of acrolein, all 24-hour acute CR estimates for years 2011, 2022, and 2032 were less than a value of one (1.0) under the 'Airport Alone' scenario, indicating that contributions from the airport are not expected to result in adverse acute inhalation health effects.

For the 2011 Airport Alone operational scenario, acute 24-hour CR estimates were greater than a value of one (CR > 1.0) for the MPOI and the two (2) commercial receptor locations.

For the 2022 Airport Alone operational scenario, acute 24-hour CR estimates were greater than a value of one (CR > 1.0) for the MPOI, the two (2) commercial receptor locations, and at two (2) of the residential receptor locations.

For the 2032 Airport Alone operational scenario, acute 24-hour CR estimates were greater than a value of one (CR > 1.0) for the MPOI, the two (2) commercial receptor locations, and at three (3) of the residential receptor locations.

The 2032 Airport Alone scenario represents the worst case operational scenario with respect to emissions produced from Toronto Pearson, as it is anticipated that air traffic will be greater than the other years evaluated. While the maximum predicted 24-hour air concentrations of acrolein from the 2032 scenario produced a CR > 1.0 for at a number of locations, the actual number of occurrences where the predicted air concentration was greater than the TRV must also be considered.

Frequency analyses of the predicted 24-hour average concentrations for acrolein were conducted for two (2) receptor locations, R2 and R7, which generally represented the commercial and residential receptor locations, respectively, with the highest exposures to Toronto Pearson-sourced emissions. The maximum 24-hour average concentration of acrolein was determined using predicted 24-hour average concentrations over a total of 5 years or 1,827 24-hour periods.

Acrolein

The maximum predicted 24-hour average acrolein concentration resulting from Toronto Pearson emissions in 2032 exceeded the MOE (2012) 24-hour AAQC of 0.4 µg/m^3 at the MPOI, the commercial receptor locations, and some residential receptor locations.

A frequency analysis indicated that the 24-hour average acrolein concentrations predicted at commercial receptor location R2 under the 2032 Airport Alone Case exceeded the 24-hour MOE (2012) AAQC of 0.4 µg/m^3 approximately 78 times out of the total 1,827 days modelled (Golder, 2015). As a result, the 24-hr AAQC for acrolein would be exceeded approximately 4.3% of the time at location R2. Similarly, at residential receptor location R7 (2032 Airport Alone), it was predicted that concentration of acrolein would exceed the MOE (2012) AAQC approximately 11 times out of the total 1,827 days modelled (Golder, 2015), or approximately 0.6% of the time at location R7.

The inhalation exposure limit used in the current assessment was established by the MOE (2012), based upon observations in a sub-chronic inhalation study of rats exposed to acrolein due to an absence of appropriate human exposure data. In the underlying study used to develop this limit (Dorman *et al*. 2008), exposures to concentrations of acrolein of 458 µg/m^3 did

not result in any adverse effects in rats. Exposures to concentrations at the next study exposure level of 1,374 µg/m^3 resulted in histological changes of the respiratory tract in rats associated with longer-term irritation.

In addition to adjustments to account for continuous exposure and differences between human and rat exposure factors, a 30-fold uncertainty factor (to account for the uncertainty inherent within the derived exposure limit) was applied to derive the ultimate AAQC of 0.4 µg/m^3. The standardized safety (uncertainty) factors applied, which are recognized by the US EPA, Health Canada and the WHO, included adjustments to address animal to human extrapolation (three-fold) and potential human sensitive sub-population (ten-fold). It is these uncertainty factors that account for a great deal of conservatism in HHRA.

The maximum predicted 2032 24-hour maximum concentration of acrolein at commercial receptor location R2 was 1.24 µg/m^3, which is approximately 660-fold less than the concentration (458 µg/m^3) that did not elicit any effects in the animal study conducted and approximately 2,000-fold less than the lowest concentration (1,374 µg/m^3) did elicit effects.

Similarly, the maximum predicted 2032 24-hour maximum concentration of acrolein at residential receptor location R7 was 0.69 µg/m^3, which is approximately 370-fold less than the concentration (458 µg/m^3) that did not elicit any effects in the animal study conducted and approximately 1,100-fold less than the lowest concentration (1,374 µg/m^3) did elicit effects.

Given that the predicted exceedances for acrolein were highly intermittent in nature and the conservative nature of the exposure limit used to derive the AAQC, it is not anticipated that the levels of acrolein exposure expected at the receptor locations represent a significant health risk to the general population.

6.2 Chronic Inhalation Assessment

The potential for chronic adverse health effects resulting from long-term exposures (via inhalation) were evaluated at the receptor locations. Chronic CR values and incremental lifetime cancer risks (ILCR) at the receptor locations are presented for each of the receptor locations under the 2011, 2022, and 2032 airport operational scenarios. CR and ILCR values were presented for those COCs with TRV data corresponding to the relevant exposure duration.

Considering the various assumptions used that attempt to over predict rather than under predict ground-level air concentrations and the typical uncertainty factors applied during the development of a health-based TRV, a CR value less than or equal to one (CR value ≤ 1) at the receptor locations is a strong indicator of negligible health risks resulting from exposure to a particular COC.

The ILCR estimates are a result of long-term exposure to the maximum predicted annual average ground-level air concentration resulting from the ‘Airport Alone’ emissions at the various receptor locations. Most regulatory agencies assume that any level of long-term exposure to a carcinogenic substance is associated with some “hypothetical cancer risk”. As a result, regulatory agencies have typically identified acceptable ILCR levels (i.e., over and above existing baseline conditions) of between the 1-in-10,000 and 1-in-1,000,000 (*i.e.*, 1E-04 to 1E-06). ILCR estimates consider risks related to a particular emission source (*e.g.*, ‘Airport Alone’)

in that the cancer risks are expressed on an incremental increase over existing background cancer risks. In Ontario, the *de minimis* (negligible) ILCR benchmark is one-in-one million (1.0E-06).

As previously discussed, in order to account for the amount of time an individual may spend at the one of the receptor locations assessed, annual average air concentrations were time-weighted to provide more realistic risk estimates.

For the MPOI, which was located at the airport property fence-line, an individual working at the airport was hypothetically assumed to be present at or very near the fence line location 10 hours per day, 5 days per week, 48 weeks per year, for a working tenure of 35 years while being exposed to maximum predicted annual average concentrations.

For the commercial receptor locations, which are located at R1 and R2, an individual working within a commercial environment was hypothetically assumed to be present at one of these receptor locations for 8 hours per day, 5 days per week, 52 weeks per year, for a working tenure of 35 years while being exposed to maximum predicted annual average concentrations.

For the residential receptor locations, which are located at R3 through R11, an individual was hypothetically assumed to be present at one of these receptor locations for an entire lifetime. As a result, the individual was assumed to be present for 24 hours per day, 7 days per week, 52 weeks per year, for 80 years while being exposed to maximum predicted annual average concentrations (*i.e.,* no time-weighting of the maximum predicted annual average air concentration).

6.2.1 Chronic Inhalation Risk Estimates

Tables 6-7 and 6-8 present the chronic inhalation risk estimates, expressed as CR values and ILCRs, for 2011, respectively. Tables 6-9 and 6-10 present the chronic inhalation risk estimates for 2022, and Tables 6-11 and 6-12 present the chronic inhalation risk estimates for 2032. Risk estimates for the Background Case and Cumulative Effects Case are presented in Appendix E.

Table 6-7 Summary of Annual Average Concentration Ratios – 2011 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen dioxide (NO_2)	5.4E-02	4.7E-02	3.7E-02	4.8E-02	3.0E-02	2.1E-02	8.9E-03	6.7E-02	1.3E-02	1.9E-02	1.2E-02	7.5E-03
Coarse Particulate Matter (PM_{10})	7.1E-03	5.5E-03	4.0E-03	4.3E-03	2.2E-03	1.3E-03	4.0E-04	3.2E-03	6.8E-04	1.4E-03	7.2E-04	4.3E-04
Fine Particulate Matter ($PM_{2.5}$)	1.4E-02	1.0E-02	7.8E-03	9.0E-03	4.7E-03	2.7E-03	8.3E-04	6.7E-03	1.4E-03	2.9E-03	1.5E-03	9.1E-04
Sulphur Dioxide (SO_2)	1.3E-02	9.0E-03	8.1E-03	1.1E-02	5.0E-03	3.3E-03	1.4E-03	1.3E-02	1.9E-03	3.2E-03	2.0E-03	1.3E-03
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	3.3E-04	2.9E-04	2.0E-04	2.0E-04	9.5E-05	5.5E-05	2.2E-05	1.7E-04	3.4E-05	5.9E-05	3.3E-05	2.1E-05
Acetone	2.4E-07	2.1E-07	1.4E-07	1.5E-07	6.8E-08	3.9E-08	1.6E-08	1.2E-07	2.4E-08	4.2E-08	2.4E-08	1.5E-08
Acrolein and related	**1.5E+00**	**1.3E+00**	9.0E-01	9.1E-01	4.2E-01	2.4E-01	9.8E-02	7.6E-01	1.5E-01	2.6E-01	1.5E-01	9.6E-02
Aldehydes, other	3.9E-03	3.4E-03	2.3E-03	2.4E-03	1.1E-03	6.3E-04	2.6E-04	2.0E-03	4.0E-04	6.8E-04	3.9E-04	2.5E-04
Aliphatic alcohols	2.7E-05	2.4E-05	1.6E-05	1.7E-05	7.7E-06	4.5E-06	1.8E-06	1.4E-05	2.8E-06	4.8E-06	2.7E-06	1.7E-06
Alkanes/alkenes, other C1-4	1.4E-04	1.3E-04	8.7E-05	8.9E-05	4.1E-05	2.4E-05	9.6E-06	7.4E-05	1.5E-05	2.5E-05	1.4E-05	9.3E-06
Alkanes/alkenes, other C5-8	7.1E-06	6.1E-06	4.3E-06	4.3E-06	2.0E-06	1.2E-06	4.7E-07	3.6E-06	7.2E-07	1.2E-06	7.1E-07	4.6E-07
Alkanes/alkenes, other C>8-10	2.2E-04	1.9E-04	1.3E-04	1.3E-04	6.1E-05	3.5E-05	1.4E-05	1.1E-04	2.2E-05	3.8E-05	2.1E-05	1.4E-05
Alkanes/alkenes, other C>10-12	1.1E-05	9.9E-06	6.9E-06	7.0E-06	3.3E-06	1.9E-06	7.6E-07	5.9E-06	1.2E-06	2.0E-06	1.1E-06	7.4E-07
Alkanes/alkenes, other C>12-16	1.7E-05	1.5E-05	1.0E-05	1.0E-05	4.8E-06	2.8E-06	1.1E-06	8.6E-06	1.7E-06	3.0E-06	1.7E-06	1.1E-06
Benzene and related	1.2E-02	1.0E-02	7.0E-03	7.1E-03	3.3E-03	1.9E-03	7.6E-04	5.9E-03	1.2E-03	2.0E-03	1.1E-03	7.4E-04
Butadiene, 1,3-	9.1E-03	7.9E-03	5.5E-03	5.6E-03	2.6E-03	1.5E-03	6.0E-04	4.7E-03	9.3E-04	1.6E-03	9.1E-04	5.9E-04

Table 6-7 Summary of Annual Average Concentration Ratios – 2011 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	2.1E-06	1.8E-06	1.2E-06	1.3E-06	5.9E-07	3.4E-07	1.4E-07	1.1E-06	2.1E-07	3.6E-07	2.1E-07	1.3E-07
Ethylbenzene and related	1.1E-04	9.2E-05	6.4E-05	6.5E-05	3.0E-05	1.8E-05	7.1E-06	5.5E-05	1.1E-05	1.9E-05	1.1E-05	6.9E-06
Formaldehyde and related	1.9E-02	1.6E-02	1.1E-02	1.2E-02	5.4E-03	3.1E-03	1.3E-03	9.7E-03	1.9E-03	3.3E-03	1.9E-03	1.2E-03
Hexane, n-	6.3E-06	5.4E-06	3.8E-06	3.8E-06	1.8E-06	1.0E-06	4.1E-07	3.2E-06	6.4E-07	1.1E-06	6.2E-07	4.0E-07
Naphthalene and related	3.0E-03	2.6E-03	1.8E-03	1.8E-03	8.6E-04	4.9E-04	2.0E-04	1.5E-03	3.1E-04	5.3E-04	3.0E-04	1.9E-04
Styrene	6.8E-06	5.9E-06	4.1E-06	4.1E-06	1.9E-06	1.1E-06	4.5E-07	3.5E-06	6.9E-07	1.2E-06	6.7E-07	4.4E-07
Toluene and related	3.5E-06	3.1E-06	2.1E-06	2.2E-06	1.0E-06	5.8E-07	2.3E-07	1.8E-06	3.6E-07	6.2E-07	3.5E-07	2.3E-07
Xylenes	1.2E-04	1.1E-04	7.4E-05	7.5E-05	3.5E-05	2.0E-05	8.1E-06	6.2E-05	1.2E-05	2.1E-05	1.2E-05	7.9E-06
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Table 6-8 Summary of Annual Average Incremental Lifetime Cancer Risks – 2011 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen dioxide (NO_2)	-	-	-	-	-	-	-	-	-	-	-	-
Coarse Particulate Matter (PM_{10})	-	-	-	-	-	-	-	-	-	-	-	-
Fine Particulate Matter ($PM_{2.5}$)	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	-	-	-	-	-	-	-	-	-	-	-	-
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	4.6E-07	4.6E-07	3.2E-07	7.7E-08	3.6E-08	2.1E-08	8.4E-09	6.5E-08	1.3E-08	2.2E-08	1.3E-08	8.1E-09
Acetone	-	-	-	-	-	-	-	-	-	-	-	-
Acrolein and related	-	-	-	-	-	-	-	-	-	-	-	-
Aldehydes, other	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic alcohols	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C1-4	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C5-8	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>8-10	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-
Benzene and related	4.4E-07	3.8E-07	2.6E-07	6.1E-07	2.9E-07	1.6E-07	6.6E-08	5.1E-07	1.0E-07	1.8E-07	1.0E-07	6.5E-08
Butadiene, 1,3-	4.0E-09	3.4E-09	2.4E-09	5.6E-09	2.6E-09	1.5E-09	6.0E-10	4.7E-09	9.3E-10	1.6E-09	9.1E-10	5.9E-10

Table 6-8	Summary of Annual Average Incremental Lifetime Cancer Risks – 2011 Airport Alone Assessment Scenario											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene and related	-	-	-	-	-	-	-	-	-	-	-	-
Formaldehyde and related	4.5E-07	3.9E-07	2.7E-07	6.3E-07	2.9E-07	1.7E-07	6.8E-08	5.2E-07	1.0E-07	1.8E-07	1.0E-07	6.6E-08
Hexane, n-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene and related	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Toluene and related	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	2.6E-07	1.9E-07	1.4E-07	3.7E-07	1.9E-07	1.1E-07	3.5E-08	2.8E-07	5.8E-08	1.2E-07	6.2E-08	3.8E-08

Bolded values highlighted in grey are in excess of the acceptable ILCR of one-in-one million ($1x10^{-6}$).

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Table 6-9 Summary of Annual Average Concentration Ratios – 2022 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen dioxide (NO_2)	5.6E-02	4.7E-02	3.8E-02	6.1E-02	4.3E-02	2.6E-02	1.1E-02	9.2E-02	2.2E-02	2.6E-02	1.5E-02	9.0E-03
Coarse Particulate Matter (PM_{10})	1.0E-02	6.8E-03	5.1E-03	5.8E-03	3.0E-03	1.7E-03	5.6E-04	5.1E-03	1.3E-03	1.8E-03	8.9E-04	5.1E-04
Fine Particulate Matter ($PM_{2.5}$)	2.1E-02	1.2E-02	9.7E-03	1.2E-02	6.2E-03	3.7E-03	1.2E-03	1.1E-02	2.7E-03	3.7E-03	1.9E-03	1.1E-03
Sulphur Dioxide (SO_2)	2.7E-02	1.4E-02	1.2E-02	2.1E-02	1.1E-02	6.2E-03	2.1E-03	2.8E-02	5.1E-03	5.9E-03	3.1E-03	1.9E-03
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	4.9E-04	4.0E-04	2.9E-04	4.1E-04	1.9E-04	1.1E-04	3.7E-05	4.7E-04	9.3E-05	1.1E-04	5.4E-05	3.2E-05
Acetone	3.6E-07	2.9E-07	2.1E-07	3.0E-07	1.4E-07	8.2E-08	2.7E-08	3.5E-07	6.8E-08	8.1E-08	3.9E-08	2.4E-08
Acrolein and related	**2.3E+00**	**1.8E+00**	**1.3E+00**	**1.9E+00**	8.6E-01	5.1E-01	1.7E-01	**2.2E+00**	4.3E-01	5.0E-01	2.5E-01	1.5E-01
Aldehydes, other	5.8E-03	4.7E-03	3.4E-03	4.8E-03	2.2E-03	1.3E-03	4.3E-04	5.5E-03	1.1E-03	1.3E-03	6.3E-04	3.7E-04
Aliphatic alcohols	4.2E-05	3.4E-05	2.4E-05	3.4E-05	1.6E-05	9.4E-06	3.1E-06	4.0E-05	7.8E-06	9.3E-06	4.5E-06	2.7E-06
Alkanes/alkenes, other C1-4	1.7E-04	1.4E-04	9.9E-05	1.4E-04	6.4E-05	3.8E-05	1.2E-05	1.6E-04	3.2E-05	3.7E-05	1.8E-05	1.1E-05
Alkanes/alkenes, other C5-8	5.1E-06	4.2E-06	3.0E-06	4.2E-06	1.9E-06	1.2E-06	3.8E-07	4.9E-06	9.6E-07	1.1E-06	5.6E-07	3.3E-07
Alkanes/alkenes, other C>8-10	3.3E-04	2.6E-04	1.9E-04	2.7E-04	1.2E-04	7.4E-05	2.4E-05	3.1E-04	6.1E-05	7.3E-05	3.5E-05	2.1E-05
Alkanes/alkenes, other C>10-12	1.5E-05	1.2E-05	8.7E-06	1.2E-05	5.6E-06	3.3E-06	1.1E-06	1.4E-05	2.8E-06	3.3E-06	1.6E-06	9.6E-07
Alkanes/alkenes, other C>12-16	2.6E-05	2.1E-05	1.5E-05	2.1E-05	9.7E-06	5.8E-06	1.9E-06	2.5E-05	4.8E-06	5.7E-06	2.8E-06	1.7E-06
Benzene and related	1.3E-02	1.0E-02	7.4E-03	1.0E-02	4.8E-03	2.8E-03	9.3E-04	1.2E-02	2.4E-03	2.8E-03	1.4E-03	8.1E-04
Butadiene, 1,3-	1.4E-02	1.1E-02	8.0E-03	1.1E-02	5.1E-03	3.1E-03	1.0E-03	1.3E-02	2.5E-03	3.0E-03	1.5E-03	8.8E-04

Table 6-9	Summary of Annual Average Concentration Ratios – 2022 Airport Alone Assessment Scenario											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	5.0E-07	4.1E-07	3.0E-07	4.2E-07	1.9E-07	1.1E-07	3.7E-08	4.8E-07	9.5E-08	1.1E-07	5.5E-08	3.3E-08
Ethylbenzene and related	1.1E-04	9.0E-05	6.5E-05	9.1E-05	4.2E-05	2.5E-05	8.2E-06	1.1E-04	2.1E-05	2.5E-05	1.2E-05	7.2E-06
Formaldehyde and related	2.8E-02	2.3E-02	1.7E-02	2.3E-02	1.1E-02	6.4E-03	2.1E-03	2.7E-02	5.3E-03	6.3E-03	3.1E-03	1.8E-03
Hexane, n-	1.5E-06	1.2E-06	9.0E-07	1.3E-06	5.8E-07	3.5E-07	1.1E-07	1.5E-06	2.9E-07	3.4E-07	1.7E-07	9.9E-08
Naphthalene and related	4.6E-03	3.7E-03	2.7E-03	3.8E-03	1.7E-03	1.0E-03	3.4E-04	4.4E-03	8.7E-04	1.0E-03	5.0E-04	3.0E-04
Styrene	1.0E-05	8.4E-06	6.1E-06	8.5E-06	3.9E-06	2.3E-06	7.7E-07	9.9E-06	1.9E-06	2.3E-06	1.1E-06	6.7E-07
Toluene and related	3.1E-06	2.5E-06	1.8E-06	2.6E-06	1.2E-06	7.0E-07	2.3E-07	3.0E-06	5.9E-07	7.0E-07	3.4E-07	2.0E-07
Xylenes	8.9E-05	7.2E-05	5.2E-05	7.4E-05	3.4E-05	2.0E-05	6.6E-06	8.5E-05	1.7E-05	2.0E-05	9.6E-06	5.8E-06
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Table 6-10 Summary of Annual Average Incremental Lifetime Cancer Risks – 2022 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen dioxide (NO_2)	-	-	-	-	-	-	-	-	-	-	-	-
Coarse Particulate Matter (PM_{10})	-	-	-	-	-	-	-	-	-	-	-	-
Fine Particulate Matter ($PM_{2.5}$)	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	-	-	-	-	-	-	-	-	-	-	-	-
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	8.2E-08	6.6E-08	4.8E-08	1.5E-07	7.1E-08	4.2E-08	1.4E-08	1.8E-07	3.5E-08	4.2E-08	2.0E-08	1.2E-08
Acetone	-	-	-	-	-	-	-	-	-	-	-	-
Acrolein and related	-	-	-	-	-	-	-	-	-	-	-	-
Aldehydes, other	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic alcohols	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C1-4	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C5-8	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>8-10	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-
Benzene and related	4.8E-07	3.9E-07	2.8E-07	9.0E-07	4.1E-07	2.5E-07	8.1E-08	1.0E-06	2.1E-07	2.4E-07	1.2E-07	7.1E-08
Butadiene, 1,3-	5.9E-09	4.8E-09	3.5E-09	1.1E-08	5.1E-09	3.1E-09	1.0E-09	1.3E-08	2.5E-09	3.0E-09	1.5E-09	8.8E-10

Table 6-10	Summary of Annual Average Incremental Lifetime Cancer Risks – 2022 Airport Alone Assessment Scenario											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene and related	-	-	-	-	-	-	-	-	-	-	-	-
Formaldehyde and related	6.7E-07	5.4E-07	3.9E-07	**1.3E-06**	5.8E-07	3.4E-07	1.1E-07	**1.5E-06**	2.9E-07	3.4E-07	1.7E-07	9.9E-08
Hexane, n-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene and related	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Toluene and related	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	3.7E-07	2.2E-07	1.8E-07	5.0E-07	2.6E-07	1.5E-07	4.9E-08	4.5E-07	1.1E-07	1.5E-07	7.7E-08	4.4E-08

Bolded values highlighted in grey are in excess of the acceptable ILCR of one-in-one million ($1x10^{-6}$).

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Table 6-11 Summary of Annual Average Concentration Ratios – 2032 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen dioxide (NO_2)	6.3E-02	5.2E-02	4.3E-02	7.1E-02	5.0E-02	3.1E-02	1.2E-02	1.0E-01	2.1E-02	3.0E-02	1.7E-02	1.0E-02
Coarse Particulate Matter (PM_{10})	1.2E-02	8.1E-03	6.0E-03	6.9E-03	3.6E-03	2.1E-03	6.8E-04	6.2E-03	1.5E-03	2.1E-03	1.1E-03	6.0E-04
Fine Particulate Matter ($PM_{2.5}$)	2.2E-02	1.4E-02	1.1E-02	1.4E-02	7.4E-03	4.3E-03	1.4E-03	1.3E-02	3.2E-03	4.4E-03	2.2E-03	1.2E-03
Sulphur Dioxide (SO_2)	3.2E-02	1.7E-02	1.5E-02	2.6E-02	1.3E-02	7.4E-03	2.6E-03	3.4E-02	6.2E-03	7.3E-03	3.8E-03	2.2E-03
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	6.0E-04	4.7E-04	3.4E-04	5.0E-04	2.3E-04	1.3E-04	4.4E-05	5.8E-04	1.1E-04	1.3E-04	6.6E-05	3.9E-05
Acetone	4.4E-07	3.5E-07	2.5E-07	3.7E-07	1.7E-07	9.7E-08	3.3E-08	4.3E-07	8.2E-08	9.8E-08	4.9E-08	2.9E-08
Acrolein and related	**2.8E+00**	**2.2E+00**	**1.6E+00**	**2.3E+00**	1.0E+00	6.1E-01	2.0E-01	**2.7E+00**	5.1E-01	6.1E-01	3.1E-01	1.8E-01
Aldehydes, other	7.1E-03	5.5E-03	4.0E-03	5.8E-03	2.6E-03	1.5E-03	5.2E-04	6.8E-03	1.3E-03	1.5E-03	7.8E-04	4.5E-04
Aliphatic alcohols	5.1E-05	4.0E-05	2.9E-05	4.2E-05	1.9E-05	1.1E-05	3.7E-06	4.9E-05	9.3E-06	1.1E-05	5.6E-06	3.3E-06
Alkanes/alkenes, other C1-4	2.0E-04	1.6E-04	1.2E-04	1.7E-04	7.6E-05	4.5E-05	1.5E-05	2.0E-04	3.7E-05	4.5E-05	2.2E-05	1.3E-05
Alkanes/alkenes, other C5-8	6.1E-06	4.7E-06	3.5E-06	5.0E-06	2.3E-06	1.3E-06	4.5E-07	5.9E-06	1.1E-06	1.3E-06	6.7E-07	3.9E-07
Alkanes/alkenes, other C>8-10	4.0E-04	3.1E-04	2.3E-04	3.3E-04	1.5E-04	8.7E-05	2.9E-05	3.9E-04	7.4E-05	8.8E-05	4.4E-05	2.6E-05
Alkanes/alkenes, other C>10-12	1.8E-05	1.4E-05	1.0E-05	1.5E-05	6.7E-06	3.9E-06	1.3E-06	1.7E-05	3.3E-06	3.9E-06	2.0E-06	1.2E-06
Alkanes/alkenes, other C>12-16	3.1E-05	2.4E-05	1.8E-05	2.6E-05	1.2E-05	6.9E-06	2.3E-06	3.0E-05	5.8E-06	6.9E-06	3.5E-06	2.0E-06
Benzene and related	1.5E-02	1.2E-02	8.6E-03	1.2E-02	5.6E-03	3.3E-03	1.1E-03	1.5E-02	2.8E-03	3.3E-03	1.7E-03	9.7E-04
Butadiene, 1,3-	1.7E-02	1.3E-02	9.4E-03	1.4E-02	6.2E-03	3.6E-03	1.2E-03	1.6E-02	3.0E-03	3.6E-03	1.8E-03	1.1E-03

Table 6-11 Summary of Annual Average Concentration Ratios – 2032 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	5.1E-07	4.0E-07	2.9E-07	4.2E-07	1.9E-07	1.1E-07	3.8E-08	5.0E-07	9.4E-08	1.1E-07	5.6E-08	3.3E-08
Ethylbenzene and related	1.3E-04	1.0E-04	7.6E-05	1.1E-04	5.0E-05	2.9E-05	9.8E-06	1.3E-04	2.5E-05	2.9E-05	1.5E-05	8.6E-06
Formaldehyde and related	3.5E-02	2.7E-02	2.0E-02	2.8E-02	1.3E-02	7.5E-03	2.5E-03	3.3E-02	6.3E-03	7.6E-03	3.8E-03	2.2E-03
Hexane, n-	1.6E-06	1.2E-06	8.9E-07	1.3E-06	5.8E-07	3.4E-07	1.1E-07	1.5E-06	2.9E-07	3.4E-07	1.7E-07	1.0E-07
Naphthalene and related	5.6E-03	4.4E-03	3.2E-03	4.7E-03	2.1E-03	1.2E-03	4.2E-04	5.5E-03	1.0E-03	1.2E-03	6.2E-04	3.6E-04
Styrene	1.3E-05	9.9E-06	7.2E-06	1.0E-05	4.7E-06	2.8E-06	9.3E-07	1.2E-05	2.3E-06	2.8E-06	1.4E-06	8.2E-07
Toluene and related	3.7E-06	2.9E-06	2.1E-06	3.1E-06	1.4E-06	8.2E-07	2.8E-07	3.6E-06	6.9E-07	8.2E-07	4.1E-07	2.4E-07
Xylenes	1.0E-04	8.2E-05	6.0E-05	8.7E-05	3.9E-05	2.3E-05	7.7E-06	1.0E-04	1.9E-05	2.3E-05	1.2E-05	6.8E-06
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values highlighted in grey are in excess of the acceptable CR of 1.0.

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Table 6-12 Summary of Annual Average Incremental Lifetime Cancer Risks – 2032 Airport Alone Assessment Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen dioxide (NO_2)	-	-	-	-	-	-	-	-	-	-	-	-
Coarse Particulate Matter (PM_{10})	-	-	-	-	-	-	-	-	-	-	-	-
Fine Particulate Matter ($PM_{2.5}$)	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	-	-	-	-	-	-	-	-	-	-	-	-
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	1.0E-07	7.8E-08	5.7E-08	1.9E-07	8.5E-08	5.0E-08	1.7E-08	2.2E-07	4.2E-08	5.0E-08	2.5E-08	1.5E-08
Acetone	-	-	-	-	-	-	-	-	-	-	-	-
Acrolein and related	-	-	-	-	-	-	-	-	-	-	-	-
Aldehydes, other	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic alcohols	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C1-4	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C5-8	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>8-10	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>10-12	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-
Benzene and related	5.7E-07	4.5E-07	3.3E-07	**1.1E-06**	4.9E-07	2.9E-07	9.7E-08	**1.3E-06**	2.4E-07	2.9E-07	1.4E-07	8.5E-08
Butadiene, 1,3-	7.2E-09	5.6E-09	4.1E-09	1.4E-08	6.2E-09	3.6E-09	1.2E-09	1.6E-08	3.0E-09	3.6E-09	1.8E-09	1.1E-09

Table 6-12	Summary of Annual Average Incremental Lifetime Cancer Risks – 2032 Airport Alone Assessment Scenario											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene and related	-	-	-	-	-	-	-	-	-	-	-	-
Formaldehyde and related	8.2E-07	6.4E-07	4.6E-07	**1.5E-06**	7.0E-07	4.1E-07	1.4E-07	**1.8E-06**	3.4E-07	4.1E-07	2.1E-07	1.2E-07
Hexane, n-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene and related	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	-	-	-	-	-	-	-	-	-
Toluene and related	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	3.9E-07	2.6E-07	2.1E-07	6.0E-07	3.1E-07	1.8E-07	5.9E-08	5.4E-07	1.3E-07	1.8E-07	9.2E-08	5.2E-08

Bolded values highlighted in grey are in excess of the acceptable ILCR of one-in-one million ($1x10^{-6}$).

- Indicates that an appropriate exposure limit (TRV) was not available for this chemical.

Annual Average Concentration Ratios

With the exception of acrolein, all annual average chronic CR estimates for years 2011, 2022, and 2032 were less than a value of one (1.0) under the 'Airport Alone' scenario, indicating that contributions from the airport for the remaining COCs are not expected to result in adverse chronic inhalation non-cancer health effects.

- For the 2011 Airport Alone operational scenario, chronic CR estimates for acrolein were greater than a value of one (CR > 1.0) for the MPOI and one (1) commercial receptor location.
- For the 2022 Airport Alone operational scenario, chronic CR estimates for acrolein were greater than a value of one (CR > 1.0) for the MPOI, the two (2) commercial receptor locations, and at two (2) of the residential receptor locations.
- For the 2032 Airport Alone operational scenario, chronic CR estimates for acrolein were greater than a value of one (CR > 1.0) for the MPOI, the two (2) commercial receptor locations, and at two (2) of the residential receptor locations.

While somewhat counterintuitive, risk estimates were greater for some of the residential locations than the MPOI despite the MPOI having the highest COC concentrations by definition. This was because of the time-weighting, or adjustment factors, applied to the air concentrations at the MPOI under the assumption that an industrial receptor was only present at the MPOI for 27% of the year. In contrast, the resident was assumed to spend 100% of their time at the receptor location of interest.

As with the acute risks related to acrolein exposures, the chronic endpoint of concern for acrolein is specifically nasal irritation potentially leading to nasal lesions due to continuous long-term exposures to this irritant.

The inhalation exposure limit used in the current assessment was established by the US EPA IRIS (2003), based upon observations in a sub-chronic inhalation study of rats exposed to acrolein due to an absence of appropriate human exposure data. In the underlying study used to develop this limit (Feron *et al*. 1978), exposures to concentrations of acrolein of 900 µg/m^3 resulted in slight nasal irritation in 1 of the 12 studied rats. Though the same study was also conducted in hamsters and rabbits, none of these health-related environmental effects were observed at this exposure concentration (*i.e.*, rats were the most sensitive species).

In addition to adjustments to account for continuous exposure and differences between human and rat exposure factors, a 1,000-fold uncertainty factor (to account for the considerable uncertainty inherent within the derived exposure limit) was applied to derive the ultimate reference concentration of 0.02 µg/m^3. The standardized safety (uncertainty) factors applied, which are recognized by the US EPA, Health Canada and the WHO, included adjustments to address animal to human extrapolation (three-fold), potential human sensitive sub-population (ten-fold), the use of a sub-chronic to convert to an equivalent chronic study (ten-fold), and for the use of the lowest-observed-effects-level (three-fold). It is these uncertainty factors that account for a great deal of conservatism in HHRA.

The maximum predicted annual average concentration of acrolein at residential receptor location R7 was 0.054 µg/m^3, which is approximately 17,000-fold less than the concentration

(900 µg/m^3) that elicited minor nasal irritation for a sensitive test species (*i.e.*, in only 1 of 12 studied rats). Based on the conservatisms applied in deriving the US EPA IRIS (2003) exposure limit, it is unlikely that prolonged exposure at the maximum predicted annual average concentration acrolein would result in any appreciable health risk to the overall population.

Incremental Lifetime Cancer Risks

The annual average chronic ILCR estimates for COCs other than benzene and formaldehyde were less than a value of one-in-one million ($1.0x10^{-6}$) under the 'Airport Alone' scenario, indicating that contributions of the COCs other than benzene and formaldehyde from the airport are not expected to result in adverse carcinogenic health effects.

- For the 2011 Airport Alone operational scenario, all COCs for all receptor locations had ILCR estimates less than or equal to one-in-one million (ILCR ≤ $1x10^{-6}$).
- For the 2022 Airport Alone operational scenario, ILCR estimates were greater than a value of one-in-one million (ILCR > $1.0x10^{-6}$) for formaldehyde only. ILCRs greater than one-in-one million were predicted for two (2) of the residential receptor locations.
- For the 2032 Airport Alone operational scenario, ILCR estimates were greater than a value of one-in-one million (ILCR > $1.0x10^{-6}$) for benzene and formaldehyde. ILCRs greater than one-in-one million were predicted for two (2) of the residential receptor locations.

Based on the comparisons presented, the estimated exposures from 2022 and 2032 result in ILCRs slightly greater than the MOECC acceptable regulatory-established cancer risk benchmark of 1-in-1,000,000. This suggests that the potential for an elevated level of risk above MOECC's acceptable ILCR for formaldehyde and benzene, the significance of which must be balanced against the high degree of conservatism incorporated in the risk assessment.

Given that the exceedances occurred at residential receptor locations (*i.e.,* R3 and R7), consideration should be given to the conservative nature of the exposure scenarios used in the HHRA. At these locations, an individual was hypothetically assumed to be born at the location and assumed to be present 24-hours per day and 365 days per year for their entire lifetime (*i.e.*, 80 years). It is highly unlikely that an individual would spend their entire lifetime at a single location.

Based on the conservative residential receptor characteristics and the 2032 assessment scenario, an ILCR of $1.8x10^{-6}$ for formaldehyde was predicted at receptor location R7. This ILCR was the highest predicted ILCR for any chemical under any scenario. As indicated above, this ILCR was estimated for an individual that was assumed to be born and present for their entire lifetime at this location. If the individual was to spend only half of their entire lifetime at receptor location R7, the predicted ILCR for would be less than one-in-one million, or acceptable.

While there are limited exceedances of the acceptable ILCR levels, based on the conservative assumptions utilized within the HHRA, it is not anticipated that there are any significant risks of carcinogenic effects from any of the COCs related to the predicted emissions from Toronto Pearson operations for the general population.

Further to this, the acceptable level of risk is an issue of policy rather than a scientific decision (CCME, 2006), and is set by regulatory agencies as opposed to risk assessors. Regulatory agencies have typically employed acceptable ILCR levels) between 1-in-100,000 and 1-in-1,000,000. While the MOECC considers an ILCR of 1-in-1,000,000 to be acceptable for HHRAs in the Province of Ontario, Health Canada (2012) has specified that an ILCR of 1-in-100,000 is acceptable and is considered "essentially negligible". The highest ILCR predicted across all scenarios (formaldehyde: receptor location R7; year 2032) is less than this value specified by Health Canada (2012).

6.2.2 Contributions of Toronto Pearson to Cumulative Air Quality Risks

Toronto Pearson represents a large area within the Greater Toronto Area (GTA), bordering the City of Toronto, the City of Mississauga, and the City of Brampton. Using five runways and two major terminals, Toronto Pearson handles approximately 35 million passengers and 450,000 aircraft movements annually. As a result of the significant volume of air and road traffic Toronto Pearson represents, the airport could represent a major emission source within the GTA. Through the Cumulative Effects Case, the overall contribution of Toronto Pearson to air quality impact within the areas surrounding the airport property was investigated.

The 2032 Airport Alone scenario represents the worst case operational scenario with respect to emissions produced from Toronto Pearson, as it is anticipated that air traffic will be greater than the earlier years evaluated. Therefore, the non-carcinogenic annual average risks from the 2032 Airport Alone operational scenario were compared against the 2032 Cumulative Effects Case. Table 6-13 presents the contribution of risk from Toronto Pearson alone with respect to the overall air quality risk (Cumulative Effects). Contributions for carbon monoxide could not be quantified as no suitable exposure limits to evaluate chronic carbon monoxide exposure were identified.

Table 6-13 Summary of Contributions from Airport to Cumulative Air Quality Risk Estimates – 2032 Annual Average Scenario												
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Criteria Air Contaminants (CACs)												
Carbon monoxide (CO)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen dioxide (NO_2)	17%	44%	36%	12%	13%	9%	3%	22%	6%	8%	5%	2%
Coarse Particulate Matter (PM_{10})	2%	2%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Fine Particulate Matter ($PM_{2.5}$)	2%	5%	4%	1%	1%	0%	0%	1%	0%	0%	0%	0%
Sulphur Dioxide (SO_2)	2%	37%	33%	16%	8%	4%	2%	13%	2%	3%	4%	3%
Volatile Organic Chemicals (VOCs)												
Acetaldehyde	25%	23%	18%	7%	3%	2%	1%	8%	2%	2%	1%	1%
Acetone	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Acrolein and related	86%	84%	80%	58%	38%	26%	11%	61%	23%	27%	15%	10%
Aldehydes, other	20%	18%	14%	5%	2%	1%	1%	6%	1%	1%	1%	0%
Aliphatic alcohols	-	-	-	-	-	-	-	-	-	-	-	-
Alkanes/alkenes, other C1-4	14%	13%	10%	3%	2%	1%	0%	4%	1%	1%	0%	0%
Alkanes/alkenes, other C5-8	13%	12%	9%	3%	2%	1%	0%	4%	1%	1%	0%	0%
Alkanes/alkenes, other C>8-10	91%	90%	87%	69%	51%	37%	17%	73%	33%	37%	23%	15%
Alkanes/alkenes, other C>10-12	36%	34%	27%	11%	5%	3%	1%	13%	3%	3%	2%	1%
Alkanes/alkenes, other C>12-16	-	-	-	-	-	-	-	-	-	-	-	-
Benzene and related	21%	20%	15%	6%	3%	2%	1%	7%	1%	2%	1%	0%
Butadiene, 1,3-	74%	72%	65%	39%	22%	14%	5%	43%	12%	15%	8%	5%

Table 6-13	Summary of Contributions from Airport to Cumulative Air Quality Risk Estimates – 2032 Annual Average Scenario											
Chemicals of Concern	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Cycloalkanes and cycloalkenes	4%	4%	3%	1%	0%	0%	0%	1%	0%	0%	0%	0%
Ethylbenzene and related	21%	20%	15%	6%	3%	2%	1%	7%	1%	2%	1%	0%
Formaldehyde and related	43%	41%	33%	15%	7%	4%	2%	17%	4%	4%	2%	1%
Hexane, n-	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Naphthalene and related	67%	64%	57%	31%	17%	11%	4%	35%	9%	11%	6%	3%
Styrene	45%	43%	35%	16%	8%	5%	2%	18%	4%	5%	2%	1%
Toluene and related	6%	5%	4%	1%	1%	0%	0%	2%	0%	0%	0%	0%
Xylenes	7%	6%	5%	2%	1%	0%	0%	2%	0%	0%	0%	0%
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(a)pyrene TEQ-equivalents	-	-	-	-	-	-	-	-	-	-	-	-

As shown in Table 6-13, as expected the contributions from Toronto Pearson were lower for those locations further away from the airport property, with locations R9 through R11 often being 0% for some VOCs. Contributions from the Toronto Pearson were greater than 50% for acrolein (*i.e.,* it was the major contributor of this chemical to the Study Domain), alkanes/alkenes (C>10-12), 1,3-butadiene, and naphthalene for at least one receptor location.

However, there is the potential that the contributions from Toronto Pearson to the overall Study Domain air quality is overestimated. The regional background VOC dataset that acted as the Baseline Case and consequently, were used in conjunction from the Airport Alone Case to produce the Cumulative Effects Case were from the National Air Pollution Surveillance Program (NAPS) of Environment Canada. These data were largely collected from a local ambient air quality station (Centennial Park, NAPS 60413), which is located near receptor locations R4 and R9. Given that this location is within the Study Domain, there is the potential that Toronto Pearson is contributing to the air quality at the monitoring location, and that it does not represent true background conditions.

Moreover, ambient air data from the Centennial Park NAPS station were not available for all COCs, namely acetone, aliphatic alcohols, alkanes/alkenes with C>12-16, and the aldehydes, which encompasses a total of seven (7) COC groupings evaluated in the HHRA (*i.e.,* acetaldehyde, acetone, acrolein, aliphatic alcohols, alkanes/alkenes (other C>12-16), formaldehyde, and other aldehydes).

An air quality station from another large urban area, Windsor, Ontario (60211) was identified to have ambient air quality data representative of five (5) COC groups missing from the Centennial Park dataset (*i.e.,* acetaldehyde, acetone, acrolein, formaldehyde, and other aldehydes). These data, collected in 2010 were used in the Background Case and Cumulative Effects Case assessments.

While Windsor is an urbanized area, the density and intensity of other emissions sources within the Study Domain, such as the 400-series highways surrounding Toronto Pearson, are not likely adequately captured within the NAPS data used for the five (5) COC groups missing from the Centennial Park dataset. However, in the absence of more adequate data, this represents a source of uncertainty.

Suitable speciated ambient air quality data representative of the aliphatic alcohols and the alkanes/alkenes (other C>12-16) were not identified. As a result, contributions from the Airport for these chemicals could not be calculated.

6.3 Multi-Media Pathway Assessment

As demonstrated by the multi-media screening approach (Section 3.3.3), not all COCs identified for evaluation *via* inhalation will persist and/or accumulate in the environment. The multimedia screening approach identified those COCs that have the potential to persist and/or accumulate in the environment, therefore, triggering a quantitative multi-media exposure assessment. As a result of this screening, benzo(a)pyrene TEQ was retained for quantitative multi-media assessment.

The objective of the multi-media assessment was to predict human health risks resulting from chronic exposures to COC *via* multiple exposure pathways and environmental media. Risk estimates for the multiple pathway exposure estimates for benzo(a)pyrene TEQ for years 2011, 2022, and 2032 are provided in Tables 6-14 through 6-16. Given that there are no suitable non-cancer TRVs for benzo(a)pyrene TEQ (Section 5.2.2), only ILCRs are presented.

Table 6-14 Multi-Media Risk Estimates – 2011 Assessment Scenario

Chemical of Concern	*Receptor Locations*	*Incremental Lifetime Cancer Risk from Airport Alone*[a]
Benzo(a)pyrene TEQ	MPOI	5.1E-07
	R1	4.6E-07
	R2	3.4E-07
	R3	8.8E-08
	R4	4.8E-08
	R5	3.1E-08
	R6	9.5E-09
	R7	6.5E-08
	R8	1.9E-08
	R9	3.2E-08
	R10	1.4E-08
	R11	9.9E-09

Bolded values highlighted in grey are in excess of the acceptable ILCR of one-in-one million ($1x10^{-6}$).
[a] ILCR estimates were based on predicted exposures of the composite (or lifetime) receptor.

Table 6-15 Multi-Media Risk Estimates – 2022 Assessment Scenario

Chemical of Concern	*Receptor Locations*	*Incremental Lifetime Cancer Risk from Airport Alone*[a]
Benzo(a)pyrene TEQ	MPOI	6.9E-07
	R1	5.6E-07
	R2	4.4E-07
	R3	1.2E-07
	R4	7.3E-08
	R5	4.2E-08
	R6	1.7E-08
	R7	1.1E-07
	R8	3.1E-08
	R9	4.2E-08
	R10	2.1E-08
	R11	1.1E-08

Bolded values highlighted in grey are in excess of the acceptable ILCR of one-in-one million ($1x10^{-6}$).
[a] ILCR estimates were based on predicted exposures of the composite (or lifetime) receptor.

Table 6-16 Multi-Media Risk Estimates – 2032 Assessment Scenario		
Chemical of Concern	***Receptor Locations***	***Incremental Lifetime Cancer Risk from Airport Alone***[a]
Benzo(a)pyrene TEQ	MPOI	7.7E-07
	R1	6.6E-07
	R2	4.8E-07
	R3	1.3E-07
	R4	8.5E-08
	R5	5.1E-08
	R6	1.9E-08
	R7	1.3E-07
	R8	3.4E-08
	R9	5.2E-08
	R10	2.9E-08
	R11	1.2E-08

Bolded values highlighted in grey are in excess of the acceptable ILCR of one-in-one million ($1x10^{-6}$).

[a] ILCR estimates were based on predicted exposures of the composite (or lifetime) receptor.

As presented in Tables 6-14 through 6-16, multi-media ILCR estimates for years 2011, 2022, and 2032 were less than a value of one-in-one million ($1.0x10^{-6}$) under the 'Airport Alone' scenario. This indicates that contributions from Toronto Pearson are not expected to result in adverse carcinogenic health effects through the multi-media exposure pathways considered in the HHRA.

6.4 Additive Risks for Mixtures

As discussed in Section 5.3, health effects from mixtures are typically assessed by assuming additive effects of chemicals with similar exposure characteristics (*e.g.*, acute exposure; chronic exposure) and similar toxic effects (*e.g.*, respiratory irritants, nasal irritants, reproductive effects, cancer) (Health Canada, 2012). However, there are currently no Ontario or Canadian regulatory benchmarks by which one could evaluate whether exposure to a given mixture from, or in isolation from, multiple sources could pose a health concern.

As there is no regulatory guidance for an appropriate comparative benchmark for mixture groups of similar toxicity, it would be inappropriate to compare these predictions to existing benchmarks recommended by regulatory agencies for one chemical. Therefore, in the current assessment, risk estimates for each chemical in a mixture were simply summed for illustrative purposes.

6.4.1 Acute Inhalation Assessment of Mixtures

The various mixture groups and the individual COCs considered within each group were presented in Table 5-4. Acute CR estimates resulting from 1-hour and 24-hour exposures to various chemical mixtures are presented below for years 2011, 2022, and 2032 (Tables 6-17 through 6-19). Risk estimates for the Background Case and Cumulative Effects Case are presented in Appendix E.

No Provincial or Federal regulatory benchmarks are currently available (beyond those chemical groups that have established toxic equivalent factors) by which one could evaluate whether exposure to a given chemical mixture could pose a health concern. The conservatism of the

approach used (Section 5.3.1) and the magnitude of the CR values generated must be taken into consideration.

Table 6-17	Summary of 1-Hour and 24-Hour Concentration Ratios for Mixtures by Endpoint – 2011 Airport Alone Assessment Scenario											
Potential Endpoint of Mixture	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
1-Hour Exposures												
Eye irritants	3.6E+00	2.2E+00	2.3E+00	1.8E+00	9.1E-01	6.9E-01	5.0E-01	1.7E+00	5.1E-01	6.9E-01	3.4E-01	3.3E-01
Respiratory irritants	3.7E+00	1.8E+00	2.3E+00	1.6E+00	9.5E-01	8.1E-01	6.2E-01	1.7E+00	7.1E-01	8.0E-01	6.6E-01	7.1E-01
Neurological effects	8.5E-04	5.2E-04	5.3E-04	4.3E-04	2.2E-04	1.6E-04	1.2E-04	4.0E-04	1.2E-04	1.6E-04	8.1E-05	7.9E-05
Reproductive/ developmental effects	8.5E-03	5.2E-03	5.3E-03	4.3E-03	2.1E-03	1.6E-03	1.2E-03	4.0E-03	1.2E-03	1.6E-03	8.0E-04	7.8E-04
24-Hour Exposures												
Eye irritants	2.1E+00	1.5E+00	1.4E+00	4.8E-01	4.1E-01	2.6E-01	1.1E-01	3.7E-01	1.9E-01	2.1E-01	1.2E-01	1.4E-01
Respiratory irritants	5.9E-01	4.0E-01	3.5E-01	1.4E-01	1.1E-01	6.6E-02	6.0E-02	1.7E-01	7.7E-02	7.1E-02	3.7E-02	4.7E-02
Neurological effects	2.3E-03	2.1E-03	2.0E-03	1.6E-03	1.6E-03	1.5E-03	1.5E-03	1.6E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03
Reproductive/ developmental effects	3.4E-02	2.5E-02	2.3E-02	7.8E-03	6.7E-03	4.1E-03	1.7E-03	6.0E-03	3.1E-03	3.4E-03	2.0E-03	2.2E-03

Table 6-18	Summary of 1-Hour and 24-Hour Concentration Ratios for Mixtures by Endpoint – 2022 Airport Alone Assessment Scenario											
Potential Endpoint of Mixture	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
1-Hour Exposures												
Eye irritants	1.0E+01	6.2E+00	6.9E+00	3.0E+00	2.1E+00	2.1E+00	9.1E-01	3.7E+00	1.8E+00	1.5E+00	1.2E+00	7.6E-01
Respiratory irritants	6.0E+00	3.1E+00	3.6E+00	1.9E+00	1.6E+00	1.3E+00	9.3E-01	2.7E+00	1.5E+00	1.1E+00	9.6E-01	7.7E-01
Neurological effects	1.3E-03	7.9E-04	8.8E-04	3.8E-04	2.6E-04	2.6E-04	1.1E-04	4.7E-04	2.2E-04	1.9E-04	1.5E-04	9.6E-05
Reproductive/ developmental effects	2.3E-02	1.4E-02	1.6E-02	7.0E-03	4.8E-03	4.8E-03	2.1E-03	8.6E-03	4.1E-03	3.6E-03	2.7E-03	1.8E-03
24-Hour Exposures												
Eye irritants	5.0E+00	3.4E+00	2.6E+00	1.4E+00	8.7E-01	6.4E-01	2.5E-01	1.4E+00	4.0E-01	5.4E-01	3.1E-01	2.8E-01
Respiratory irritants	1.0E+00	5.5E-01	5.1E-01	2.5E-01	1.5E-01	1.1E-01	9.6E-02	3.0E-01	1.2E-01	1.1E-01	6.2E-02	8.2E-02
Neurological effects	2.9E-03	2.5E-03	2.3E-03	2.0E-03	1.8E-03	1.8E-03	1.7E-03	2.0E-03	1.7E-03	1.7E-03	1.7E-03	1.7E-03
Reproductive/ developmental effects	7.9E-02	5.3E-02	4.0E-02	2.2E-02	1.4E-02	1.0E-02	4.0E-03	2.2E-02	6.3E-03	8.6E-03	4.9E-03	4.4E-03

Table 6-19	Summary of 1-Hour and 24-Hour Concentration Ratios for Mixtures by Endpoint – 2032 Airport Alone Assessment Scenario											
Potential Endpoint of Mixture	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
1-Hour Exposures												
Eye irritants	1.2E+01	6.9E+00	8.0E+00	4.1E+00	2.8E+00	2.2E+00	9.9E-01	4.5E+00	2.1E+00	2.6E+00	1.1E+00	9.5E-01
Respiratory irritants	6.6E+00	3.5E+00	4.0E+00	2.4E+00	1.9E+00	1.4E+00	1.0E+00	2.7E+00	1.6E+00	1.5E+00	1.0E+00	1.0E+00
Neurological effects	1.5E-03	8.5E-04	9.8E-04	5.1E-04	3.4E-04	2.8E-04	1.2E-04	5.6E-04	2.6E-04	3.2E-04	1.3E-04	1.2E-04
Reproductive/ developmental effects	2.8E-02	1.6E-02	1.9E-02	9.6E-03	6.4E-03	5.2E-03	2.3E-03	1.1E-02	4.8E-03	6.0E-03	2.5E-03	2.2E-03
24-Hour Exposures												
Eye irritants	5.8E+00	3.8E+00	3.2E+00	1.7E+00	1.3E+00	7.7E-01	2.4E-01	1.8E+00	5.0E-01	6.4E-01	3.3E-01	2.7E-01
Respiratory irritants	1.2E+00	5.9E-01	6.6E-01	2.9E-01	2.0E-01	1.3E-01	8.8E-02	3.4E-01	1.6E-01	1.2E-01	6.8E-02	8.6E-02
Neurological effects	3.2E-03	2.8E-03	2.6E-03	2.2E-03	2.1E-03	2.0E-03	1.9E-03	2.3E-03	1.9E-03	2.0E-03	1.9E-03	1.9E-03
Reproductive/ developmental effects	9.2E-02	6.0E-02	5.0E-02	2.6E-02	2.0E-02	1.2E-02	3.7E-03	2.8E-02	7.8E-03	1.0E-02	5.1E-03	4.2E-03

6.4.2 Chronic Inhalation Assessment of Mixtures

The various mixture groups and the individual COCs considered within each group were presented in Table 5-4. Chronic CR estimates resulting from annual average exposures to various chemical mixtures are presented below for years 2011, 2022, and 2032 (Tables 6-20 through 6-22). Risk estimates for the Background Case and Cumulative Effects Case are presented in Appendix E.

No Provincial or Federal regulatory benchmarks are currently available (beyond those chemical groups that have established toxic equivalent factors) by which one could evaluate whether exposure to a given chemical mixture could pose a health concern. The conservatism of the approach used (Section 5.3.1) and the magnitude of the CR values generated must be taken into consideration.

Table 6-20	Summary of Annual Average Concentration Ratios for Mixtures by Endpoint – 2011 Airport Alone Assessment Scenario											
Potential Endpoint of Mixture	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Respiratory irritants	1.5E+00	1.3E+00	9.1E-01	9.3E-01	4.3E-01	2.5E-01	1.0E-01	7.7E-01	1.5E-01	2.7E-01	1.5E-01	9.7E-02
Respiratory effects	8.9E-02	7.2E-02	5.7E-02	7.3E-02	4.1E-02	2.8E-02	1.2E-02	8.9E-02	1.7E-02	2.7E-02	1.6E-02	1.0E-02
Liver effects	2.4E-04	2.1E-04	1.5E-04	1.5E-04	7.0E-05	4.0E-05	1.6E-05	1.2E-04	2.5E-05	4.3E-05	2.4E-05	1.6E-05
Neurological effects	1.5E-04	1.3E-04	8.8E-05	9.0E-05	4.2E-05	2.4E-05	9.7E-06	7.5E-05	1.5E-05	2.6E-05	1.5E-05	9.4E-06
Reproductive/ developmental effects	9.1E-03	7.9E-03	5.5E-03	5.6E-03	2.6E-03	1.5E-03	6.0E-04	4.7E-03	9.3E-04	1.6E-03	9.1E-04	5.9E-04
Hematological effects	1.2E-02	1.0E-02	7.1E-03	7.2E-03	3.4E-03	1.9E-03	7.8E-04	6.0E-03	1.2E-03	2.1E-03	1.2E-03	7.6E-04

Table 6-21	Summary of Annual Average Concentration Ratios for Mixtures by Endpoint – 2022 Airport Alone Assessment Scenario											
Potential Endpoint of Mixture	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Respiratory irritants	2.3E+00	1.9E+00	1.4E+00	1.9E+00	8.7E-01	5.2E-01	1.7E-01	2.2E+00	4.3E-01	5.1E-01	2.5E-01	1.5E-01
Respiratory effects	1.1E-01	8.0E-02	6.5E-02	1.0E-01	6.3E-02	3.8E-02	1.5E-02	1.4E-01	3.1E-02	3.7E-02	2.1E-02	1.2E-02
Liver effects	3.7E-04	3.0E-04	2.2E-04	3.0E-04	1.4E-04	8.3E-05	2.7E-05	3.5E-04	6.9E-05	8.2E-05	4.0E-05	2.4E-05
Neurological effects	1.1E-04	8.9E-05	6.4E-05	9.0E-05	4.1E-05	2.5E-05	8.1E-06	1.0E-04	2.1E-05	2.4E-05	1.2E-05	7.1E-06
Reproductive/ developmental effects	1.4E-02	1.1E-02	8.0E-03	1.1E-02	5.2E-03	3.1E-03	1.0E-03	1.3E-02	2.6E-03	3.0E-03	1.5E-03	8.8E-04
Hematological effects	1.3E-02	1.0E-02	7.6E-03	1.1E-02	4.9E-03	2.9E-03	9.6E-04	1.2E-02	2.4E-03	2.9E-03	1.4E-03	8.4E-04

Table 6-22	Summary of Annual Average Concentration Ratios for Mixtures by Endpoint – 2032 Airport Alone Assessment Scenario											
Potential Endpoint of Mixture	***Receptor Location of Concern***											
	Industrial	***Commercial***		***Residential***								
	MPOI	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**
Respiratory irritants	2.8E+00	2.2E+00	1.6E+00	2.3E+00	1.1E+00	6.2E-01	2.1E-01	2.7E+00	5.2E-01	6.2E-01	3.1E-01	1.8E-01
Respiratory effects	1.3E-01	9.2E-02	7.5E-02	1.2E-01	7.4E-02	4.4E-02	1.7E-02	1.6E-01	3.2E-02	4.3E-02	2.4E-02	1.5E-02
Liver effects	4.5E-04	3.5E-04	2.6E-04	3.7E-04	1.7E-04	9.8E-05	3.3E-05	4.3E-04	8.3E-05	9.9E-05	4.9E-05	2.9E-05
Neurological effects	1.3E-04	1.0E-04	7.4E-05	1.1E-04	4.8E-05	2.8E-05	9.5E-06	1.3E-04	2.4E-05	2.8E-05	1.4E-05	8.3E-06
Reproductive/ developmental effects	1.7E-02	1.3E-02	9.5E-03	1.4E-02	6.2E-03	3.6E-03	1.2E-03	1.6E-02	3.1E-03	3.7E-03	1.8E-03	1.1E-03
Hematological effects	1.6E-02	1.2E-02	8.8E-03	1.3E-02	5.8E-03	3.4E-03	1.1E-03	1.5E-02	2.9E-03	3.4E-03	1.7E-03	1.0E-03

6.4.3 Discussion of Additive Risks for Mixtures via Inhalation

Given that chemical exposures rarely occur in isolation, the potential health effects associated with mixtures of COC were considered. The interaction between chemicals can take many forms and as such, Health Canada (2012) recommends that additive interactions be assumed when chemicals (within a given mixture) are structurally similar, act toxicologically through similar mechanisms or affect the same target tissue in the body (*i.e.*, share a common effect).

There are currently no Provincial or Federal benchmarks (beyond those chemical groups that have established toxic equivalent factors such as polycyclic aromatic hydrocarbons) by which one can evaluate whether exposure to a given mixture from, or in isolation from, multiple sources could pose a health concern. As a result, risk estimates (non-cancer CR values) for each chemical in a given mixture were summed for illustrative, rather than regulatory compliance purposes.

As described in Tables 6-16 through 6-21, two (2) chemical mixtures were found to exceed the single-chemical benchmark of 1.0 (*i.e.*, applying a CR value of 1.0 for an entire chemical mixture as opposed to a single chemical) at receptor locations. These chemical mixtures were those with eye irritation (acute exposure) and respiratory irritation (acute and chronic) endpoints.

Although 1-hour, 24-hour, and chronic CR estimates for these chemical mixtures exceeded the single-chemical regulatory benchmark of 1.0 (under worst-case conditions), no Provincial or Federal regulatory benchmarks are currently available by which one could evaluate whether exposure to a given chemical mixture could pose a health concern.

Acute inhalation risks (*i.e.*, 1-hour and 24-hour CR estimates) associated with the eye irritation mixture under Airport Alone Case conditions exceeded the single-chemical benchmark of 1.0. Acute risks for this endpoint were driven by the direct summation of acute risks from acrolein and formaldehyde, which represented the majority of the total acute CR estimates presented for the eye irritant mixture. Similarly, acute inhalation risks associated with the respiratory irritation mixture under Airport Alone Case conditions exceeded the single-chemical benchmark of 1.0. Acute risks for this endpoint were driven by the direct summation of acute risks from NO_2, SO_2, and formaldehyde, which represented the majority of total acute CR estimates presented for the respiratory irritant mixture. However, the maximum 1-hour and 24-hour background concentrations of NO_2 and SO_2 for all years were significantly higher than the contribution from the Airport Alone.

Chronic inhalation risks associated with the respiratory irritation mixture under Airport Alone Case conditions exceeded the single-chemical benchmark of 1.0. Chronic risks for this endpoint were driven by the direct summation of chronic risks from acrolein, which represented the majority the chronic CR estimate presented for the respiratory irritant mixture.

7.0 UNCERTAINTY ANALYSIS

In any detailed HHRA, the intention is to obtain the most accurate evaluation of risk based upon the available data and state of knowledge, without underestimating the potential health risks. With any such assessment, there are always a number of administrative and technical boundaries that limit the ability of the assessment to quantify risk with absolute certainty. The following section provides an overview of the key administrative and technical boundaries inherent within the current HHRA.

Quantitative HHRA involves assigning numerical values to input parameters in an appropriate exposure or risk model to obtain a quantitative estimate of risk. Numerical values are required for parameters describing chemical concentrations in environmental media, chemical fate and transport, human exposure and toxic response. These values may be measured, assumed, prescribed, or based on published literature. Variability and uncertainty in the input parameters or risk model result in variability and uncertainty in the estimate of risk. The US EPA (2005) suggests that the risk characterization process maintain transparency, clarity, consistency, and reasonableness. The goal of risk characterization is to clearly communicate the key findings of the assessment and to provide a clear and balanced assessment of the strengths and limitations of the process. Risk characterization involves both scientific and policy based decision making, thereby resulting in a decision making process that blends both elements.

When assumptions are made during the risk assessment process, either because of data gaps or knowledge gaps, each can result in some degree of uncertainty in the overall conclusions. In order to understand the uncertainties within the HHRA and to ensure that the implications of these uncertainties are understood and addressed, it is important to document and characterize them. To ensure that the risk assessment does not underestimate the potential for the occurrence of adverse effects, it is necessary to make assumptions that are conservative (protective). In other words, assumptions should be made that tend to overestimate exposure, toxicity, and risk, rather than underestimate these parameters.

The following sections describe uncertainty within the HHRA, and discuss the potential impacts of these limitations on the conclusions drawn from the assessment. Given the tendency for the assumptions described below to overestimate both exposure and toxicity, it is likely that the risk characterization errs on the side of caution and over predicts risk. A summary of the conservative assumptions that were incorporated into the HHRA can be found in Table 7-1, arranged according to the steps of the risk assessment paradigm. Examination of the table shows that conservatism was introduced at virtually every step of the assessment, and extended to the problem formulation, exposure assessment, and toxicity assessment of the HHRA.

Table 7-1 Major Assumptions Used in the HHRA		
Risk Assessment Paradigm	***Assumption***	***Discussion of Conservatism***
Problem Formulation	Selection of chemicals of concern is adequate to characterize potential Toronto Pearson emissions	Chemical selection and identification was dependant solely on the assumptions made within the FAA EDMS, which utilizes realistic emissions and traffic data from airports and associated facilities.
	Air quality assessment scenarios reflect realistic operating conditions of Toronto Pearson, particularly with respect to the future scenarios (*i.e.,* 2022 and 2032)	Careful consideration was given to the assessment scenarios evaluated in the HHRA, with reasonable worst-case operating conditions assumed for the air quality assessment and ultimately the HHRA.
	The Baseline Case and Cumulative Effects Case could only be conducted for some COCs due to an absence of information.	Regional background concentrations were only available for the COCs analyzed as part of the Environment Canada (2006) SMOKE database or Environment Canada NAPS program. No other sources of background ambient air quality data were available for use.
	Potential exposures were evaluated throughout the Study Domain.	Care was taken to select locations in the surrounding area that would likely demonstrate the highest potential impacts from Toronto Pearson. Residential receptor locations representing actual nearby geographical locations that currently have occupied by residential dwellings were evaluated in the HHRA.
Exposure Assessment	Maximum 1-hour and 24-hour air concentrations predicted at each of the receptor locations were used to evaluate acute inhalation risks.	In reality, the frequency with which the maximum would occur at any one receptor location varies with respect to the COC and the receptor location. Individual exposure to 1-hour and 24-hour maximum ground-level air concentrations requires that a receptor (person) is present at the same time and duration of the maximum predicted air concentration at that particular receptor location.
	Annual average air concentrations for carcinogenic PAHs, as benzo(a)pyrene-TEQ predicted at each of the receptor locations were estimated using predicted $PM_{2.5}$ concentrations.	EDMS, which was used to estimate chemical emission concentration information for the assessment, does not produce PAH concentrations. Instead, speciated PAH concentrations were estimated based on the total $PM_{2.5}$ concentrations predicted from EDMS. The speciated PAH information used was based on a study from an airport in Rome, Italy (Cavallo et *al.*, 2006). It was assumed that the PAH-emissions profile from Toronto Pearson was comparable. The speciated PAH emissions were then converted to benzo(a)pyrene toxicity equivalents (TEQ) using toxicity potency factors (TEFs) from regulatory agencies.
	Maximum predicted annual average ground-level air concentrations and chemical-specific deposition rates were used to predict various environmental media concentrations (*e.g.*, soil and garden vegetables) at each receptor location assuming that deposition had already occurred for 30 years.	As an added protective measure, the multi-media assessment assumed that maximum chemical-specific annual deposition rates would occur for 30 years prior to exposure, resulting in receptors being exposed to maximum predicted environmental media concentrations.

Table 7-1 Major Assumptions Used in the HHRA		
Risk Assessment Paradigm	***Assumption***	***Discussion of Conservatism***
	Ground-level air concentrations of COCs related to emissions from various scenarios were estimated based on mathematical air dispersion models.	The HHRA relied on the results of air dispersion modelling to evaluate the health risks from direct inhalation exposure as well as to predict inhalation health risks. The MOECC has discussed matters of confidence and uncertainty in the predictions of dispersion models with regard to ground level concentrations and deposition rates. This remains the best mechanism to forecast future distributions of emissions in built environments. The air dispersion models used to provide data for the current assessment are approved by the MOECC and the US EPA for use on these types of emission studies. Refer to Golder (2015) for further discussion of the uncertainty inherent in the use of these models.
	Residential receptors were assumed to be present at a given receptor grid location for 24 hours/day, 7 days/week, 52 weeks/year for an entire lifetime.	The inhalation and multi-media assessment assumed all receptors would never leave the assessed receptor location and, in the case of developing CR and ILCR estimates, live an entire lifetime at this location while being exposed to maximum predicted environmental media concentrations. In reality, it is not realistic to assume individuals would spend an entire lifetime at a given location without leaving.
	All receptor locations evaluated in the multi-media assessment were assumed to be residential.	For ease-of-modelling purposes, the residential receptor was selected for non-residential receptor locations. It is not anticipated that certain exposure pathways evaluated in the multi-media assessment such as ingestion of home-grown produce would be relevant to the MPOI or commercial receptor locations. This likely represents a source of overestimation of exposure.
	All COCs evaluated in the multi-media assessment were assumed to be 100% bioavailable via the oral route.	The magnitude of the toxicological impact of a chemical on a receptor is dependent on the fraction of the ingested quantity of the chemical that is absorbed and subsequently transported to target tissues or organs. Complete absorption of a chemical almost never occurs; some fraction is not absorbed, but is excreted from the body, and is thus not available to exert a toxic effect. For this assessment it was assumed that 100% of all COC concentrations in various environmental media (*e.g.*, soil, food) were 100% available *via* the oral route.
Toxicity Assessment	Toxicity reference values (TRVs) have been developed by regulatory agencies with sufficient conservatism to assure protection of the most sensitive and/or susceptible individuals within the general population (*e.g.*, infants and young children, the elderly, individuals with compromised health).	A considerable amount of conservatism is incorporated in the TRVs developed by regulatory agencies. TRVs are deliberately set by regulatory agencies with the protection of the most sensitive individuals in mind. Typically, the TRVs used in the current assessment were derived from the most sensitive health-related endpoints, and then adjusted to account for differences in sensitivity to chemicals among individuals. The use of uncertainty factors (of 10 to 1,000 fold) are directed, in part, toward the protection of sensitive individuals.

Table 7-1 Major Assumptions Used in the HHRA		
Risk Assessment Paradigm	***Assumption***	***Discussion of Conservatism***
	For genotoxic carcinogens, it was assumed that no repair of genetic lesions occurs, and therefore, no threshold can exist for chemicals that produce self-replicating lesions.	The existence of enzymes and biological pathways that routinely repair damage to genetic material (DNA) is well documented in the scientific literature. The potential adverse health outcomes arising from damage to DNA are usually observed only when the ability of these repair enzymes to "fix" the damage is blocked or exceeded.
	Humans were assumed to be the most sensitive species with respect to toxic effects of COC.	For obvious reasons, toxicity assays are not generally conducted on humans, so toxicological data from the most sensitive laboratory species were used in the estimation of toxicological criteria for humans, as appropriate. In some cases, however, human-specific data was available and was used in the Toxicity Assessment.
	Any potential health implications related to exposures to ultrafine particulate matter emitted from the airport were considered to be accounted for within assessment of the $PM_{2.5}$ size fraction.	Currently there are no established regulatory benchmarks or standardized approaches to evaluation of the health impact related to exposures to the ultrafine particulate matter fraction. As such, for the current assessment, the ultrafine fraction was considered as part of the evaluation of health impacts related to the $PM_{2.5}$ group. However, the uncertainties related to both exposures and health impacts from UFPs, particularly as it pertains to emissions from large-scale airports, is something that should flagged for further consideration in the future once additional scientific information on this particle size fraction becomes available.

8.0 OVERALL FINDINGS AND CONCLUSIONS

Toronto Pearson had previously completed air quality emissions estimation and dispersion modelling in 1990/1991 and 2003/2004, and an HHRA in 2003/2004. The GTAA undertook an update to its emissions inventory and dispersion modelling to better quantify and assess the current and projected future air quality associated with operations of the airport. The current HHRA provides health context and interpretation for the current and projected future air quality study information.

To ensure that potential incremental environmental effects from Toronto Pearson were adequately assessed, exposure and risk estimates were developed for several different assessment scenarios. Three cases were evaluated in the HHRA: Baseline, Airport Alone, and Cumulative Effects. For each of these cases, separate time periods were considered as part of the assessment, including current conditions (Year 2011) and two likely future conditions (Year 2022 and Year 2032). The Airport Alone case forms the basis of the current HHRA.

Both an inhalation assessment, which evaluated air exposures to chemicals, and a multi-media assessment, which evaluated exposures arising from the oral and dermal pathways, were completed.

The results of the acute inhalation assessment indicate that a limited number of short-term exceedances of the acceptable risk levels were predicted for SO_2, acrolein, and formaldehyde for at least one receptor location. An exceedance of the acceptable risk levels does not necessarily indicate that an adverse health will occur but that additional investigation is required. As a result, frequency analyses were conducted to determine how often the exposure limits were exceeded. Based on these analyses, the predicted exceedances for these chemicals were highly intermittent in nature, and therefore were not considered to represent a significant health risk to the general population. Furthermore, the regulatory benchmarks used in the current assessment incorporate considerable safety factors to provide an additional degree of protection for sensitive individuals.

The results of the chronic inhalation assessment indicate that the annual average acceptable of acrolein, benzene, and formaldehyde exceeded the acceptable risk levels for at least one receptor location. An exceedance of the acceptable risk levels does not necessarily indicate that an adverse health will occur but that additional investigation is required. As a result, further investigations were conducted to determine why the exposure limits were exceeded.

As with the acute risks related to acrolein exposures, the chronic endpoint of concern for acrolein is specifically nasal irritation potentially leading to nasal lesions due to continuous long-term exposures to this irritant. Due to the absence of chronic human exposure data, laboratory animal data were used to derive the exposure limit used within the assessment. Significant uncertainty factors that account for a great deal of conservatism in HHRA were applied to the animal test data for a relatively minor effect, such that the exposure limit derived is approximately 17,000 times lower than the test concentrations used in the laboratory study.

The estimated exposures for benzene and formaldehyde for years 2022 and 2032 resulted in ILCRs slightly greater than the MOECC acceptable regulatory-established cancer risk benchmark of 1-in-1,000,000. This suggests that the potential for an elevated level of risk above MOECC's acceptable ILCR may be present, the significance of which must be balanced against the high degree of conservatism incorporated in the risk assessment. For example, should the resident individual spend only half of their entire lifetime at the receptor location, the predicted ILCR for would be less than one-in-one million, or considered acceptable.

Further to this, the acceptable level of risk is an issue of policy rather than a scientific decision (CCME, 2006), and is set by regulatory agencies as opposed to risk assessors. Regulatory agencies have typically employed acceptable ILCR levels between 1-in-100,000 and 1-in-1,000,000. While the MOECC considers an ILCR of 1-in-1,000,000 to be acceptable for HHRAs in the Province of Ontario, Health Canada (2012) has specified that an ILCR of 1-in-100,000 is acceptable and is considered "essentially negligible". The highest ILCR predicted across all scenarios is less than this value specified by Health Canada (2012).

For the multi-media assessment, none of the multi-media exposures (*i.e.*, soil, dust, home garden grown produce, and breast milk ingestion by infants) showed predicted risk levels that exceeded the relevant regulatory benchmarks. Therefore, it is not anticipated that the deposition of chemicals from operations at Toronto Pearson would contribute to the development of adverse health effects in residents within the Study Domain.

In conclusion, the results of the HHRA indicate that the predicted air emissions could potentially result in unacceptable health risks to the surrounding community. However, the predicted exceedances for these chemicals were either based on highly intermittent events or on highly conservative exposure assumptions that are not likely representative of the general population. Therefore, it is not anticipated that the emissions from Toronto Pearson represent a significant health risk to the general population.

9.0 DOCUMENT SIGN-OFF

The risk assessment has been performed in accordance with accepted practice and usual standards of thoroughness and competence for the profession of toxicology and environmental risk assessment. The information, opinions and recommendations provided within the aforementioned report have been developed using reasonable and responsible practices, and the report was completed to the best of our knowledge and ability.

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