

Chapter 12

Air Quality

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12. Air Quality

12.1 Introduction

This chapter forms part of a Comprehensive Study (CS) for the Parallel Runway Project (PRP) at the Calgary International Airport (YYC). The CS is being prepared as part of an EA process initiated by the Calgary Airport Authority (the Authority). The process shadows the EA process under the Canadian Environmental Assessment Act (CEAA). This chapter examines the potential residual and cumulative effects that the construction and operational phases of the PRP are likely to have on air quality within the study area. The PRP consists of a 14,000 ft. (4,267 m) runway and associated infrastructure. The project components are described in further details in Volume II, Chapter 7 of the CS.

Air quality has been selected as a valued component (VC) because of its intrinsic importance to the health and well-being of humans, wildlife and vegetation. Air can be a key pathway for the transport of contaminants to the freshwater, terrestrial, and human environments. Several epidemiological studies published over the last few decades have demonstrated the link between poor air quality and negative human health outcomes, including premature deaths.

This effects assessment was completed following the general methods outlined in Chapter 1 of this Volume. In summary, the assessment was scoped, identifying the following: scenarios that may occur; issues and VCs that may be affected by the PRP; and temporal and spatial boundaries that will constrain the scope of the assessment. Baseline information used for this assessment is taken from Volume V, Item 10, Air Quality Baseline Report. It includes measurements of relevant air pollutant concentrations that currently occur within the study area.

The effects assessment includes a review of the potential effects on air quality and examines potential environmental effects that might result from the PRP. The overall significance of the effect of the PRP on air quality, taking into consideration the context of the study area, is discussed.

The general organization of the assessment for the potential effects of the PRP on air quality is as follows:

- scoping;
- approach and methodology;
- assessment of the existing air quality;
- analysis of effects on existing and baseline air quality levels; and
- summary of residual effects.

12.2 Scoping the Assessment

Scoping the assessment involves the identification of key issues of concern (VCs), thereby ensuring that the assessment remains focused and the analysis remains manageable and practical. The assessment framework used for the PRP followed four tasks that must be completed in scoping: issue identification, selection of VCs, setting of boundaries, and initial identification of potential effects.

An issues based approach was used to focus the baseline data collection program and effects assessment. All issues raised by the public, stakeholders, and government agencies were recorded and are tabulated in Volume IV, Chapter 1.

Issues identified during the process that were considered to be pertinent to defining air quality effects that could result from the PRP are presented in Section 11.11 of this chapter. Analysis of, and responses to, those issues are dealt with in this chapter.

12.2.1 Applicable Regulations and Guidelines

The following outlines the regulations and guidelines required from all levels of government to ensure the project meets the regulatory requirements for air emissions in Alberta. Ambient air quality standards and guidelines for a range of pollutants have been proposed by Alberta Environment (AENV), Environment Canada (EC), and the Canadian Council of Ministers of the Environment (CCME).

Table 12-1 International and Federation Regulations and Guidelines

Permit / Authorization	Agency	Rationale
Air Quality Procedures for Civilian Airports and Air Force Bases, FAA-AEE-97-03.	Federal Aviation Administration	This guideline is a U.S. resource that ensures the use of the dispersion modelling is consistent for aviation air quality assessments.
<i>Clean Air Act</i>	Environment Canada	This regulation is a federal regulation to help protect human health and the environment by taking an integrated approach to reducing air pollutant emissions.
National Air Quality Objectives	Environment Canada	Federal/provincial/regional governments use these objectives as guides in making decisions. These objectives are a national goal for outdoor air quality to protect public health, the environment, or aesthetic properties of the environment.
Canada Wide Standards	Canadian Council of Ministers of the Environment	Canada Wide Standards are considered environmental quality objectives under the Canadian Environmental Protection Act 1999.

Table 12-2 Provincial Regulations and Guidelines

Permit / Authorization / Guideline	Agency	Rationale
Alberta Ambient Air Quality Objectives and Guidelines (June 2009)	Alberta Environment	AENV uses the air quality objectives to: <ul style="list-style-type: none"> • assess compliance and evaluate facility performance; and • determine adequacy of facility design. In Alberta, the guidelines are used for: <ul style="list-style-type: none"> • airshed planning and management; • performance indicators; and • assessing local concerns.
Air Quality Model Guideline (2009)	Alberta Environment	This guideline is a resource that will help ensure that the use of the dispersion modelling is consistent with regulatory applications in Alberta.

12.2.2 Air Monitoring Criteria

The evaluation of ambient air monitoring results typically relies on regulatory standards or objectives with respect to atmospheric concentrations. Although the Alberta government has the primary responsibility for various aspects of air pollution control, federal actions are also commonly integrated into air quality assessments. The Federal government's objectives for air quality are taken into account by federal agencies in project reviews.

AENV has developed the Alberta Ambient Air Quality Objectives (AAAQOs) to protect Alberta's air quality under Section 14(1) of the *Environmental Protection and Enhancement Act* (EPEA). The AAAQOs are set below levels at which adverse health and/or environmental effects are not expected. For the purpose of the air quality assessment, it is appropriate to use the AAAQOs 1-hour and 24-hour average ambient air quality criteria.

The *Canadian Environmental Protection Act* (CEPA) 1999 allows for the federal regulation and control of air emissions and concentrations. Two federal tools are used to help control air quality pollutants:

- National Ambient Air Quality Objectives (NAAQOs); and
- Canada Wide Standards (CWS).

The NAAQOs are primarily effects-based, but are also reflective of technological, economic and societal information. These objectives are national goals for outdoor air quality for the protection of public health, the environment and aesthetic properties of the environment.

The NAAQOs from the federal government are based on a three-tier structure and are defined as follows:

- The Maximum Desirable Level (MDL) is the long term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of pollution control technology.
- The Maximum Acceptable Level (MAL) is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being.
- The Maximum Tolerable Level (MTL) denotes time-based concentrations of air contaminants beyond which, because of a diminishing margin of safety, appropriate action is required to protect the health of the general population.

Under CEPA, CWS are considered environmental quality objectives. Alberta has endorsed the CWS for PM.

Through the remainder of this report, limits or objectives for air quality will be termed air criteria. The applicable federal and provincial criteria that will be used for this air monitoring program are summarized in Table 12-3.

Table 12-3 Federal and Provincial Ambient Air Quality Criteria

Pollutant	Averaging Time Period	Alberta ^a	Canada			
		Ambient Air Quality Criteria	Canada Wide Standards ^b	Ambient Air Quality Objectives ^c		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
CO ($\mu\text{g}/\text{m}^3$)	1-hour	15,000	-	14,900	35,500	-
	8-hour	6,000	-	5,700	14,888	19,468
NO ₂ ($\mu\text{g}/\text{m}^3$)	1-hour	400	-	-	400	1000
	24-hour	200	-	-	200	300
	Annual	60	-	60	100	-
PM ₁₀ ($\mu\text{g}/\text{m}^3$)	24-hour	50 ^d	-	-	-	-
PM _{2.5} ($\mu\text{g}/\text{m}^3$)	24-hour	30	30	-	-	-
Benzene ($\mu\text{g}/\text{m}^3$)	1-hour	30	-	-	-	-
Naphthalene ($\mu\text{g}/\text{m}^3$)	24-hour	22.5 ^e	-	-	-	-

^a Alberta Environment (June 2009), *Air Quality Objectives and Standards*.

^b CCME (2000), *Canadian Wide Standards*.

^c Government of Canada (2004), *National Ambient Air Quality Objectives*.

^d There is no PM₁₀ guideline for Alberta, the guideline from British Columbia is used for reference (*Air Quality Objectives and Standards, British Columbia, Ministry of Environment, 1995*).

^e *Ambient Air Quality Criteria developed by the Ontario Ministry of the Environment (MOE 2008)*.

12.2.3 Scenarios

The modelling and the emissions inventory were completed for the following four scenarios:

- the 2015 Do-Nothing scenario (DN), which describes YYC and the local road network without the parallel runway in place in 2015, the proposed first operational year for the PRP;
- the 2015 Do-Something scenario (DS), describes YYC and the local road network with the parallel runway in place in 2015;
- the 2025 Do-Nothing scenario (DN), which describes YYC and the local road network without the parallel runway in place in 2025; and
- the 2025 Do-Something scenario (DS), describes YYC and the local road network with the parallel runway in place in 2025

The DN scenarios were compared as future baseline scenarios to the DS scenarios to appropriately gauge and assess the potential effects of the project on air quality.

12.2.4 Spatial and Temporal Boundaries

12.2.4.1 Spatial Boundaries

The Local Study Area (LSA) for the assessment is the zone of influence of the project air emissions, including the sensitive receptors nearest to the PRP site. As such, the LSA is a 16 kilometres (km) by 17 km domain surrounding the PRP, which includes the commercial properties and nearest residential communities surrounding the PRP.

12.2.4.2 Temporal Boundaries

Temporal boundaries for the effects assessment of air quality have been developed in consideration of those time periods during which project emissions have the potential to affect air quality concentrations in the atmospheric environment. These include periods of construction and operation.

The construction phase for the project is expected to have a duration of approximately three years, starting in 2011. During this time period, emissions from the construction activities are expected to occur up to 16 hours a day, five to seven days per week, for up to nine months a year during the typical construction season.

It is expected that the majority of the air quality emissions will occur during the operational phase. Air quality emissions will occur during the required operations for the approaches and departures of aircraft. As such, emissions will occur 24 hours a day, seven days a week for 365 days a year. Air quality was assessed for the period of one year based on the 90th busy day operational scenario. The years assessed were 2015 and 2025 using project forecasts for expected increases in aircraft operations.

For criteria air pollutants (CACs) and hazardous air pollutants (HAPs), the temporal boundary also includes a variety of time averaging intervals. The potential effects on air quality are presented for various averaging time periods in accordance with the time periods outlined for the identified air quality criteria. Other temporal boundaries include variations in meteorological conditions, which alter conditions for contaminant transport.

It should be noted that the air quality assessment for the existing conditions included a temporal boundary of six months for site specific air monitoring for August 2009 through to February 2010.

12.3 Issues Identified

Air quality is identified as a VC for the assessment. In order to assess those potentially significant issues/effects associated with the PRP, the potential effects on air quality associated with project-related alterations are assessed relative to baseline conditions.

The proposed runway has the potential to affect air quality during both its construction and operational phases. The main effects during the construction phase will be related to the airborne particulate matter (PM) and diesel emissions generated by construction activities. Following construction of the runway, the main effects on air quality will result from the change in emissions of local air quality pollutants, in particular nitrogen dioxide (NO₂) and particulate matter caused by changes in airport activities and road traffic flows on routes to and from YYC.

The issues raised during the public meetings related to air quality resulting from the PRP are addressed in Section 12.7.

12.4 Key Indicators and Measurable Parameters

Table 12-4 summarizes the potential issue/effect, the relevant key indicator and the measurable parameter.

Table 12-4 Key Indicators and Measurable Parameters

Issue/Effect	Key Indicator	Measurable Parameter
Dust from project activities may cause nuisance by deposition on cars, windows and property.	Criteria Air Contaminants (CACs)	PM
Alterations in air quality associated with: Construction phase: Road traffic emissions Construction equipment diesel emissions Particulate emissions from staging and storage areas Construction activities air emissions Operational phase: Aircraft operations Mobile ground sources Stationary ground sources Change in local traffic patterns	CACs Hazardous Air Pollutants (HAPs)	Benzene Carbon Monoxide (CO) Fine PM (PM ₁₀ , PM _{2.5}) Naphthalene Nitrogen Dioxide (NO ₂)

12.4.1 Criteria Air Contaminants

CACs include air quality parameters such as CO, PM and NO₂. The concern with the emissions of CACs is generally focused on impacts to other elements of the environment, property and humans.

CO is a colourless, odourless gas resulting from the incomplete combustion of hydrocarbon fuels. For this project, CO emissions may result from the use of mobile equipment, increased air traffic and stationary combustion sources such as diesel generators.

The oxides of nitrogen (NO_x) comprise nitric oxide (NO) and NO₂. The majority of NO_x emitted from vehicles is in the form of NO, which is oxidized in air to produce NO₂. The conversion of NO to NO₂ takes place via reactions with chemically active species, such as ozone (O₃). NO₂ is emitted as a primary pollutant by aircraft, although the majority of total aircraft NO_x emissions are as NO. NO_x is emitted from all combustion sources, including aircraft, auxiliary power units (APUs) and ground support equipment (GSE) airside at airports, and from heating plant and road traffic groundside and in areas surrounding airports. As there are regional and national air quality objectives for NO₂ and because both airport operations and road traffic are significant sources of NO_x emissions, the effect of the proposed runway on ambient NO₂ concentrations will be considered in detail within this study.

PM is characterized according to size. PM is the general term used for a mixture of solid particles and liquid droplets in the air. It includes aerosols, smoke, fumes, dust, ash, and pollen. During the construction phase, PM may be emitted through road travel and earth moving activities. The construction contractor will apply typical dust control measures as appropriate during the construction phase. During the operational phase, the project activities may result in emissions of fine PM from combustion sources such as aircraft engines, APUs, GSE airside at airports, from heating plant and road traffic landside, and in areas surrounding the airport. In addition, brake and tire wear from aircraft during takeoff and landing has the potential to result in emissions of PM.

Fine PM is composed of a wide range of materials arising from a variety of sources, and is typically assessed as a mass size fraction. PM₁₀ expresses particulate concentrations as the total mass size fraction at or below an aerodynamic diameter of 10 microns (µm). PM_{2.5} is defined as PM with a diameter of less than 2.5 µm. As there are provincial and federal air quality objectives for PM₁₀ and PM_{2.5} in order to minimize potential nuisance and health effects and because both airport operations and road traffic are significant sources of particulate emissions, the ambient PM₁₀ and PM_{2.5} concentrations have been assessed for this assessment.

12.4.2 Hazardous Air Pollutants

HAPs are substances released into the air by industries, vehicle emissions, agricultural activities, and other sources that are considered to be possible threats to human health under certain exposure conditions. Some of these activities include burning waste, landfill fires, burning wood or coal for home heating, motor vehicles, smoking, and spray painting using solvent base paints. Many organic HAPs are present as vapours, such as volatile organic compounds (VOCs).

VOCs include a large group of chemicals containing carbon and hydrogen atoms that can react quickly to form other chemicals in the atmosphere. VOCs can react with NO_x in the presence of sunlight to form O₃ and photochemical smog, and can also be toxic to humans, animals, and vegetation. Sources of VOC emissions will include emissions from airplane traffic, vehicle traffic, construction equipment, and dredging activities. Road traffic is likely to be an important source of VOCs in proximity to YYC with emissions arising directly from airport activities being a smaller contributor.

A human health relative risk screening analysis was completed to identify the most sensitive speciated VOC that was to be assessed for the project. The screening analysis took into consideration the Reference Concentration (RfC) for chronic inhalation exposure and established ambient air quality criteria for all speciated VOCs. The relative risk quotient was calculated by dividing the VOC concentration by the RfC. The RfC values were obtained from the U.S. Environmental Protection Agency's Integrated Risk Information System website. The same assessment was undertaken for the ambient air quality criteria. The speciated VOC compound that was identified as having the highest relative risk was benzene. As such, the assessment of the project effects on VOCs was completed through a detailed analysis for benzene. In addition, naphthalene was added to the assessment of HAPs due to the established Alberta air criteria limits for naphthalene and the expected project emissions of naphthalene.

12.5 Existing Conditions

This section presents the existing air quality conditions in the vicinity of YYC. Figure 12-1 illustrates the location of the air monitoring stations that were used to assess the existing conditions, while Table 12-5 presents the monitoring site locations. The rationale for the location of the air monitoring stations is provided in the *Parallel Runway Project Volume V – Item 10 Air Quality Baseline Report*.

Table 12-5 Locations of the Air Quality Monitoring Stations for the PRP

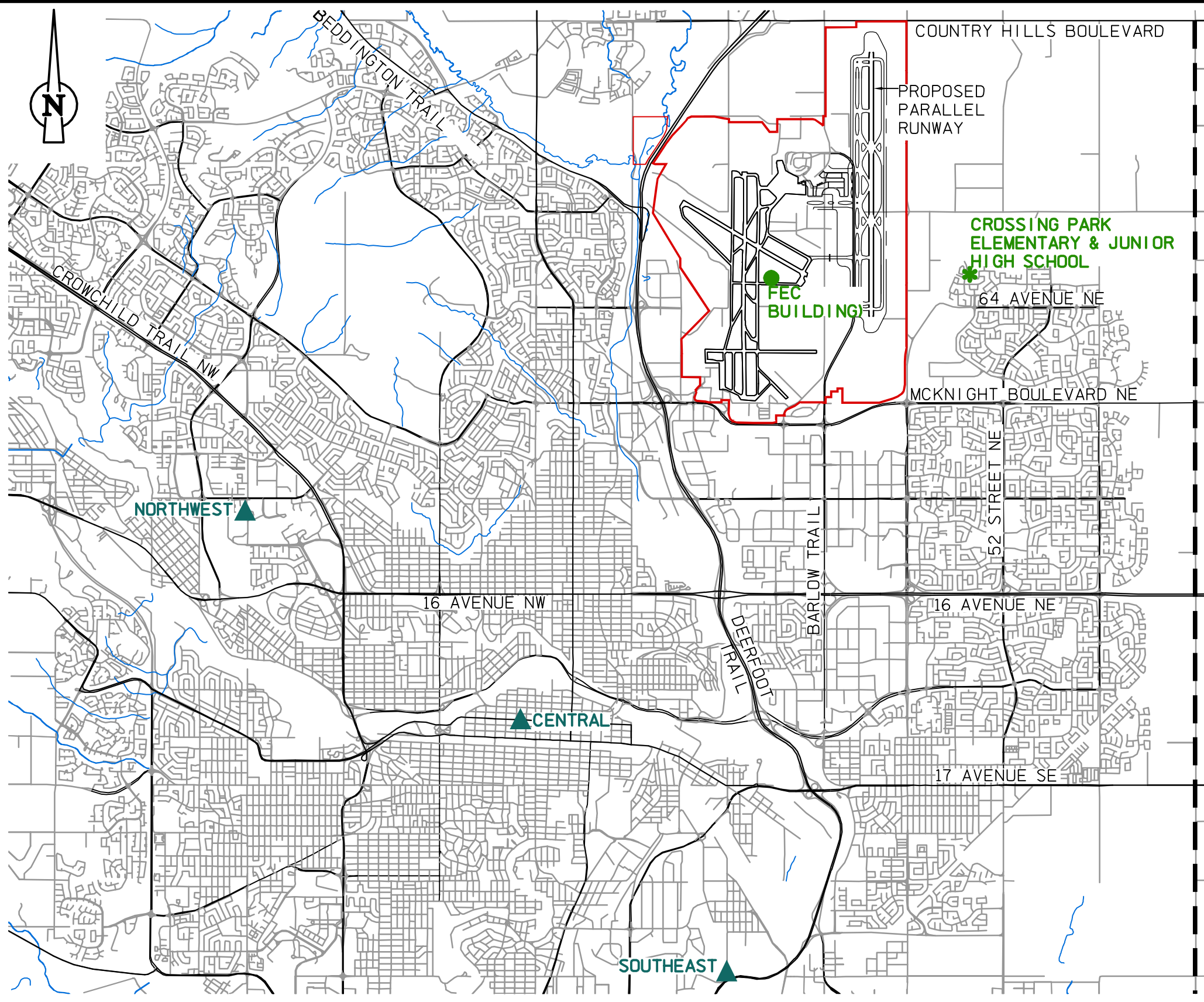
Monitoring Station	Easting ^(a)	Northing ^(a)	Zone	Elevation (m)
Calgary Northwest (CRAZ)	700198	5662521	11	1,116
Calgary Central (CRAZ)	705006	5659190	11	1,049
Calgary Southeast (CRAZ)	708671	5655067	11	1,030
On-Site	708957	5666853	11	1,080
Off-Site	292353	5666986	12	1,093

(a) Universal Transverse Mercator (UTM): NAD83.

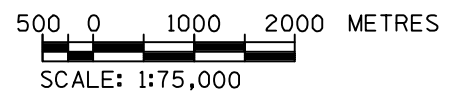
The parameters assessed for the existing ambient air quality included CO, O₃, NO₂, PM_{2.5}, PM₁₀, and VOCs.

The existing baseline technical data relating to air quality are presented in this section to serve as a current reference of existing environmental conditions within the LSA for the PRP. The ambient air quality data measured around the LSA are considered to be within a typical range of emissions for an urban neighbourhood. Monitoring data for CO, NO₂ and VOCs were below Alberta air criteria. However, CO, NO₂, O₃, PM_{2.5}, and PM₁₀ occasionally exceeded the air criteria. Despite these exceedences, the 90th percentile for all data was below the air criteria.

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- LEGEND**
- AIRPORT PROPERTY BOUNDARY
 - CALGARY CITY BOUNDARY
 - ▲ CRAZ AIR MONITORING STATION
 - ONSITE PROJECT SPECIFIC MONITORING STATION
 - ✱ OFFSITE PROJECT SPECIFIC MONITORING STATION



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AECOM

The Calgary Airport Authority
 Runway Development Program
 Parallel Runway Project
Location of Air Monitoring Stations **Figure 12-1**

There are several industrial sources of emissions in the LSA. The impact of these emissions on existing air quality has been captured through the ambient air monitoring programs. In addition to the ambient air monitoring, the National Pollutant Release Inventory (NPRI) provides supplementary information for the assessment of the existing conditions. The NPRI emissions inventory for CAC emissions for all sources in Alberta indicates that PM emissions are largely due to open sources. Open sources include agriculture, construction activities, landfill sites, mine tailings, paved and unpaved roads, forest fires, and prescribed burning. SO₂, NO₂, and VOC emissions are mainly due to industrial sources in Alberta, while CO emissions are largely due to transportation sources.

The air quality analysis presented in this report demonstrates that the existing concentrations for the parameters of concern are generally low in magnitude for the LSA.

The following tables summarize the monitoring data for CO, O₃, NO₂, PM_{2.5}, PM₁₀, and VOCs.

Table 12-6 Ambient Air Quality Monitoring Data for CO

Station	Averaging Period	Air Criteria ¹ (µg/m ³)	Average (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	80 th Percentile (µg/m ³)	90 th Percentile (µg/m ³)	Frequency of Exceedence
Calgary Central (CRAZ)	1-hour	15,000	526.8	9,847.9	0.0	615.5	861.7	0.0
	8-hour	6,000	527.1	5,785.7	93.9	646.3	815.5	0.0
Calgary Southeast (CRAZ)	1-hour	15,000	547.2	8,863.1	0.0	714.0	984.8	0.0
	8-hour	6,000	547.2	6,478.1	92.3	692.4	923.2	0.1%
Calgary Northwest (CRAZ)	1-hour	15,000	372.0	4,800.9	0.0	492.4	615.5	0.0
	8-hour	6,000	372.1	3,216.0	123.1	446.2	553.9	0.0
On-Site	1-hour	15,000	377.6	2,437.5	0.0	534.0	772.4	0.0
	8-hour	6,000	376.4	1,724.0	0.0	523.6	713.3	0.0
Off-Site	1-hour	15,000	225.5	3,357.7	0.0	386.9	659.1	0.0
	8-hour	6,000	223.1	1,828.2	0.0	390.3	607.9	0.0

¹ Alberta Ambient Air Quality Objectives and Guidelines (Alberta Environment June 2009).

Table 12-7 Ambient Air Quality Monitoring Data for O₃

Station	Averaging Period	Air Criteria ¹ (µg/m ³)	Average (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	80 th Percentile (µg/m ³)	90 th Percentile (µg/m ³)	Frequency of Exceedence
Calgary Central (CRAZ)	1-hour	160	34.9	160.3	0.0	58.0	71.7	0.002%
	8-hour	128	34.9	120.2	0.0	54.3	65.9	0
Calgary Southeast (CRAZ)	1-hour	160	37.3	151.9	0.0	65.4	80.2	0
	8-hour	128 ²	37.4	131.8	0.0	60.1	72.8	0.01%
Calgary Northwest (CRAZ)	1-hour	160	49.3	154.0	0.0	75.9	88.6	0
	8-hour	128 ²	49.3	148.7	0.0	72.2	84.1	0.03%
On-Site	1-hour	160	27.4	117.0	0.0	46.8	57.5	0
	8-hour	128 ²	27.4	103.5	0.0	42.6	53.5	0
Off-Site	1-hour	160	34.7	140.4	0.0	55.3	66.0	0
	8-hour	128 ²	32.7	130.6	0.0	50.8	60.9	0.04%

¹ Alberta Ambient Air Quality Objectives and Guidelines (Alberta Environment June 2009).

Table 12-8 Ambient Air Quality Monitoring Data for NO₂

Station	Averaging Period	Air Criteria ¹ (µg/m ³)	Average (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	80 th Percentile (µg/m ³)	90 th Percentile (µg/m ³)	Frequency of Exceedence
Calgary Central (CRAZ)	1-hour	400	47.1	196.1	4.0	66.7	79.9	0
	24-hour	200	47.1	123.6	13.6	61.5	71.0	0
	Annual	60	47.0	49.5	42.1	48.8	49.1	0
Calgary Southeast (CRAZ)	1-hour	400	43.6	400.4	2.0	66.7	80.9	0.002%
	24-hour	200	43.6	183.2	6.2	57.9	68.8	0
	Annual	60	43.6	45.6	42.0	44.8	45.2	0
Calgary Northwest (CRAZ)	1-hour	400	28.2	153.7	0.0	44.5	60.7	0
	24-hour	200	28.2	88.4	4.8	39.7	49.2	0
	Annual	60	28.1	30.2	26.0	29.2	29.7	0
On-Site	1-hour	400	35.5	167.3	0.0	63.2	81.6	0
	24-hour	200	36.9	118.0	6.0	56.0	71.2	0
	Annual	60	-	-	-	-	-	-
Off-Site	1-hour	400	34.4	165.2	0.0	69.4	85.7	0
	24-hour	200	36.4	105.1	0.3	57.4	74.9	0
	Annual	60	-	-	-	-	-	-

¹ Alberta Ambient Air Quality Objectives and Guidelines (Alberta Environment June 2009).

Table 12-9 Ambient Air Quality Monitoring Data for PM

Parameter	Station	Averaging Period	Air Criteria ¹ (µg/m ³)	Average (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	80 th Percentile (µg/m ³)	90 th Percentile (µg/m ³)	Frequency of Exceedence
PM _{2.5}	Calgary Central (CRAZ)	1-hour	-	6.3	91.8	0.0	9.6	13.7	-
		24-hour	30	7.4	33.5	0.0	10.6	15.4	0.2%
	Calgary Southeast (CRAZ)	1-hour	-	7.4	136.4	0.0	11.3	15.4	-
		24-hour	30	7.4	42.2	0.6	10.1	12.6	0.05%
	Calgary Northwest (CRAZ)	1-hour	-	4.5	63.8	0.0	7.1	9.9	-
		24-hour	30	4.5	28.4	0.0	6.5	8.3	0
	On-Site	1-hour	-	6.5	65.0	0.0	11.0	16.0	-
		24-hour	30	6.4	31.4	0.0	10.4	12.9	0.5%
	Off-Site	1-hour	-	6.8	71.0	0.0	11.0	17.0	-
		24-hour	30	6.7	30.0	0.0	10.7	14.4	0.5%
PM ₁₀	Calgary Central (CRAZ)	24-hour	50 ²	25.1	125.9	1.1	35.5	43.5	6%
	On-Site	24-hour	50 ²	22.4	83.0	3.0	34.0	44.5	7%
	Off-Site	24-hour	50 ²	24.0	106.3	1.9	39.6	53.3	12%

¹ Alberta Ambient Air Quality Objectives and Guidelines (Alberta Environment June 2009).

² There is no PM₁₀ guideline for Alberta, the guideline from British Columbia is used for reference (Air Quality Objectives and Standards, British Columbia, Ministry of Environment 1995).

Table 12-10 Ambient Air Quality Monitoring Data for VOCs

Parameter	Station	Averaging Period	Air Criteria ¹ (µg/m ³)	Average (µg/m ³)	Maximum (µg/m ³)	Minimum (µg/m ³)	80 th Percentile (µg/m ³)	90 th Percentile (µg/m ³)	Frequency of Exceedence
Benzene	Calgary Central (CRAZ)	1-hour	30	2.4	8.6	0.5	3.1	4.0	0
		24-hour	-	1.0	3.6	0.2	1.3	1.6	-
	On-Site	1-hour	30	2.9	10.3	0.5	3.8	4.4	0
		24-hour	-	1.2	4.2	0.2	1.5	1.8	-
	Off-Site	1-hour	30	2.6	10.6	0.5	3.8	4.2	0
		24-hour	-	1.1	4.4	0.2	1.6	1.7	-
Naphthalene	Calgary Central (CRAZ)	1-hour	-	0.4	2.1	0.0	0.6	0.8	-
		24-hour	22.5	0.2	0.9	0.0	0.3	0.3	0
	On-Site	1-hour	-	6.0	21.8	0.0	10.0	14.9	0
		24-hour	22.5	0.9	9.0	0.0	0.6	3.2	-
	Off-Site	1-hour	-	1.9	6.4	0.0	3.6	4.5	0
		24-hour	22.5	0.3	2.6	0.0	0.0	1.3	-

¹ Alberta Ambient Air Quality Objectives and Guidelines (Alberta Environment June 2009).

12.6 Effects Assessment

12.6.1 Effects Assessment Methodology

For the purposes of assessing the effects of the PRP on air quality, potential effects were characterized in relation to the following criteria:

- Direction;
- Magnitude;
- Geographic Extent;
- Frequency;
- Duration; and
- Reversibility.

The threshold for the determination of significant adverse effects on air quality is defined as follows:

- there are frequent or sustained exceedences of air quality criteria;
- the duration of the adverse effect is long term and high in magnitude; and
- the effect on air quality will persist after the project is complete.

It should be noted that these are not regulatory criteria, but are criteria that are used to provide a methodology to rank the potential effects of the PRP. Table 12-11 provides the definition and criteria rating for each characterization criterion.

Table 12-11 Environmental Effects Rating Criteria

Effect Criteria	Criteria Rating	Definition
Direction	Beneficial	The effect reduces the air contaminant loading as a result of project actions.
	Negligible	No change.
	Adverse	The effect worsens the existing air quality conditions and trends.
Magnitude	Low	Effect is detectable but is within normal variability of baseline conditions.
	Moderate	Effect is detectable and is above existing conditions.
	High	Effect occurs singly or as a substantial contribution with other sources and causes a change from baseline conditions of 10% or more.
Geographic Extent	Site-Specific	The effect is restricted to the property boundary of YYC.
	Local	The effect is spatially restricted within the City of Calgary.
	Regional	The effect extends beyond the LSA.
Frequency	Sporadic	Effect occurs intermittently and irregularly.
	Regular	Effect occurs regularly and at regular intervals.
	Continuous	Effect occurs continuously.
Duration	Short Term	Effect occurs for less than one month.
	Medium Term	Effect occurs for one month but less than ten years.
	Long Term	Effect occurs for longer than 10 years.
Reversibility	Reversible	The effect on the VC will cease after the project is complete.
	Irreversible	The effect on the VC will continue after the project is complete.

For any environmental effect assessment, it is essential to accurately determine a baseline against which predicted effects can be gauged and assessed. Additionally, detailed data for the existing environment is also particularly desirable for air quality effects assessments involving modelling, as it enables modelled concentrations for the baseline situation to be correlated with monitored concentrations.

The potential affect of the project activities on receptors outside of the property boundary was assessed. The following assessments were completed:

- existing regional air quality within the LSA;
- potential affect on air quality due to construction activities associated with the PRP;
- expected air quality emissions resulting from future operations that can be directly attributed to the PRP and the potential impact to surrounding communities; and
- identification of mitigation measures that might be introduced to reduce or eliminate air quality emissions resulting from construction and future use of the parallel runway.

The construction phase effects were qualitatively assessed and typical mitigation measures for the construction phase were discussed. The operational phase of the project was quantitatively assessed using emission inventory calculations along with appropriate air dispersion models. The dispersion model for the operational phase considered all significant sources of emissions to air.

Outputs from the dispersion models were in the form of pollutant concentration plots. For the operational phase, the concentration plots and the maximum concentration results were used to assess air quality in terms of the DS and DN scenarios at the most impacted receptor. The significance of the residual effect on air quality, in consideration of the proposed mitigation measures, was determined.

Details on the emission sources included within the model and the dispersion modelling methods are discussed further below.

12.6.1.1 Identification of Sources and Contaminants

The Federal Aviation Administration (FAA) and the United States Air Force (USAF) along with other agencies have developed the handbook for Air Quality Procedures for Civilian Airports and Air Force Bases (FAA 1997). The handbook is intended to guide air quality professionals on the requirements for air quality assessments for airports and air bases. The air quality assessment for the PRP is conducted in accordance with the handbook for Air Quality Procedures for Civilian Airports and Air Force Bases.

This assessment has used emission inventories and dispersion models as the primary tool to assess potential air quality impacts. As such, the general steps for this air quality assessment included identification of sources and contaminants, development of emission rates for each identified source, and development of dispersion modelling files. The Emissions and Dispersion Modelling System (EDMS) was used to assess the emissions inventory from YYC activities. In 1998, FAA revised its policy on air quality modelling procedures and identified EDMS as the required model for air quality analyses for aviation. As such, the assessment of emissions was completed through the use of EDMS as this method meets acceptable jurisdictional requirements for aviation air quality assessments. EDMS in conjunction with computer dispersion modelling programs were used to complete the air quality assessment. This section further outlines the sources considered for the air quality assessment.

The effects of air quality were assessed for the following sources:

- landing and takeoff (LTO) operations;
- airside movements, which include aircraft use of auxiliary generators, mobile generators, aircraft manoeuvring, air start compressors, ground vehicles, and equipment;
- stationary power generation plants;
- road vehicles for both visitors' and employees' trips; and
- aircraft de-icing and anti-icing fluid use.

As previously discussed, the measureable parameters included in the emissions inventory and dispersion modelling are benzene, CO, PM_{2.5}, PM₁₀, naphthalene, and NO₂. O₃ from existing conditions at the off-site station was used as background concentrations for O₃ in order to convert NO_x emissions to NO₂ emissions for the air quality assessment. The following sections provide further details for each atmospheric emission source considered in this assessment.

Aircraft

Aircraft are classified into small aircraft such as the Bombardier Learjet 35, large aircraft such as the Boeing 737 or the Airbus A320 and heavy aircraft such as the Boeing B747 or the Airbus A330. The default engines, in the International Civil Aviation Organization (ICAO) databank, for each aircraft were employed for the assessment. These engines represent the most common or the most widely used engine types for each aircraft type. Over 41 different aircraft were identified for the study. Aircraft with similar engine types and emissions were grouped together for the dispersion modelling assessment. Table 12-12 outlines the aircraft and the aircraft groups.

Table 12-12 Aircraft Groups and the Associated Aircraft and Engines

Aircraft Group	Aircraft Description	Engine
A	Cessna 172 Skyhawk	IO-360-B
	Cessna 402	TIO-540-J2B2
	Piper PA-28 Cherokee Series	O-320
	Piper PA-30 Twin Comanche	IO-320-D1AD
	Piper PA-31 Navajo	TIO-540-J2B2
	Raytheon Beech Baron 58	TIO-540-J2B2
B	Airbus A300B4-600 Series	CF6-80E1A3
	Airbus A310-300 Series	CF6-80E1A4
	Airbus A330-200 Series	CF6-80E1A4
	Airbus A330-300 Series	CF6-80E1A4
C	Boeing 737-600 Series	CFM56-7B22
	Boeing 737-700 Series	CFM56-7B22
D	Cessna 208 Caravan	PT6A-114A
	Cessna 500 CitationI	JT15D-1 Series
	Cessna 501 CitationISP	JT15D-1 Series
	Cessna 525 Citation Jet	JT15D-1 Series
	Pilatus PC-12	PT6A-67B
	Raytheon Beech 1900-D	PT6A-67D
	Raytheon KingAir 90	PT6A-60
	Raytheon SuperKing Air200	PT6A-42
E	Cessna 550 CitationII	JT15D-4 Series
	Cessna 560 Citation Excel	JT15D-5,-5A,-5B
	Cessna 560 Citation V	JT15D-5,-5A,-5B
F	Bombardier Learjet 35	TFE731-2-2B
	Bombardier Learjet 40	TFE731-2-2B
	Bombardier Learjet 45	TFE731-2-2B
G	Bombardier Learjet 55	TFE731-3
	Hawker HS-125 Series 700	TFE731-3
H	Cessna 441 ConquestII	TPE331-10
	Rockwell Commander 690	TPE331-10
I	Airbus A320-200 Series	V2527-A5
	Airbus A321-100 Series	V2530-A5
J	DeHavilland DHC-6-300 Twin Otter	PT6A-27
	Raytheon KingAir 100	PT6A-28
K	DeHavilland DHC-8-300	PW123
	Dornier 328-100 Series	PW119B
L	Bombardier CRJ-100	CF34-3A1
	Bombardier CRJ-200	CF34-3B
M	Bombardier CRJ-700	CF34-8C1
	Bombardier CRJ-900	CF34-8C5
N	Embraer ERJ190	CF34-10E

Airfield simulation documents (Airbiz 2009a and Airbiz 2009b) that were prepared by Airbiz Aviation Strategies Ltd. (Airbiz) were used as a guide to determine the total number of departures and arrivals. Based on these documents and communication with Airbiz staff, arrival and departure gate allocations and taxi pathway routes were determined. Apron I was categorized into three area sources with respect to the arriving and departing aircraft size. For the 2025 assessment, two additional aprons on the east side of PRP, Tango II and Tango III were included and assumed 30% of the aircraft movements from Apron 3/4/5. The addition of Tango II and Tango III was to ensure that taxiway Tango was included for the 2025 DS assessment.

Table 12-13 presents the annual aircraft movements associated with the aprons and concourses for the proposed DN and DS scenarios for 2015 employed in this study. The annual aircraft movements include total number of arrivals and departures. It should be noted that total number of aircraft movements for both DN and DS scenarios are the same; however, the taxi routes change depending on the runway and type of aircraft used for arrival and departure operations.

Table 12-13 Annual Aircraft Movements for 2015

Aircraft Group	Apron Type	Apron I	IFP Apron	Aprons III/IV/V	Aprons VI/VIII
A	Small	n/a ¹	n/a	18,616	4,016
B	Medium	608	8,152	1,096	6,570
C	Medium	69,922	7,092	n/a	5,476
D	Small	11,208	n/a	46,570	10,476
E	Small	n/a	n/a	7,898	1,592
F	Small	n/a	n/a	730	2,190
G	Small	n/a	n/a	4,908	2,392
H	Small	n/a	n/a	1,460	n/a
I	Medium	22,234	6,236	n/a	n/a
J	Small	n/a	n/a	9,856	n/a
K	Small	26,408	2,336	6,296	730
L	Small	20,558	4,218	2,966	n/a
M	Small	7,030	9,248	1,242	n/a
N	Medium	13,434	5,910	n/a	n/a
Total		171,402	43,192	101,638	33,442

Notes: ¹ n/a means that no aircraft are allocated for that apron or concourse.

Table 12-14 outlines the total number of aircraft movements associated with the aprons and concourses for the proposed DN and DS scenarios for 2025. Total numbers of movements reflect the annual arrivals and departures for the aprons and concourses presented in the table below. Taxi paths taken for arrival and departure operations vary between the DN and DS scenarios; however, the total annual movements for both scenarios remain the same for 2025.

Table 12-14 Annual Aircraft Movements for 2025

Aircraft Group	Apron Type	Apron I	IFP Apron	Aprons VI/VIII	Aprons III/IV/V	Apron Tango II	Apron Tango III
A	Small	4,312	890	3,528	16,884	6,826	410
B	Medium	23,512	15,542	8,060	2,022	538	328
C	Medium	89,952	11,518	5,110	n/a ¹	n/a	n/a
D	Small	26,210	5,580	8,142	44,610	18,242	876
E	Small	n/a	n/a	2,300	6,566	2,814	n/a
F	Small	n/a	n/a	1,278	4,472	1,916	n/a
G	Small	15,998	5,680	2,392	7,934	3,400	n/a
H	Small	n/a	n/a	n/a	512	220	n/a
I	Medium	19,576	5,610	n/a	1,278	n/a	548
J	Small	n/a	n/a	1,216	4,258	1,826	n/a
K	Small	24,778	1,878	2,426	7,748	2,610	712
L	Small	13,888	3,250	n/a	1,544	662	n/a
M	Small	5,664	5,286	n/a	1,534	658	n/a
N	Medium	7,004	4,310	366	512	220	n/a
Total		230,894	59,544	34,818	99,874	39,932	2,874

Notes: ¹ n/a means that no aircraft are allocated for that apron or concourse.

Aircraft Activity

The six modes of operation of aircraft activities are defined as follows:

- Approach: The airborne segment of an aircraft's arrival extending from the start of the flight profile (or the mixing height, whichever is lower) to touchdown on the runway.
- Taxi In: The landing ground roll segment (from touchdown to the runway exit) of an arriving aircraft, including reverse thrust, and the taxiing from the runway exit to a gate.
- Start-up: The aircraft main engine start-up, which occurs at the gate.
- Taxi Out: The taxiing from the gate to a runway end.
- Takeoff: The portion from the start of the ground roll on the runway, through wheels off, and the airborne portion of the ascent up to cutback during which the aircraft operates at maximum thrust.
- Climb Out: The portion from engine cutback to the end of the flight profile (or the mixing height, whichever is lower) (EDMS Manual, 2008).

The above-mentioned modes constitute an LTO cycle. Each mode of the LTO cycle corresponds to a different power setting and ultimately, fuel consumption values, which are used to estimate aircraft engine emissions. Sequence modelling was employed in EDMS, which factors in the number of movements of each aircraft type in a given period, the gates and runways used by said aircraft and any delays associated with airport capacity to model the ground movement of each aircraft and to determine specific taxi in and taxi out times for each gate/runway combination. The use of the sequence modelling required site specific airport configurations that specified the gate, taxiways, runway, and taxi path associated with each aircraft movement. AECOM defined the airport configurations using the Airfield Simulation Assumption Documents as a guide for each scenario assessed (Airbiz 2009a and Airbiz 2009b). Figure 12-2 through to Figure 12-4 show the different taxiways, runways, and aprons that were considered for each scenario that was assessed. The sequence modelling does not account for ground delays for arriving aircraft. It assumes arriving aircraft approach the designated gates unimpeded. Furthermore, it should be noted that effects related to arrival delays in the stack are not considered for the air dispersion modelling since emissions above 3,000 ft are not expected to significantly impact the quality of air for the local receptors in the LSA.

Modelled aircraft movements for the 90th percentile busiest day were provided by Airbiz for 2015 and 2025, which were subsequently used to estimate annual aircraft movements by multiplying by a factor of 365. It should be noted that deriving annual aircraft movements from the 90th percentile busiest day is likely to have led to the number of annual aircraft movements being over-estimated, meaning the results of this assessment can be considered conservative. Furthermore, as outlined in the Airbiz documents for the 90th percentile busiest day, the 2015 and 2025 modelling assessment used only the north-south runways (16L/34R and 16R/34L).

Quarter-hourly, daily and monthly operational profiles were also developed, based on 2009 movement data for YYC obtained from Airscene, to reflect the variation in intensity of airport operations over the course of a day, week and year.

Stationary Sources

The stationary sources considered in this study are stationary power generation plants, and aircraft de-icing and anti-icing areas.

Stationary Power Generation

Currently, there are three natural gas fired space heaters in the terminal, which are used for heating and for providing hot water for the facility. Table 12-15 presents the stack parameters for the boilers that were used for the dispersion modelling assessment. For the proposed scenarios in 2015 and 2025, the fuel consumption for stationary power generation was doubled to account for heating requirements for the proposed IFP.

Table 12-15 Stack Parameters

Parameters	Existing Case
Stack Height (m)	15.85
Stack Diameter (m)	1.07
Stack Exit Temperature (C)	204
Stack Exit Velocity (m/sec)	30

De-icing

De-icing on the ground is the process of removing frozen contaminants such as snow, ice and slush from the critical surfaces of aircraft (such as the wings and fuselage). De-icing can be accomplished by mechanical methods (scraping, pushing), by heat application, by using chemicals designed to lower the freezing point of water, or by a combination of these techniques. At YYC, a glycol and water mixture is used as the primary method of de-icing.

Prior to departures at YYC, de-icing techniques are applied at each apron. With the PRP, a centralized de-icing facility will be commissioned to meet the increased volume of aircrafts requiring de-icing. Consequently, to assess the 2015 and 2025 scenarios, emissions from the de-icing process were modelled to be localized within the proposed central de-icing facility. De-icing fluid contains ethylene glycol or other hydrocarbons that can evaporate upon application to the aircraft or runway (FAA 1997). These atmospheric emissions contribute to emissions of VOCs.

The emissions from de-icing were calculated based on glycol consumption for each of the future scenarios. For each future scenario, the increase in aircraft volumes from 2007 operations were used to estimate glycol consumption required for de-icing. The glycol consumption for 2007 was 1,087,300 L of 50% water and 50% glycols additives (EBA, 2008 GHG Assessment) This data were based on information contained in the methodology previously used by YYC for GHG emissions. As outlined in the schedule developed from the Airbiz documents, the aircraft traffic for 2025 was expected to double compared to the aircraft traffic for 2008. As such, the glycol consumption was doubled for 2025 operations. The consumption for the assessment is listed in Table 12-16.

Table 12-16 Glycols Consumption

Scenario	Glycols mass (kg)
Proposed (2015)	1,060
Proposed (2025)	1,423

Ground Support Equipment

Once an aircraft arrives at a gate, GSE are used to unload baggage and service the lavatory and cabin. Additionally, while an aircraft is parked at a gate, mobile generators and air conditioning units may be used to provide electricity and conditioned air. Prior to aircraft departure, GSE are used to load baggage, food and fuel. When an aircraft departs from a gate, a tug may be used to push or tow the aircraft away from the gate to a taxiway. For this study, the GSE were assigned to each aircraft using the default values for each aircraft type as found in EDMS. This was to ensure that the emissions inventory and dispersion modelling for GSE operations were based on the likely activity of each aircraft assessed.

The GSE types that are considered include air conditioners, air start, aircraft tractors, baggage tractors, belt loaders, bobtails, cabin service trucks, cargo loaders, carts, catering trucks, de-icers, fork lifts, fuel trucks, generators, ground power units, hydrant trucks, lavatory trucks, lifts, passenger stands, service trucks, sweepers, and water service vehicles.

Auxiliary Power Units

APUs are mostly on-board small turbine engine generators that provide electrical power to the aircraft while its engines are shut down. Generally, APUs are started when taxiing to and from the gate. APUs also provide the required power to start the main engines of aircraft prior to take off. As APUs are onboard aircraft, they are modelled based on an aircraft's activity. For this study, the APUs were assigned to each aircraft using the default values for each aircraft type as found in EDMS. This was to ensure that the emission inventory and dispersion modelling for APU operations were based on the likely activity of each aircraft assessed.

Road Traffic Vehicles and Parking

The emissions for on-road vehicles were estimated for CACs and HAPs. The annual travelled distance and traffic volumes were determined for traffic within the airport area and included the following roads: Aero Drive, Aero Gate, 64 Avenue Northeast, 11 Street Northeast, Airport Trail, Barlow Trail, Aviation Boulevard, 36 Street, and McCall Way. Road traffic allocations from road closures and vehicle routing changes were considered to estimate potential air quality effects for the proposed scenarios. For example, the closure of Barlow Trail, as a result of the PRP, was considered and the distance of the alternate route and the change in traffic volumes were used in the air quality emission calculations. The road traffic emission calculations considered the length of the road, the vehicle speed and the number of vehicles on the roads.

Parking lots were also identified as an emission source. Modelling emissions from parking is similar to the method employed for road traffic, but with lower vehicle speeds and increased idle times. The default options within the EDMS program for the type of vehicles on roads and using parking facilities were employed to calculate the emissions inventory.

12.6.1.2 Emissions Estimating

The EDMS model generates area sources with associated hourly emission rate files for each aircraft mode of operation, i.e., start-up, taxiing, takeoff, and climb-out, and for the APU and GSE emissions associated with each gate. The area sources and hourly emission files were then used to undertake dispersion modelling. The calculation methodology for the emissions for each source is discussed further below.

Emissions factors were used to calculate CACs and HAPs hourly and annual emissions for this study. The general method for emissions inventories is to multiply the activity by the associated emission factor.

These activities were quantified based on information regarding the type, quantity and operating time of equipment.

For most aircraft engines, the emission factors were obtained from the ICAO Aircraft Engine Exhaust Databank, a publicly available database. The data from the databank is supplemented by engine emissions data provided directly from the manufacturer. For older aircraft, engine data were obtained from the Environmental Protection Agency (EPA AP-42), Part II, Section 1. The default power settings for each aircraft during each mode of operation determined the fuel consumption which, in turn, was used to determine emission quantities released into the atmosphere.

The methodologies and factors for computing stationary source emissions were based on the Air Quality Handbook for Air Quality Procedures for Civilian Airports and Air Force Bases. The general methodology for calculating emissions from these sources considered the amount of fuel or substance consumed. Based on the nature of the fuel, the amount of fuel consumed and emission factors, the emission quantities released into the atmosphere were determined.

The GSE emission factors are from EPA's NONROAD2005 model and are based on the following variables: fuel, brake horsepower and load factor. Also, a deterioration factor is employed based on the age of the engine. The fuel, the horsepower and the year of manufacture determine the emission factor and the age and GSE type determine the proper deterioration factor. To account for all the previously mentioned variables, the default EPA-derived national fleet average age distribution was used to estimate CAC emissions from GSE.

The methodology for calculating emissions from APUs was adapted from the U.S. EPA's Procedures for Emission Inventory Preparation, Volume IV, Chapter 5. The on-board APU are small turbine engines and the calculations for their emissions are similar to aircraft engines operating in one power setting only.

MOBILE 6.2 emission factors (grams/vehicle-mile) were used to estimate emissions from the nearby movement of vehicles on local roads. MOBILE 6.2 employs site temperatures, elevation, travelled distance, vehicles speed, and class to calculate emissions. The total emissions for a roadway are the product of the emission factors, the annual traffic volume, and the roadway length.

For parking emissions, the parking facility emission factor included road traffic emission factors for moving vehicles and the idle emission factor for idling vehicles. These two factors were combined to produce a parking facility emission factor (grams/vehicle). The atmospheric emissions from parking were determined by multiplying the parking facility emission factor with the number of vehicles per parking facility.

12.6.1.3 Dispersion Modelling

For the quantitative assessment, air dispersion modelling was used to assess the air quality effects due to the PRP's activities. Air dispersion models are important tools that can be used to assess the likelihood of compliance with air quality criteria at a particular location. These dispersion models mathematically predict the behaviour of contaminant emissions by accounting for emission rates, terrain effects, geometry and location of the sources, receptor locations, and meteorology.

The American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC) was formed to introduce state-of-the-art modelling concepts into the EPA's air quality models. Through AERMIC, a modelling system, AERMOD, was introduced that incorporated air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including

treatment of both surface and elevated sources, and both simple and complex terrain (EPA 2008). AERMOD also considers variable urban treatment as a function of city population, and can selectively model sources as rural or urban. Furthermore, air dispersion modelling requirements in Alberta are outlined in the Air Quality Model Guideline (May 2009) by the Government of Alberta. One of the regulatory approved dispersion models in Alberta is AERMOD. In addition, the FAA recognizes AERMOD as the preferred model to use with EDMS. As such, it was decided to use AERMOD as the preferred model for this assessment.

A refined dispersion modelling assessment was conducted to determine the potential effects on ambient atmospheric environment associated with emissions from the PRP for the scenarios previously discussed. Dispersion models simulate how emission sources influence concentrations of substances during specified meteorological conditions for the associated terrain in the study area. The Air Quality Model Guideline (AENV 2009) was used as a technical guide for the air dispersion modelling assessment using AERMOD. The chosen air dispersion model, AERMOD, is a steady-state Gaussian plume dispersion model which incorporates terrain algorithms, meteorology and building downwash effects on air concentrations.

Meteorological Data

Air quality is dependent on the rate of pollutant emissions into the atmosphere and the ability of the atmosphere to disperse the pollutant emissions. The dispersion of air pollutants is affected by local meteorological patterns. The wind direction controls the path that air pollutants follow from the point of emission to the receptors. In addition, wind speeds affect the time taken for pollutants to travel from source to receptor and the distance over which air pollutants travel. As a result, wind speeds also impact the dispersion of air pollutants. Therefore, it is important to assess local meteorological patterns to assess potential air quality effects.

The meteorological data for the quantitative assessment was obtained from meteorological stations that would best represent the conditions for the region of the project. Raw meteorological (MET) data was obtained from the on-site meteorological station from Environment Canada, available online (<http://www.weatheroffice.gc.ca>). One year of site specific meteorological data was used for surface wind parameters. As per the Air Quality Model Guideline, the use of one year site specific meteorological data is a preferred method to represent the project specific meteorological characteristics for the purposes of dispersion modelling.

In addition, raw MM5 meteorological data developed by Alberta Environment (AENV) was used for all other surface parameters and upper air data. AENV's Multi-Model Extraction Utility (MMEU) program with the MM5 data was used to generate the surface and upper air meteorological files for the LSA.

AERMET, a meteorological data program, was run in EDMS to generate the formatted meteorological files required for the dispersion modelling with AERMOD and to develop the hourly emission profiles using EDMS. The area within a 3 km radius of the site was examined using aerial photos. It was estimated that more than 80% of the surrounding land use is of urban type; therefore, a surface roughness of 1.0 was used in EDMS to create the AERMOD surface and profile files.

Terrain Data

Topographical features, such as river valleys and mountainous terrain, can have an important effect on airflow and, therefore, the dispersion of atmospheric contaminants. Examples of topographically induced circulations include mountain-valley circulations and flow around topographical boundaries (McQueen,

Draxler, Rolph 1995). As such, terrain data was reviewed and included in the dispersion modelling assessment.

For the dispersion modelling assessment, terrain data was based on Canadian digital elevation data (CDED). This data was obtained from the Geobase Canada website (<http://www.geobase.ca>). Geobase Canada provides the terrain data in USGS DEM files for a 1:50,000 and a 1:250,000 map scale (NAD83). The appropriate region was selected based on the UTM coordinates of the project site.

Receptor Grid

Receptor grids are required to define the locations where maximum impacts of the project are expected. The modelled concentrations of CACs and HAPs were predicted by AERMOD using an array of receptors. The Cartesian receptor grids were developed to capture the change of regional topography in the study area. The modelled receptor grid was based on the following spacing and distances:

- 250 m spaced receptors within 2 km from the property boundary; and
- 500 m spaced receptors within 5 km from the property boundary.

In addition, 20 metre spaced receptors were placed along the facility's property line as a distinction of the boundary with ambient air and restricted public access.

12.6.2 Assumptions and Limitations

Emissions factors were used for the emission calculations in this study. These emission calculations form the foundation of the air quality assessment. Uncertainty due to the emissions calculations is associated with the variability in activities or conditions and the use of default emission factors. The calculations developed for the assessment study incorporate a variety of assumptions concerning YYC operational activities. In addition, some of the calculations rely upon conservative emission factors, default values for aircraft engine characteristics and default values for GSE and APUs required for each aircraft. These defaults and factors introduce uncertainty to the resulting emissions estimates.

Air dispersion models, such as AERMOD, develop a mathematical evaluation of ambient concentration levels resulting from emission sources. The model input parameters include source emissions, meteorological conditions and topography. The dispersion modelling results are inherently approximated predictions for ambient observation levels. However, these models have been validated and tested before they were approved for regulatory applications in the U.S. and Canada (EPA 2003).

The predicted emission rates and dispersion modelling files are calculated based on the 90th percentile busiest operating day. In reality, the actual operations will vary from hour to hour and day to day, and actual annual operations will be less than those used in this assessment, thus providing a conservative estimate of air quality concentrations. Therefore, the rating of confidence in the results is high for the project based on the quality of baseline data, emissions data, and the conservative nature of the analytical techniques applied for this assessment.

Specific details of the most important assumptions are discussed below.

Default engines, in the ICAO library, for each aircraft were employed in this assessment. Those engines represent the most common or the most widely used engine types for each aircraft type. Additionally, LTOs correspond to different power settings for takeoff, climb, approach, and taxi/idle time and, ultimately, fuel consumption values and travelled distances, which are used to estimate CAC emissions.

The number of aircraft, aircraft taxiing routes and allocation of aircraft to aprons were based on information from the reports published by Airbiz in 2009. Changes of airport configurations and taxi pathways for the maximum operating conditions outlined by Airbiz in 2009 may alter the estimated CAC and HAP ground emissions. For the taxi delay times, the sequencing module in EDMS was used as a default.

Emissions from on-road vehicles vary by age, by fuel type and by vehicle type. However, this detailed information was not available for the vehicle population associated with YYC for this assessment. Therefore, CAC and HAP emission factors were used with the default vehicle fleet mix in EDMS. The default fleet mix was employed to determine CAC and HAP emissions from road traffic.

Boiler fuel usage was assumed to be doubled due to the new IFP terminal. However, it should be noted that this is a conservative assumption as the IFP terminal will have geothermal heating. As such, the IFP is expected to be more energy efficient than the existing terminal. Therefore, assuming that the IFP heating will require the same amount of fuel as the existing terminal is a conservative assumption for the operational years 2015 and 2025. Boiler fuel usage was the same for all 2015 and 2025 scenarios that were assessed.

APUs are small turbine engines, while the GSE are powered by diesel or gasoline engines. A population of GSE and APUs were assigned through default values for each aircraft.

For aircraft main engine start-ups, the EDMS methodology only accounts for VOC emissions.

Sequence modelling was employed in EDMS to determine aircraft ground movement. The delay and sequence modelling factors in the aircraft operational schedule demands, active runway configurations, and delays associated with airport capacity. However, the sequence modelling module assumes that arrivals will have unimpeded travel to the gates; as such, delays that may be experienced in landing are excluded. Improvements in operational efficiency that may be realized as a result of the project may directly improve airport activities, including reducing landing delays. These improvements could lead to benefits in the form of reduced air quality emissions. However, these effects have not been included in the quantitative assessment since this is the accepted protocol used when calculating air quality emissions with EDMS and the FAA. The exclusion of this improvement leads to a more conservative assessment between the DN and the DS scenarios.

Furthermore, as outlined in the Airbiz documents for the 90th percentile busiest day, the 2015 and 2025 modelling assessment assumed that 100% of the arrivals and departures only used the north-south runways (16L/34R and 16R/34L). The runway use in the assessment assumed a 50% split between the use of the existing runway (16L/34R) and the parallel runway (16R/34L). This split leads to a conservative assessment. In reality, the 50% split is likely to be used mostly in peak operating periods. It is expected during other operating periods there is a potential that aircraft will use runways that are closest to their assigned gates. By assuming a 50% split, the air dispersion model accounts for a larger amount of taxiing than would occur with the PRP scenario in reality.

12.6.3 Effects Assessment by Project Phase

The project may result in the increased discharge of several gaseous and particulate emissions into the atmospheric environment which, in turn, may result in possible changes to ambient air quality. The potential effects of the project on air quality will be assessed in this section.

12.6.3.1 Construction Phase

The assessment of the potential air quality effects for the construction phase of the PRP are described in this section.

Effects Analysis

The proposed runway will result in emissions of CACs and HAPs during the construction phase. Of these emissions, diesel exhaust and PM emissions will be the primary project emissions. Potential effects on air quality may occur from increased fuel consumption during the construction phase due to the increased amount of vehicles and diesel powered equipment. Land clearing activities will also affect CAC and HAP emissions. Furthermore, the construction activities may result in emissions of airborne PM from road dust and storage piles. The construction activities involved in the project, which have the potential to affect the local air quality include:

- construction of and use of temporary facilities and construction staging area;
- general earthworks for site preparation, construction, and landscaping;
- installation of site services; and
- paving of runway, taxiways, and aprons.

These construction activities will require the use of a number of pieces of heavy construction equipment and vehicles including pile drivers, dump trucks, concrete trucks, excavators, backhoes, front end loaders; and miscellaneous smaller contractor equipment. The large diesel powered equipment will generate combustion gases. In addition, the use of vehicles will also generate gaseous emissions such as PM as they travel to and from, as well as on, the construction site. As a result, it is expected that the construction phase will result in effects to existing air quality by increasing the emissions of CACs and HAPs.

Mitigation

A number of mitigation measures will be implemented to minimize the effects on local air quality. As some of the air quality emissions are directly linked to fuel consumption, some of the mitigation measures outlined focus on reducing fuel consumption by efforts to increase fuel efficiency. Mitigation of the effect of the operation of heavy diesel vehicles and equipment on air quality may include:

- minimization of vehicle idling and turning off equipment when not in use;
- implementation of best practices to ensure vehicles and construction equipment are properly tuned and maintained;
- on-site speed limits; and
- careful selection of trucking routes and vehicle movements to minimize travel distances.

Effective mitigation measures will be implemented to minimize the fugitive airborne PM generated by construction activities. The effective mitigation measures will be implemented through collaboration between the Calgary Airport Authority, the City of Calgary, the construction manager, and Alberta Environment. The mitigation measures to minimize fugitive airborne PM may include:

- installation of temporary fencing during construction;
- implementing regular street sweeping during construction;
- application of water to loose materials and exposed earth during construction;
- prevention of erosion to minimize the extent and duration of bare ground surface exposure; and
- development of a balanced earthwork management plan and keeping as much excavated earth on-site as possible to reduce off-site hauling.

These mitigation measures may be included in the ECO Plan (Volume V, Item 14) and implemented by the construction contractor.

Additionally, following land clearing for the project site and access roads, efforts will be made to revegetate appropriate areas quickly and to the greatest extent possible. Efforts will also be made to minimize land disturbance and land clearing.

Residual Effects

With effective mitigative measures implemented, significant residual effects on air quality from construction activities are unlikely. The construction activities will be of a short to medium term duration, are reversible and will likely be of low magnitude for the LSA. Therefore, no significant residual effects on air quality from construction activities are expected.

12.6.3.2 Operational Phase

The assessment of the potential air quality effects for the operational phase of the PRP are described in this section. Air quality dispersion modelling has been completed to allow the effects both with and without the parallel runway to be assessed and compared.

Effects Analysis

As outlined in the introductory section for the effects assessment, the PRP has the potential to affect air quality and contribute to local air pollution. The emissions from the operational phase of the project are from aircraft, GSE, APUs, stationary sources within the airport facility, and airport related vehicle movements along local roads. The identified measurable parameters for this assessment included benzene, CO, PM₁₀, PM_{2.5}, naphthalene, and NO₂.

Air quality dispersion modelling was used to predict the ground level concentrations of these parameters in the vicinity of the PRP. The maximum predictions associated with the project operational phase outside the project boundary for the years 2015 and 2025 are summarized in Table 12-17 and Table 12-18, respectively.

In accordance with the Alberta Air Quality Model Guideline (AENV 2009), when the 1-hour maximum predictions are compared against the respective air criteria, the highest eight 1-hour predicted average concentrations for each receptor in each single year are excluded. Therefore, the 1-hour maximum predicted concentrations presented in this assessment are the 9th highest predictions. However, the 24-hour and annual predictions presented are the absolute maximum. As the results presented are the maximum levels, these results do not show the dispersion pattern at any one point, but instead show the maximum result that occurred over the entire meteorological period used.

Furthermore, to meet the requirements of the Alberta Air Quality Model Guideline, the maximum predicted ground level concentrations are added to background ambient concentrations in order to be compared against the air criteria. The off-site air monitoring site was selected to represent the typical urban community background concentrations near the project area. It should be noted that the background concentrations for each parameter presented in the tables below reflect the average values from the six month monitoring program (from July 2009 to February 2010) at the off-site air monitoring location.

Table 12-17 Maximum Predicted Concentrations for 2015 DN and 2015 DS

Contaminant	Averaging Period	AENV AAQO ¹ (µg/m ³)	2015 DN Scenario			2015 DS Scenario		
			Maximum Predicted Concentration ² (µg/m ³)	Background Concentration ³ (µg/m ³)	Total Maximum Concentration (µg/m ³)	Maximum Predicted Concentration ² (µg/m ³)	Background Concentration ³ (µg/m ³)	Total Maximum Concentration (µg/m ³)
Benzene	1-Hour	30	7.5	2.6	10.1	5.7	2.6	8.3
CO	1-Hour	15,000	4,545.0	225.5	4,770.5	3,084.3	225.5	3,309.8
	8-Hour	6,000	2,479.4	223.1	2,702.5	1,829.0	223.1	2,052.1
Naphthalene	24-Hour	22.5 ⁴	0.3	0.3	0.6	0.3	0.3	0.6
NO ₂	1-Hour	400	449.9	34.4	484.3	351.5	34.4	385.9
	24-Hour	200	124.9	36.4	161.3	85.3	36.4	121.7
	Annual	60	47.7	36.4	84.1	26.6	36.4	63.0
PM _{2.5}	24-Hour	30	3.7	6.7	10.4	3.8	6.7	10.5
PM ₁₀	24-Hour	50 ⁵	4.6	24.0	28.6	4.5	24.0	28.5

¹ Alberta Ambient Air Quality Objectives and Guidelines (Alberta Environment June 2009). The 1-hour maximum concentrations exclude the eight highest 1-hour predictions, as per Alberta air quality model guideline (AENV 2009) for comparison with AAAQO.

² These predicted concentrations exclude the area inside the project boundary.

³ There is no PM₁₀ guideline for Alberta; the guideline from British Columbia is used for reference (Air Quality Objectives and Standards, British Columbia, Ministry of Environment 1995).

⁴ There is no naphthalene guideline for Alberta; the guideline from the Ministry of Ontario is used as a reference (MOE 2008).

⁵ The background concentrations are obtained from the six month monitoring program carried out at the off-site air monitoring station.

Table 12-18 Maximum Predicted Concentrations for 2025 DN and 2025 DS

Contaminant	Averaging Period	AENV AAQO ¹ (µg/m ³)	2025 DN Scenario			2025 DS Scenario		
			Maximum Predicted Concentration ² (µg/m ³)	Background Concentration ³ (µg/m ³)	Total Maximum Concentration (µg/m ³)	Maximum Predicted Concentration ² (µg/m ³)	Background Concentration ³ (µg/m ³)	Total Maximum Concentration (µg/m ³)
Benzene	1-Hour	30	8.0	2.6	10.6	6.3	2.6	8.9
CO	1-Hour	15000	4650.5	225.5	4876.0	3631.2	225.5	3856.7
	8-Hour	6000	2530.3	223.1	2753.4	1904.1	223.1	2127.2
Naphthalene	24-Hour	22.5 ⁴	0.4	0.3	0.7	0.4	0.3	0.7
NO ₂	1-Hour	400	687.4	34.4	721.8	519.1	34.4	553.5
	24-Hour	200	137.1	36.4	173.5	118.3	36.4	154.7
	Annual	60	50.1	36.4	86.5	28.1	36.4	64.5
PM _{2.5}	24-Hour	30	3.9	6.7	10.6	4.8	6.7	11.5
PM ₁₀	24-Hour	50 ⁵	4.7	24.0	28.7	5.0	24.0	29.0

¹ Alberta Ambient Air Quality Objectives and Guidelines (Alberta Environment June 2009). The 1-hour maximum concentrations exclude the eight highest 1-hour predictions, as per Alberta air quality model guideline (AENV 2009) for comparison with AAAQO.

² These predicted concentrations exclude the area inside the project boundary.

³ There is no PM₁₀ guideline for Alberta; the guideline from British Columbia is used for reference (Air Quality Objectives and Standards, British Columbia, Ministry of Environment 1995).

⁴ There is no naphthalene guideline for Alberta; the guideline from the Ministry of Ontario is used as a reference (MOE 2008).

⁵ The background concentrations are obtained from the six month monitoring program carried out at the off-site air monitoring station.

The results are discussed further below. Figures 12-5 to 12-28 have been created to illustrate the effect of the PRP on air quality. The figures are isopleths of predicted concentrations of CACs and HAPs for the 24-hour maximum results. The maps depict the results of the maximum predicted concentrations for the PRP effects and do not include background concentrations.

Benzene

As observed from Table 12-17, predicted 1-hour maximum ground level concentrations of benzene for the 2015 DN and 2015 DS scenarios are 10.1 µg/m³ and 8.3 µg/m³, respectively. Table 12-18 presents the 1-hour maximum ground level benzene concentrations of 10.6 µg/m³ and 8.9 µg/m³ for the 2025 DN and 2025 DS scenarios, respectively. These predicted maximum concentrations lie on the project boundary and are well below the air criterion of 30 µg/m³ for benzene.

The predicted benzene concentrations for the operational phase with the proposed runway are lower than those without the parallel runway. For example, the maximum 1-hour benzene predictions from the 2015 DS and 2025 DS scenarios were 18.2% and 16.0% lower than those for the 2015 DN and 2025 DN scenarios, respectively.

CO

Table 12-17 presents the predicted 1-hour and 8-hour maximum ground level concentrations of CO for the 2015 DN and 2015 DS scenarios. The maximum 1-hour concentrations for the 2015 DN and 2015 DS scenarios are 4,770.5 µg/m³ and 3,309.8 µg/m³, respectively. The maximum 8-hour concentrations for the 2015 DN and 2015 DS scenarios are 2,702.5 µg/m³ and 2052.1 µg/m³, respectively.

Table 12-18 shows that the 1-hour maximum ground level CO concentrations for the 2025 DN and 2025 DS scenarios are 4,876.0 µg/m³ and 3,856.7 µg/m³, respectively. The maximum 8-hour concentrations for the 2025 DN and 2025 DS scenarios are 2,753.4 µg/m³ and 2,127.2 µg/m³, respectively.

Overall, the maximum 1-hour and 8-hour concentrations predicted for both 2015 and 2025 lie on the project boundary and are well below their respective 1-hour and 8-hour air criteria of 15,000 µg/m³ and 6,000 µg/m³.

The predicted CO concentrations for the operational phase with the proposed runway are lower than those without the parallel runway. For example, the maximum 1-hour CO predictions from the 2015 DS and 2025 DS scenarios were 30.6% and 20.9% lower than those for the 2015 DN and 2025 DN scenarios, respectively. Similarly, the maximum 8-hour CO predictions from the 2015 DS and 2025 DS scenarios were 24.1% and 22.7% lower than those for the 2015 DN and 2025 DN scenarios, respectively.

Naphthalene

The maximum 24-hour predicted concentrations of naphthalene for the 2015 and 2025 scenarios are presented in Table 12-17 and Table 12-18, respectively. From Table 12-17, the maximum 24-hour concentrations of naphthalene for the 2015 DN and 2015 DS scenarios are both 0.6 µg/m³. For the 2025 DN and 2025 DS scenarios, the maximum 24-hour naphthalene concentrations are both 0.7 µg/m³. All of the maximum predicted concentrations lie on the project boundary and are well below the 24-hour air quality criteria of 22.5 µg/m³.

The predicted maximum naphthalene concentrations for the operational phase with the parallel runway in 2015 and 2025 are equal to those without the parallel runway. It is observed from the dispersion modelling results that road vehicles do not contribute to naphthalene emissions. Naphthalene emissions are directly associated with jet fuel combustion. APUs also contribute a small of naphthalene emissions.

NO₂

Table 12-17 presents the 1-hour, 24-hour, and annual maximum NO₂ predictions for the 2015 DN and 2015 DS scenarios. For the 2015 DN scenario, the maximum 1-hour, 24-hour, and annual concentrations

are 484.3 $\mu\text{g}/\text{m}^3$, 161.3 $\mu\text{g}/\text{m}^3$, and 84.1 $\mu\text{g}/\text{m}^3$, respectively. For the 2015 DS scenario, the maximum 1-hour, 24-hour, and annual concentrations are 385.9 $\mu\text{g}/\text{m}^3$, 121.7 $\mu\text{g}/\text{m}^3$, and 63.0 $\mu\text{g}/\text{m}^3$, respectively.

Table 12-18 presents the maximum 1-hour, 24-hour, and annual NO_2 concentrations for the 2025 DS and 2025 DN scenarios. The maximum 1-hour, 24-hour, and annual concentrations of NO_2 for the 2025 DN scenario are 721.8 $\mu\text{g}/\text{m}^3$, 173.5 $\mu\text{g}/\text{m}^3$, and 86.5 $\mu\text{g}/\text{m}^3$, respectively. For the 2025 DS scenario, the maximum 1-hour, 24-hour, and annual concentrations are 553.5 $\mu\text{g}/\text{m}^3$, 154.7 $\mu\text{g}/\text{m}^3$, and 64.5 $\mu\text{g}/\text{m}^3$, respectively.

The maximum 24-hour predictions in 2015 and 2025 for both DN and DS scenarios lie on the project boundary and are below the air criteria of NO_2 for the 24-hour (200 $\mu\text{g}/\text{m}^3$) averaging period. The maximum annual predictions for NO_2 lie on the project boundary and exceed the annual air criteria of 60 $\mu\text{g}/\text{m}^3$ for both DN and DS scenarios in 2015 and 2025. However, the annual project emissions prior to the addition of background concentrations are well below the annual air criteria. The 1-hour maximum predicted concentrations for the 2015 DN, 2025 DN, and 2025 DS scenarios lie on the project boundary and exceed the associated air criteria of 400 $\mu\text{g}/\text{m}^3$. However, it should be noted that the maximum predicted 1-hour concentrations for the 2015 DS scenario is lower than the 1-hour air criterion. The frequency of predicted exceedence for the 90th percentile busy day under a range of meteorological conditions was very low; i.e.:

- 2015 DM scenario: 3.8%;
- 2025 DM scenario: 10.2%; and
- 2025 DS scenario: 7.5%.

Although dispersion modelling predicted some exceedences, the frequency and magnitude of exceedences were generally low. Also, the exceedences were localized at the project boundary and dissipated quickly within less than 400 m.

Furthermore, the predicted NO_2 concentrations for the operational phase with the proposed runway are slightly lower than those without the runway. For example, the maximum 1-hour NO_2 predictions from the 2015 DS and 2025 DS scenarios were 20.3% and 23.3% lower than those for the 2015 DN and 2025 DN scenarios, respectively.

In summary, it is expected that (i) NO_2 levels in surface air beyond the airport property will be slightly lower if the PRP is completed than if not completed; and (ii) the maximum predicted concentrations are localized to the project boundary and are expected to have a very low impact on the neighbouring residential communities.

PM

As observed from Table 12-17, the predicted 24-hour maximum ground level concentrations for $\text{PM}_{2.5}$ for the 2015 DN and 2015 DS scenarios are 10.4 $\mu\text{g}/\text{m}^3$ and 10.5 $\mu\text{g}/\text{m}^3$, respectively. The 24-hour maximum ground level $\text{PM}_{2.5}$ concentrations are 10.6 $\mu\text{g}/\text{m}^3$ and 11.5 $\mu\text{g}/\text{m}^3$ for the 2025 DN and 2025 DS scenarios, respectively. These predicted maximum concentrations lie on the project boundary and are well below the air criterion of 30 $\mu\text{g}/\text{m}^3$. The predicted PM concentrations for the operational phase with the parallel runway are slightly higher than those without the parallel runway. For example, the maximum 24-hour $\text{PM}_{2.5}$ concentrations from the 2015 DS and 2025 DS scenarios were 0.8% and 8.6% higher than those for the 2015 DN and 2025 DN scenarios, respectively.

Predicted 24-hour maximum ground level concentrations for PM₁₀ are 28.6 µg/m³ and 28.5 µg/m³ for the 2015 DN and 2015 DS scenarios, respectively. For the 2025 DN and 2025 DS scenarios, the 24-hour maximum predictions for PM₁₀ are 28.7 µg/m³ and 29.0 µg/m³, respectively. Similar to the PM_{2.5} predictions, the maximum 24-hour PM₁₀ prediction from the 2025 DS scenario was 0.9% higher than the one for the 2025 DN scenarios. However, the maximum 24-hour PM₁₀ prediction from the 2015 DS scenario was 0.3% lower than the one for the 2015 DN scenarios. The maximum 24-hour PM₁₀ predictions for both scenarios lie on the project boundary and are below the air quality criteria of 50 µg/m³.

It is noted that PM is the only air quality parameter that does not show reduced concentration results due to the operation of the PRP. Unlike the other CACs and HAPs assessed, the PM emissions are largely associated with APUs and GSE located at the different aprons. In addition the PM emissions for aircraft are mostly due to takeoff (the portion from the start of the ground roll on the runway, through wheels off, and the airborne portion of the ascent up to cutback during which the aircraft operates at maximum thrust). The location of these emissions affects the dispersion of the contaminant and as a result, the operation of the PRP shows similar or slightly elevated air quality dispersion results for PM when compared to the DN scenarios.

12.7 Summary

The emissions from the operational phase of the project for the parameters investigated were generally below their respective ambient air quality criteria or guidelines. However, the maximum 1-hour and annual predicted ground-level concentrations for NO₂ occasionally exceeded their respective criteria of 400 µg/m³ and 60 µg/m³ for both 2015 and 2025. Although the dispersion modelling predicted some exceedences for NO₂, the frequency and magnitude of the exceedences were generally low and localized within 400 m of the property boundary. It should be noted that all of the maximum predicted concentrations for all of the parameters are localized to the project boundary and are expected to have a very low impact on the neighbouring residential communities.

In general, the dispersion modelling predictions of benzene, CO, naphthalene, and NO₂ for the operational phase with the parallel runway are lower than those without the parallel runway. The differences from the DN and DS scenarios have been predicted, with the DS scenario having 32% or less of a decrease from the DN scenario. The result of the air emissions being more distributed through the airport for the DS scenarios generally resulted in better air dispersion. As a result, the DS assessments have generally lower ground air concentration results than the DN scenarios.

However, the predictions of PM for the operational phase with the parallel runway are slightly higher than those without the parallel runway. Unlike the other CACs and HAPs assessed, the PM emissions are largely associated with sources that are in close proximity to the property boundary. The location of these emission sources affects the dispersion of the contaminant and as a result, the operation of the PRP shows similar or slightly elevated air quality dispersion results for PM when compared to the DN scenarios. The differences from the DN and DS scenarios have been predicted to be relatively small. The differences seen for PM are considered very small and when added to the background concentrations, the differences due to PRP operations would be difficult to measure. This is due to the background PM concentrations being much higher in magnitude when compared to PM emissions expected from the PRP operational phase.

In summary, the PRP is expected to improve the overall air quality for the LSA. Although PM will increase slightly, the results are negligible when the background concentrations are considered.

12.8 Mitigation

A number of mitigation measures will be implemented to limit the emissions of CACs and HAPs. As their emissions are directly linked to fuel consumption, the mitigation measures outlined focus on possibly reducing emissions from aircraft and GSE operations. Mitigation of the effect on CACs and HAPs emissions from the operation of the GSE fleet and APUs may include:

- minimization of vehicle idling and turning off equipment when not in use;
- use electric driven APUs;
- ensuring GSE are properly tuned and maintained; and
- implementation of on-site speed limits.

Airlines and airports can take various measures to improve the environmental performance of their aircraft operations. Such measures are for reference only. The mitigation measures for aircraft operations may include the following:

- reduced engine taxiing during taxi and idle reduces the associated emissions substantially;
- de-rate takeoff power; and
- reduce use of reverse thrust.

The mitigation measures for aircraft operations may not be feasible in all weather conditions and at times where safety considerations are the priority. The mitigation measures will be implemented as appropriate.

In consideration of the projected air traffic volumes in 2015 and 2025, the purpose of the project is to add an additional runway to alleviate air traffic congestion in the LSA. By implementing the PRP, air traffic congestion is expected to be reduced in the LSA in the future. The PRP is a mitigation measure that is expected to alleviate air traffic congestion and mitigate emissions.

12.9 Residual Effects

With effective mitigative measures implemented, significant residual effects on ambient air quality levels from the project's operational phase are unlikely. The potential effects on the ambient air quality levels of the project on the LSA are negligible in consideration of the change in the baseline levels to the project levels. For most measureable parameters, the air quality levels are expected to show a slight improvement with the PRP.

The predicted ambient concentrations during the operational phase are low in magnitude for the regional study area. Furthermore, the potential effects have a local geographical extent and are reversible. Therefore, no significant adverse residual effects on the ambient air quality levels during the operational phase are likely to occur.

12.10 Cumulative Effects

The PRP location is in an area that has been subjected to past and current activities such as industrial operations and urban development. The region in which the LSA is situated is highly urbanized in character, with some areas under existing conservation agreements, such as Nose Hill Park, Bowmont and 12 Mile Coulee Natural Areas (Calgary Parks and Recreation 1994). Those areas that are not presently under conservation agreements are intended for residential, industrial or commercial development in the foreseeable future. Although the effects of a project may be determined to not be significant, the combined effects of various other activities or projects with the project under consideration

may be significant. The cumulative effects assessment (CEA) is conducted to ensure the incremental effects resulting from the combined influences of various activities are considered.

Direct project effects on air quality were assessed prior to mitigation in the project (effects assessment section). Residual effects were then determined after mitigation measures were considered. Since the CEA builds on the assessment of the effects of the PRP, VCs that have been determined to have residual effects are subject to the CEA. As air quality will have residual effects, air quality has been considered for the CEA.

The project involves the following time frames:

- Construction: 2011 - 2014; and
- Operation: 2014 onwards.

In accordance with this time line, the temporal boundary for projects relevant to the CEA will extend from the start of the PRP (2011), through the project construction and operation phases.

For the purposes of this assessment, projects that are certain/planned or reasonably foreseeable are considered along with the PRP's potential effects. The CEA does not specifically consider past and present projects and activities. It is assumed that the existing status of air quality reflects the influence of other past and existing projects. It is also assumed that existing projects or activities will continue to be carried out in the future and will have similar effects to those they currently have. As a result, the effects of past and existing projects or activities have been evaluated in the assessment of effects of the PRP.

The CEA considers planned/certain projects. Planned/certain projects are those that have a high probability of proceeding. Reasonably foreseeable projects and activities are those that may proceed and are also considered in the CEA. These projects and activities typically include those that are identified in approved development plans or those that are in other advanced stages of planning. Hypothetical and speculative projects and activities are not considered as part of the CEA. Projects that were carried forward into the CEA overlapped the geographic extent of potential air quality effects and the temporal boundary of potential air quality effects of the PRP. Projects that did not overlap with the project in these areas were screened out of the CEA. Other projects considered in the CEA included:

- the Deerfoot North development project;
- extension of Métis Trail / Country Hills Boulevard;
- extension of Airport Trail; and
- residential and commercial development.

The gaseous emissions generated from the construction and operational phases of the PRP project will consist of HAPs and CACs. Several sources during the construction and operational phases will have the potential to create air quality conditions that will interact with the identified road improvement projects, the Deerfoot North development project, and residential and commercial development. The air quality emissions from these projects may overlap spatially and temporally and may result in residual cumulative adverse effects. However, provincial air quality criteria exist and are implemented by the Government of Alberta to limit cumulative air quality effects in communities. The project effects assessment showed that in consideration of the mitigation measures, the project contributions are expected to have a small spatial extent and are generally not expected to reduce air quality to above the established air criteria. During the construction phase, cumulative effects of air quality emissions from the PRP and any of the identified other planned projects will occur over a brief time period. During the operational phase, cumulative effects

of air quality may occur with emissions from the identified projects. However, the cumulative effects from the operational phase are expected to be low in magnitude and reversible.

Taking into account mitigation measures outlined previously in the PRP effects assessment, the project contributions during the construction phase and operational phase are not expected to increase air quality levels in the LSA significantly. Furthermore, by implementing the mitigation measures outlined in the project effects assessment, it is expected that the potential residual cumulative adverse effects on air quality are likely to be low in magnitude, reversible and have a local geographical extent.

Therefore, in consideration of the mitigation measures and potential cumulative effects associated with the project, the Deerfoot North development project, the road network improvements, and expected residential and commercial development, no significant adverse environmental effects are expected.

12.11 Follow-up and Monitoring

The maintenance of an air emissions inventory for both internal management and potential external reporting needs is recommended as an action for follow-up.

12.12 Summary of Residual Effects

The proposed runway has the potential to affect the existing ambient air quality levels during both its construction and operational phases. The main component of the construction phase that may affect ambient air quality levels is the increased diesel emissions due to increased vehicles and construction equipment on the PRP site. Various components of the PRP operational phase that may affect ambient air quality levels include the following:

- increased diesel consumption during and after the construction phase from an increased amount of vehicles and machinery; and
- changes in airplane and road traffic operations.

Taking into account mitigation measures, significant adverse residual effects are unlikely to occur. Ambient air quality levels will be affected throughout the life of the project from existing conditions. The overall effects are predicted to be a maximum increase of 8.6% from baseline conditions for the year 2015. However, for most measureable parameters, the project is expected to improve air quality from the baseline DN scenarios. As such, the CAC and HAP emissions are expected to be low in magnitude and are reversible.

Table 12-19 provides a summary of the residual environmental effects and recommended mitigation for ambient air quality.

Table 12-19 Assessment of Project Effects on Air Quality

Project-Environment Interaction	Potential Beneficial (B) or Adverse (A) Effect	Mitigation Measures	Residual Environmental Effect				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Significance
Construction Phase							
Alterations in GHG baseline levels associated with: <ul style="list-style-type: none"> Road Traffic Emissions Site Clearing and Grubbing Operation of Construction Equipment 	A	Implementation of a "No Idle" policy on-site.	Low	Local	Short Term to Medium Term / Regular	Reversible	Not Significant
		Implementation of on-site speed limits.					
		Ensure that engines are tuned and maintained.					
		Proper route selection to reduce travel distances.					
		Installation of temporary fencing during construction.					
		Performance of regular street sweeping during construction.					
		Watering down loose materials and exposed earth during construction.					
		Prevention of erosion to minimize the extent and duration of bare ground surface exposure.					
Develop a balanced earthwork management plan and keep as much excavated earth on-site as possible to reduce off-site hauling.							
Operational Phase							
Alterations in GHG baseline levels associated with: <ul style="list-style-type: none"> Changes in aircraft operations Changes in air space time for aircraft in the Calgary airshed Use of ground service vehicles Stationary combustion sources 	A	Reduced engine taxiing during taxi and idle.	Low	Local	Long Term / Regular	Reversible	Not Significant
		De-rate takeoff power.					
		Reduce use of reverse thrust.					
Cumulative Effects							
Gaseous emissions from the construction and operational phase of the project may interact with those emitted from the following: <ul style="list-style-type: none"> The Deerfoot North development project Extension of Métis Trail / Country Hills Boulevard Extension of Airport Trail Residential and commercial development 	A	Same as identified above for construction and operational phases.	Low	Local	Long Term / Regular	Reversible	Not Significant

12.13 Issues Raised by Stakeholders

During the public meetings, the following issues were identified with regards to the air quality emissions resulting from the PRP:

Issue: The potential effects of project activities on pollution levels in the Inglewood and Ramsay areas.

Issue: The potential effects of project activities on air quality levels in communities around the airport.

Response: The potential effects of project activities on air quality pollution levels for all communities surrounding the airport boundary have been quantitatively assessed using emission inventory calculations and air dispersion modelling. The potential effects are further described in Section 12.6 and dispersion contour maps that illustrate the effects can be also be found in Section 12.6.

Issue: Changes in the transportation network in and around the airport leading to a change in air emission levels.

Response: Potential air quality effects as a result of changes to the transportation network in and around the airport have been assessed for the operational phase of the project. The effects have been quantified through the use of emission inventory calculations and air dispersion modelling. The total potential effect of the airport operations and changes to the transportation network are depicted in air dispersion contour maps found in Volume III, Chapter 12. Section 12.6 also provides the findings of the effects assessment.

Issue: Air quality related human health effects.

Response: A human health risk assessment is being completed as part of this CS. The human health risk assessment has considered the effects of the changes in air quality to human health and can be found in Volume III, Chapter 15.