

# Chapter 11

Climate & Greenhouse Gases

## Table of Contents

	page
<b>11. Climate and Greenhouse Gases .....</b>	<b>11-1</b>
11.1 Introduction .....	11-1
11.2 Scoping the Assessment .....	11-1
11.2.1 Relevant Legislation and Guiding Documents.....	11-2
11.2.1.1 International and Federal .....	11-2
11.2.1.2 Provincial.....	11-2
11.2.2 Scenarios .....	11-4
11.2.3 Key Issues.....	11-4
11.2.4 Spatial and Temporal Boundaries.....	11-5
11.2.4.1 Spatial Boundaries .....	11-5
11.2.4.2 Temporal Boundaries .....	11-5
11.3 Issues Identified .....	11-5
11.4 Key Indicators and Measurable Parameters.....	11-6
11.5 Existing Conditions.....	11-6
11.6 Effects Assessment.....	11-7
11.6.1 Effects Assessment Methodology.....	11-7
11.6.2 Emissions Inventory Assessment .....	11-8
11.6.3 Assumptions and Limitations .....	11-14
11.6.4 Effects Assessment by Project Phase .....	11-16
11.6.4.1 Construction Phase .....	11-16
11.6.4.2 Operational Phase.....	11-17
11.7 Cumulative Effects Assessment .....	11-21
11.8 Follow-Up Programs and Monitoring .....	11-23
11.9 Summary .....	11-23
11.9.1 Summary of Results.....	11-23
11.9.2 Summary of Mitigation .....	11-23
11.9.3 Summary of Cumulative Effects.....	11-24
11.9.4 Summary of Residual Effects.....	11-24
11.10 Issues Raised by Stakeholders.....	11-26

### Figures

Figure 11-1	2015 DN and 2025 DN Taxiways and Runways.....	11-11
Figure 11-2	2015 DS Taxiways and Runways .....	11-12
Figure 11-3	2025 DS Taxiways and Runways .....	11-13

### List of Tables

Table 11-1	International Regulations and Guidelines .....	11-3
Table 11-2	Federation Regulations and Guidelines.....	11-3
Table 11-3	Provincial Regulations and Guidelines .....	11-3
Table 11-4	Key Indicators and Measurable Parameters.....	11-6
Table 11-5	Environmental Effects Rating Criteria .....	11-7
Table 11-6	Alberta GHG Emissions .....	11-17
Table 11-7	Alberta Projected GHG Emissions.....	11-18
Table 11-8	YYC GHG Emissions for the Proposed Cases .....	11-19
Table 11-9	YYC GHG Emissions in Context with Provincial and National GHG Emission Levels	11-19
Table 11-10	Assessment of Project Effects on GHGs .....	11-25

# 11. Climate and Greenhouse Gases

## 11.1 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 on GHGs 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.

The PRP will result in the emission of greenhouse gases (GHGs), thereby contributing to the national and provincial GHG emissions. GHGs are considered as a valued component (VC) in the environmental assessment (EA) due to their intrinsic importance to climate change as a regional and international issue. Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as “the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persist for an extended period, typically decades or longer”.

It is important, therefore, to develop an appreciation of the potential effects of the PRP on the existing and baseline GHG emission levels.

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 9, Climate and Greenhouse Gases Baseline Report. It includes all of the existing emissions that occur within the Regional Study Area (RSA).

The assessment includes a review of the potential effects on GHGs. The effects assessment examines potential environmental effects that might result from the PRP. The overall significance of the effect of the PRP on GHGs, 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 GHGs is as follows:

- Scoping;
- Approach and methodology;
- Baseline studies;
- Analysis of effects on existing GHG levels; and
- Summary of residual effects.

## 11.2 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 greenhouse gas 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 herein.

## 11.2.1 Relevant Legislation and Guiding Documents

### 11.2.1.1 *International and Federal*

The Government of Canada has set targets for the reduction of GHGs. The Kyoto Protocol is an international accord designed to help reduce the effects of climate change through the reduction of GHG emissions. Canada signed the Kyoto Protocol in 1998, which became legally binding in 2005. Under the terms of the Protocol, Canada is required to reduce GHG emissions. In March 2008, Environment Canada (EC) issued the publication “Turning the Corner, Regulatory Framework for Industrial Greenhouse Gas Emissions”. This publication further outlines Canada’s initiatives in reducing GHGs. The document outlines the regulations that will be implemented in 2010 to govern GHG emissions by major industrial sectors. The regulations will be reviewed every five years to ensure that Canada meets their GHG reduction targets. Currently, the federal regulations are focused on large facility emitters, which do not include the operations at airports. As outlined in the March 2008 publication, Canada’s future GHG reduction targets are: 20% reduction from 2006 levels in 2020, and a 60% - 70% reduction by 2050.

The most recent framework convention on climate change was held in Copenhagen in December 2009. The Copenhagen Accord was drafted by the United States. Nations that will embrace the Accord will cut their emissions by 17% by 2020 from 2005 levels. Canada has written to the UN's climate secretariat agreeing to be "listed" as a country to the Copenhagen Accord.

The PRP is to be built on lands leased from Transport Canada (TC) by the Calgary Airport Authority (the Authority). Normally this would mean that the PRP would be subject to an environmental assessment under CEAA. However, CEAA does not currently apply to airport authorities, although it may do so in the near future. The Authority has elected to subject the PRP to a CS level environmental assessment by means of a process that shadows that which would normally be followed under CEAA. Further detail is provided in Volume II, Chapter 5 of the CS.

### 11.2.1.2 *Provincial*

As stated above, the PRP is situated on federal land so Canadian legislation rather than Alberta legislation applies. It is important to note that where Canadian regulations do not deal specifically with a topic, normal Federal regulatory practice is to require that operators comply with the equivalent provincial regulation. As such, provincial regulations and guidelines for GHGs are also considered.

Many provinces have set their own standards for the reduction of GHGs. Alberta is the first jurisdiction in North America to develop and implement a regulatory-based demand for carbon reductions. Alberta Regulation 139/2007, Specified Gas Emitters Regulation (SGER), requires those facilities in Alberta that emit over 100,000 metric tonnes of carbon dioxide equivalents per year to submit annual greenhouse gas (GHG) compliance reports. As of January 1, 2010, the Specified Gas Reporting Program requires all facilities emitting over 50,000 tonnes of GHGs to report annual GHG emissions to Alberta Environment. The GHG annual report includes annual GHG emissions and production data and the facility’s emissions intensity. However, at this time, there is no compliance requirement to reduce emission intensities for facilities emitting over 50,000 tonnes of GHGs.

The following summarizes the regulations, guidelines and policies for all levels of government to assist in the assessment of potential future project effects on GHG emissions in Alberta.

**Table 11-1 International Regulations and Guidelines**

International Regulations and Guidelines		
Permit/Authorization	Agency	Rationale
Kyoto Protocol	United Nations	Established targets for reducing emissions of GHGs. Countries commit to reducing GHG emissions through their own means, but can also be met by emissions trading, and by implementing GHG reduction in developing countries.
The Copenhagen Accord		Set 17% reduction targets for Canada to be achieved by 2020 from 2005 levels.

**Table 11-2 Federation Regulations and Guidelines**

Federal Regulations and Guidelines		
Permit/Authorization	Agency	Rationale
<i>Clean Air Act</i>	Environment Canada	Covers both climate change objectives and GHG initiatives.
<i>Environment Protection Act</i>	Environment Canada	Outlines mandatory reporting requirements for facilities that emit 50,000 tonnes or more of GHGs. The requirements in this <i>Act</i> will help guide the GHG effects assessment.
Regulatory Framework for Air Emissions (2007)	Environment Canada	Presents the regulatory framework for both industrial GHGs and air pollutants emission reductions.
Regulatory Framework for Industrial GHG Emissions	Environment Canada	The document outlines the regulations that will be implemented in 2010 to govern GHG emissions by major industrial sectors. The regulations will be reviewed every five years to ensure that Canada meets their GHG reduction targets of a 20% reduction from 2006 levels in 2020, and a 60% - 70% reduction by 2050.
Incorporating Climate Change Considerations in Environmental Assessments: General Guidance for Practitioners" (2003)	Canadian Environmental Assessment Agency	Primary document for guidance for addressing climate change for CEAA. The process includes establishing GHG emissions for each phase of the PRP, estimating the contribution of the project to provincial and national emissions, and determining if the project will be a low, medium, or high emitter.

**Table 11-3 Provincial Regulations and Guidelines**

Provincial Regulations and Guidelines		
Permit/Authorization/Guideline	Agency	Rationale
<i>Climate Change and Emissions Management Act (2007)</i>	Alberta Environment	AENV outlines a 50% target reduction in specified gas emissions by 2020, relative to 1990 levels. These gases include: CO <sub>2</sub> , CH <sub>4</sub> , NO <sub>3</sub> , sulphur hexafluoride (SF <sub>6</sub> ), and VOCs. The act also outlines emission offsets and mandatory reporting. The requirement of the <i>Act</i> will be used as a resource to help guide the GHG effects assessment for the operational phase.

Provincial Regulations and Guidelines		
Permit/Authorization/Guideline	Agency	Rationale
Emissions Trading Regulation (2006)	Alberta Environment	This regulation summarizes the Alberta emissions trading program. It outlines the regulations on such processes as applying for baseline emission rates, emission credits, and use of credits for compliance.
Specified Gas Emitters Regulation (2007)	Alberta Environment	The regulation outlines that any facility emitting more than 100,000 tonnes of emissions are required to reduce emission intensities by 12% from baseline conditions. To meet this target, facilities can utilize emission offsets, fund credits and performance credits. This will be used to guide the GHG effects assessment process.
Specified Gas Reporting Regulation (2004)	Alberta Environment	These regulations outlining who is required to report emissions, and what information is required. The information that is required to meet the requirements of this regulation will be used as a guide for the effects assessment.

### 11.2.2 Scenarios

For the operational phase, a GHG emissions inventory was completed for the following four scenarios:

- the 2015 Do-Nothing scenario (DN), which describes YYC and the local road network without the proposed 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 proposed runway in place in 2015;
- the 2025 Do-Nothing scenario (DN), which describes YYC and the local road network without the proposed runway in place in 2025; and
- the 2025 Do-Something scenario (DS), describes YYC and the local road network with the proposed 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 PRP on GHG levels.

### 11.2.3 Key Issues

GHGs are gases in the earth's atmosphere which prevent the loss of heat into space. While GHGs are essential in maintaining a stable temperature and occur naturally, the rising levels of these gases in the earth's atmosphere have caused serious concern, particularly over the past few years. A potential effect of high levels of GHGs in the atmosphere is an increasing average global temperature, which can cause extreme weather conditions and rising sea-levels. Common GHGs include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). Major anthropogenic emissions including fossil fuel combustion and industrial sources are adding to the biogenic concentration of GHGs in the atmosphere. This leads to new absorption and release of energy within the atmosphere, which may lead to climate change. GHGs are important due to their effects on both the regional and global scale. Existing domestic and international aviation accounts for approximately 2% of all global anthropogenic CO<sub>2</sub> emissions (ICAO 2008).

The PRP has the potential to affect existing GHG levels during both its construction and operational phases. The main component of the construction phase that may affect GHG levels is the increased diesel emissions due to increased operation of vehicles and construction equipment on the PRP site.

In addition, various components of the PRP operational phase that may affect GHG levels include increased diesel consumption from an increased number of vehicles and machinery, and changes in airplane and road traffic volumes.

## 11.2.4 Spatial and Temporal Boundaries

### 11.2.4.1 Spatial Boundaries

The international nature of the GHGs and climate change issue dictates that the Regional Study Area (RSA) extends to include the Province of Alberta and Canada. As such, the data for GHGs will focus on information sources for the project, and a discussion of regional factors influencing provincial and national GHG emissions.

The spatial boundaries for aircraft operations include landings and takeoffs (LTOs). These operations include the following six modes of aircraft operations:

- Approach: The airborne segment of an aircraft's arrival extending from the start of the flight profile, which is approximately 3,000 ft (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: Aircraft main engine start-up occurs at the gate. This methodology is only applied to aircraft with ICAO certified engines. All other aircraft will not have start-up emissions.
- 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, which is approximately 3,000 feet (or the mixing height, whichever is lower).

### 11.2.4.2 Temporal Boundaries

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

The construction activities for the project are 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 20 hours a day, 5-7 days per week.

It is expected that the majority of the GHG emissions will occur during the operational phase. GHG emissions will occur during the required operations for the approaches and departures of aircraft. As such, emissions will occur 24 hours a day, 7 days a week for 365 days a year. GHGs were assessed for the period of one year based on the 90<sup>th</sup> busy day operational scenario. The years assessed were 2015 and 2025 using project forecasts for expected increases in aircraft operations.

## 11.3 Issues Identified

GHGs are identified as a VC for the assessment. The potential effects of the PRP on GHGs are associated with project-related alterations relative to baseline conditions.

The issues raised during the public meetings related to the GHG emissions resulting from the PRP are addressed in Section 11.9.

To address the issues from the consultation process, the GHG emissions for the PRP have been assessed for the construction and operational phase. This assisted in assessing the potential effects of the project activities on GHG baseline levels. Additionally, GHG emissions as a result to changes in the transportation network have been assessed.

#### 11.4 Key Indicators and Measurable Parameters

Table 11-4 summarizes the potential issue/effect, the relevant key indicator and the measurable parameter.

**Table 11-4 Key Indicators and Measurable Parameters**

Issue/Effect	Key Indicator	Measurable Parameters
Alterations in GHG baseline levels associated with:  Construction Phase: <ul style="list-style-type: none"> <li>• Road traffic emissions</li> <li>• Site clearing and grubbing</li> <li>• Operation of construction equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Annual GHG emissions</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon dioxide equivalents (CO<sub>2eq</sub>)</li> </ul>
Alterations in GHG baseline levels associated with:  Operational Phase: <ul style="list-style-type: none"> <li>• Changes in aircraft operations</li> <li>• Changes in air space time for aircraft in the Calgary airshed</li> <li>• Use of ground service equipment</li> <li>• Stationary combustion sources</li> <li>• Change in local traffic patterns</li> </ul>	<ul style="list-style-type: none"> <li>• GHGs</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon dioxide equivalents (CO<sub>2eq</sub>)</li> </ul>

#### 11.5 Existing Conditions

The existing regional GHG emissions were determined for the Province of Alberta and Canada by compiling data from EC's 2007 GHG Inventory (Environment Canada 2009). In addition, existing GHG emissions from current operations at YYC were determined by reviewing YYC's 2007 GHG inventory. The following sources were considered in YYC's 2007 GHG emissions inventory calculations:

- landing and takeoff operations (LTOs);
- road vehicles including both visitors' and employees' trips;
- airside movements, which include aircraft use of auxiliary generators, mobile generators, aircraft manoeuvring, air start compressors, ground vehicles, and equipment;
- stationary power generation plants;
- heating and air conditioning for buildings; and
- aircraft maintenance, engine testing, stationary emergency power generation units, airfield vehicles, aircraft de-icing and anti-icing fluid use, and fire training exercises.

For existing conditions, the YYC GHG emissions account for 0.07% and 0.02% of the provincial and national emissions, respectively. The existing contribution of the YYC operations to the provincial and national GHG emission inventory is considered to be very small.

## 11.6 Effects Assessment

### 11.6.1 Effects Assessment Methodology

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

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

For the purposes of this study, a significant adverse effect is one in which:

- there are frequent or sustained GHG emissions that are high in magnitude; or
- the effect on GHG levels continues after the project is complete.

Table 11-5 provides the definition and criteria rating for each characterization criteria.

**Table 11-5 Environmental Effects Rating Criteria**

Effect Criteria	Criteria Rating	Definition
Direction	Beneficial	The effect reduces the GHG loading as a result of project actions
	Neutral	No change
	Adverse	The effect worsens the existing GHG conditions and trends
Magnitude	Negligible	No measurable effects
	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 the YYC
	Local	The effect is spatially restricted within the City of Calgary
	Regional	The effect extends beyond the regional study area
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 10 years
	Long Term	Effect occurs for longer than 10 years
Reversibility	Reversible	The effect on the VC will cease during or after the project is complete
	Partially reversible	Effect is partially reversed after the activity ceases
	Irreversible	The effect on the VC will continue after the project is complete

The following assessments were completed:

- present contribution to regional GHG emissions from the Regional Study Area (RSA);
- contribution of GHG emissions due to construction activities associated with the PRP;
- expected GHG emissions resulting from future operations that can be directly attributed to the PRP; and
- identification of mitigation measures that might be introduced to reduce or eliminate GHG 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 appropriate calculation methodologies. The assessment focused on key project activities and physical works that may affect the regional GHG levels. The GHG calculations were built upon the methodologies developed for the baseline and were based on peak operations for normal operating conditions. The GHG calculations considered type and quantity of equipment and maximum operating times.

### 11.6.2 Emissions Inventory Assessment

Total GHG emissions are determined based on the major GHGs: CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. These GHGs are typically reported as total GHGs called CO<sub>2</sub> equivalents (CO<sub>2eq</sub>). To determine CO<sub>2eq</sub>, a Global Warming Potential (GPW) factor is assigned to the various gases that account for the differing influence of each gas to the effect of atmospheric interaction that may lead to climate change. The GPW is used to calculate each gas' emission relative to CO<sub>2</sub>. The GPWs for the above gases are listed below:

- CO<sub>2</sub> = 1.0;
- CH<sub>4</sub> = 21.0; and
- N<sub>2</sub>O = 310.0.

Using these values, total GHG emissions are calculated using the equation below:

$$\text{Total CO}_{2\text{eq}} \text{ tonnes} = (\text{CO}_2 \text{ tonnes} \times 1.0) + (\text{CH}_4 \text{ tonnes} \times 21.0) + (\text{N}_2\text{O} \text{ tonnes} \times 310.0)$$

CO<sub>2eq</sub> were assessed for the following sources:

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

For the purposes of the GHG assessment, CO<sub>2eq</sub> for aircraft movements were estimated using emission factors from the International Civil Aviation Organization (ICAO) Aircraft Engine Exhaust Databank and the use of the Emissions and Dispersion Modelling System (EDMS 2009). For older aircraft, engine data were obtained from the Environmental Protection Agency's (EPA AP-42), Part II, Section 1.

EDMS is designed to assess the CO<sub>2eq</sub> emissions from airport emission sources from aircraft movements, which include landing and takeoffs (LTOs) and aircraft manoeuvring. In 1998, Federal Aviation Administration (FAA) revised its policy on air quality modelling procedures to identify EDMS as the required model for air quality analyses for aviation.

The six modes of aircraft operations that were assessed included:

- Approach: The airborne segment of an aircraft's arrival extending from the start of the flight profile, which is approximately 3,000 ft (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: Aircraft main engine start-up occurs at the gate. This methodology is only applied to aircraft with ICAO certified engines. All other aircraft will not have start-up emissions.
- 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, which is approximately 3,000 ft (or the mixing height, whichever is lower).

The above-mentioned modes were assessed for the GHG emissions inventory and constitute an LTO cycle. LTOs correspond to different power settings and ultimately, fuel consumption values, which are used to estimate GHG emissions for aircraft. The sequence modelling was employed in EDMS to determine aircraft ground movement modelling. 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 arrival gates; as such, ground delays that may be experienced in landings are excluded from the emissions inventory.

The sequence modelling requires a defined airport configuration that specifies the gates, taxiways, runways, and taxipaths. Also, it requires the annual operations and operational profiles. The operational profiles and annual operations were determined using data from the 90<sup>th</sup> percentile busiest operational day. All these data are utilized to determine the LTO cycle and the associated power settings. AECOM defined the airport configurations using the Airfield Simulation Assumption Documents as a guide for each scenario assessed (Airbiz 2009a and Airbiz 2009b). Figure 11-1 through to Figure 11-3 show the different taxiways and runways that were considered for each scenario that was assessed.

The GHG emissions for road vehicle traffic, de-icing facility and stationary power generation plants were estimated using published emission factors based on expected typical operations. The general method for emissions inventories is to multiply the activity by the associated emission factor. As EDMS only calculates CO<sub>2</sub> emissions from aircraft movements, emission factors for vehicle traffic, de-icing and stationary combustion units were obtained from the methodology previously used for YYC GHG emission inventories. The methodology was previously used by the Authority for the YYC 2007 emissions inventory (EBA 2008).

The GHG emissions for on-road vehicles were estimated for CO<sub>2</sub>. The annual travelled distance and traffic volume were determined for traffic within the airport area and included the following roads: 11 Street Northeast, 64 Avenue NE, 78 Avenue NE, Aero Gate, Aero Drive, Airport Road NE, Aviation Boulevard North, Aviation Boulevard, Barlow Trail, and McCall Drive. Road traffic allocations from road

closures and vehicle routing changes were considered to estimate GHG emissions for the proposed scenarios. For example, the closure of Barlow Trail as a result of the airport expansion was considered and the distance of the alternate route and the change in traffic volumes for the identified roads were used in the GHG emission calculations. The total distance travelled and the appropriate emission factor was applied to calculate CO<sub>2</sub> emissions from on-road vehicles. The emission factors used were from the Greenhouse Gas Emissions Quantification Guidance (Environment Canada 2010).

De-icing operations that use materials manufactured from fossil fuels can lead to atmospheric emissions of non-methane volatile compounds. These compounds are further oxidized in the atmosphere to CO<sub>2</sub> emissions during de-icing operations. As in the Authority's 2007 GHG inventory methodology, 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 2008 operations were used to estimate glycol consumption required for de-icing. As an example, the volume consumption for 2008 was 1,087,300 L of 50% water 50% glycols additives. 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 emission factor used for de-icing operations was from YYC's CO<sub>2</sub> emission methodology, as previously discussed.

CO<sub>2</sub> emissions from the stationary power generating units are generated via the combustion of fuel gases in the boilers. Therefore, the CO<sub>2</sub> emissions for stationary power generating units were based on the fuel consumption used at each boiler. For the future scenarios, the computations were based on doubling the fuel consumption to account for the heating required for the proposed IFP terminal. The GHG emission factors used for the fuel consumption were obtained from the Greenhouse Gas Emissions Quantification Guidance (Environment Canada 2010).

The GHG emission factors for auxiliary power units (APUs) were obtained from the International Civil Aviation Organization (ICAO) Aircraft Engine Exhaust Databank, a publicly available database. Ground service equipment (GSE) GHG emissions were estimated using the published emissions factors for CO<sub>2</sub> emissions in the U.S. Environmental Protection Agency's Chapter 3, Section 3, Table 3.3-1 (EPA AP-42). A number of GSEs were allocated for each aircraft per LTO to load and unload baggage, to provide food and fuel, and to service the lavatory and the cabin.

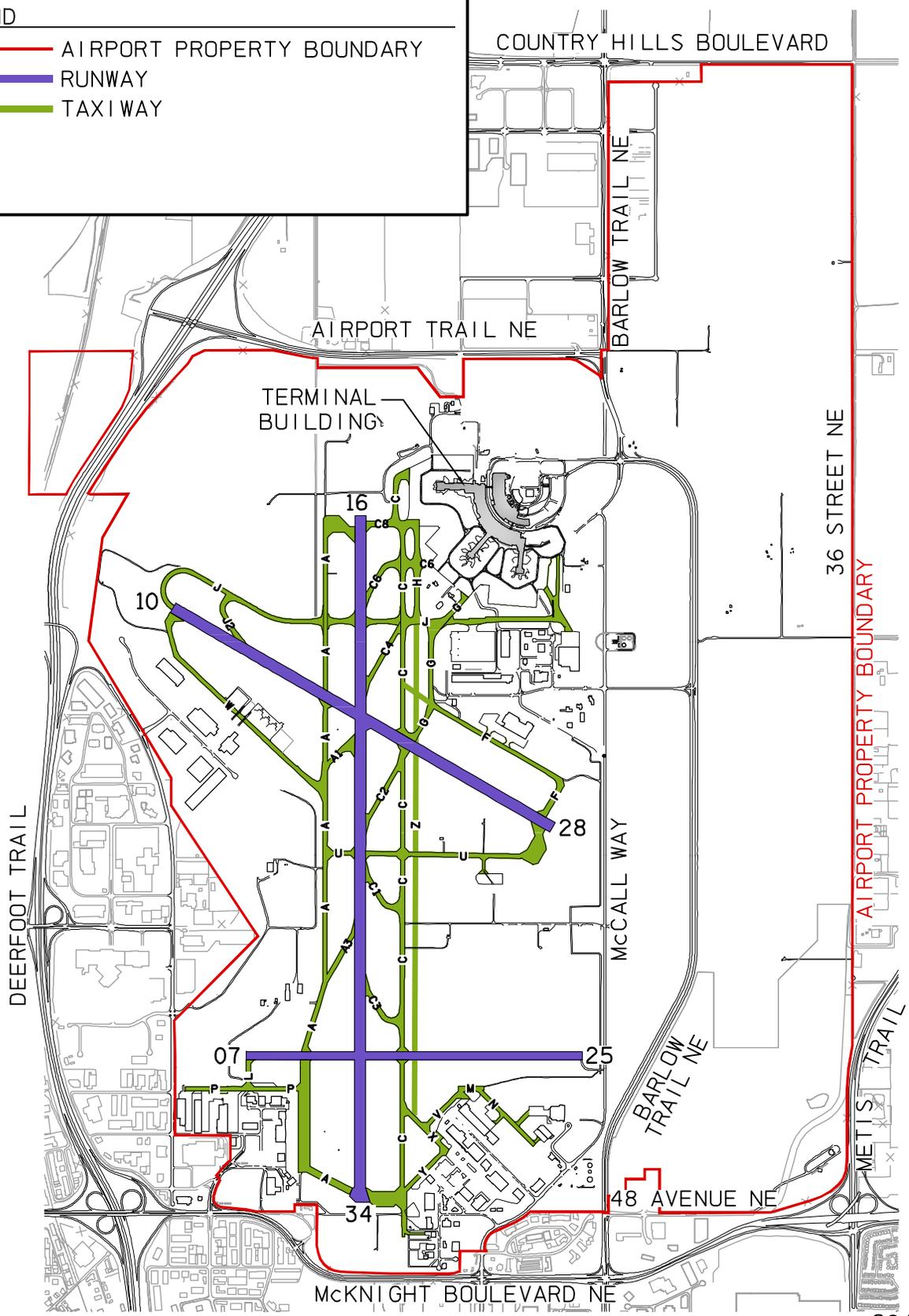
There are other sources included in the study such as warehouses, office buildings and airside vehicles. GHG emissions from these sources were used from the YYC GHG emission inventories and were assumed to be similar for the future proposed scenarios. It is not anticipated that the GHG emissions would significantly vary since it is not expected that a significant number of new buildings or warehouses are to be built as part of the PRP.

The CO<sub>2</sub> emissions for this GHG assessment were used to represent CO<sub>2eq</sub>. As N<sub>2</sub>O only represented 2.6% of the total CO<sub>2eq</sub> in previous YYC GHG emission inventories, N<sub>2</sub>O was deemed insignificant and was not considered further.

ISS/REV: A  
 YYC FILE NAME: 09c16c390\_RX.dwg  
 Saved By: BANE, ALISON  
 PLOT: 10/05/21 9:00:07 AM  
 A SIZE 8.5" x 11" (215.9mm x 279.4mm)

**LEGEND**

- AIRPORT PROPERTY BOUNDARY
- RUNWAY
- TAXIWAY



SCALE: NTS

**YYC** CALGARY AIRPORT AUTHORITY

The Calgary Airport Authority  
 Runway Development Program  
 Parallel Runway Project

**AECOM**

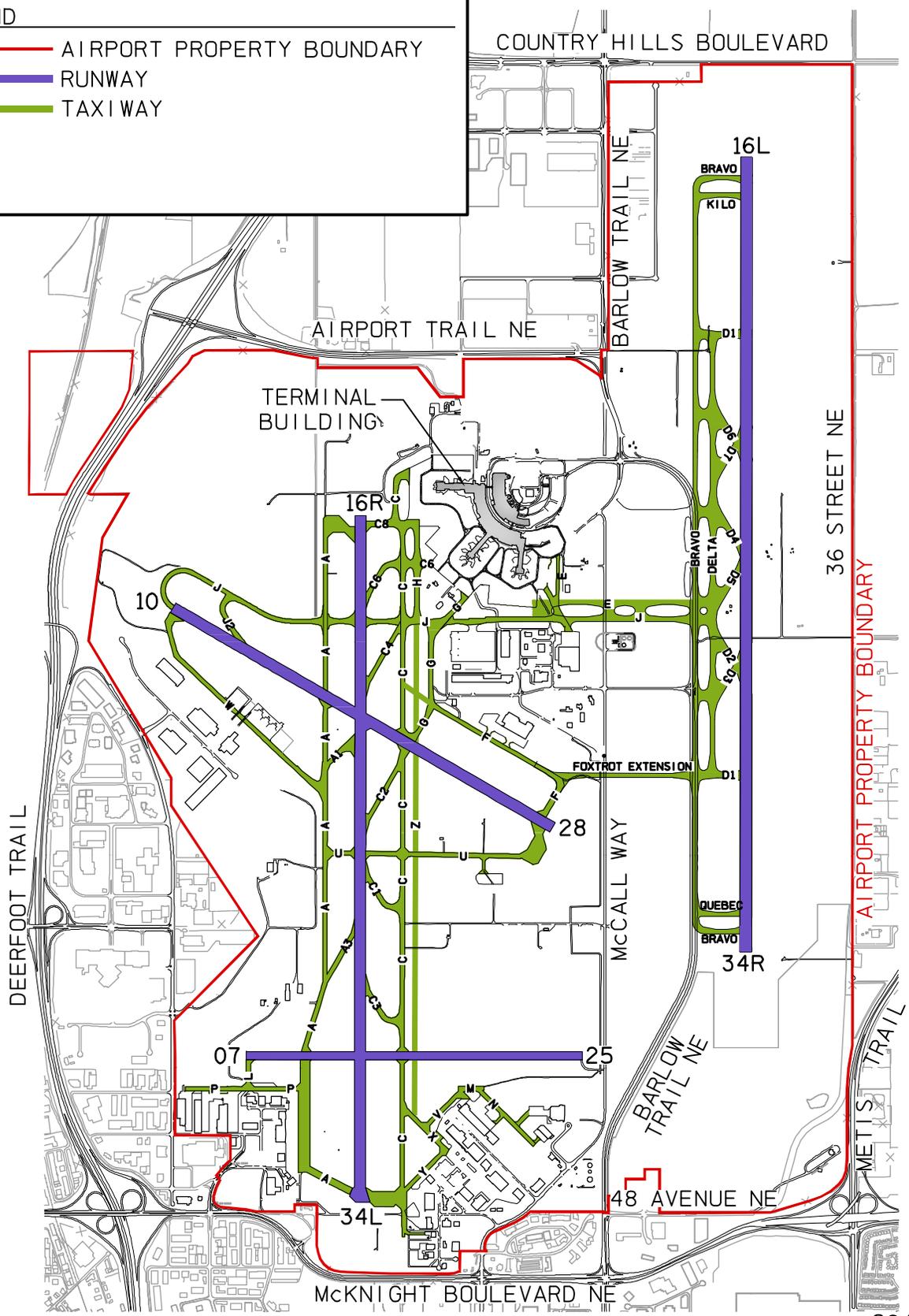
THIS DRAWING, IN ALL FORMS, ELECTRONIC OR HARD COPY, IS THE EXCLUSIVE PROPERTY OF THE CALGARY AIRPORT AUTHORITY AND MUST NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION.

2015 DN and 2025 DN Taxiways and Runways **Figure 11-1**

ISS/REV: A  
 YYC FILE NAME: 09c16c391\_RX.dwg  
 Saved By: BANE, ALISON  
 PLOT: 10/05/21 9:01:03 AM  
 A SIZE 8.5" x 11" (215.9mm x 279.4mm)

**LEGEND**

- AIRPORT PROPERTY BOUNDARY
- RUNWAY
- TAXIWAY



SCALE: NTS

**YYC** CALGARY AIRPORT AUTHORITY

The Calgary Airport Authority  
 Runway Development Program  
 Parallel Runway Project

**AECOM**

THIS DRAWING, IN ALL FORMS, ELECTRONIC OR HARD COPY, IS THE EXCLUSIVE PROPERTY OF THE CALGARY AIRPORT AUTHORITY AND MUST NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION.

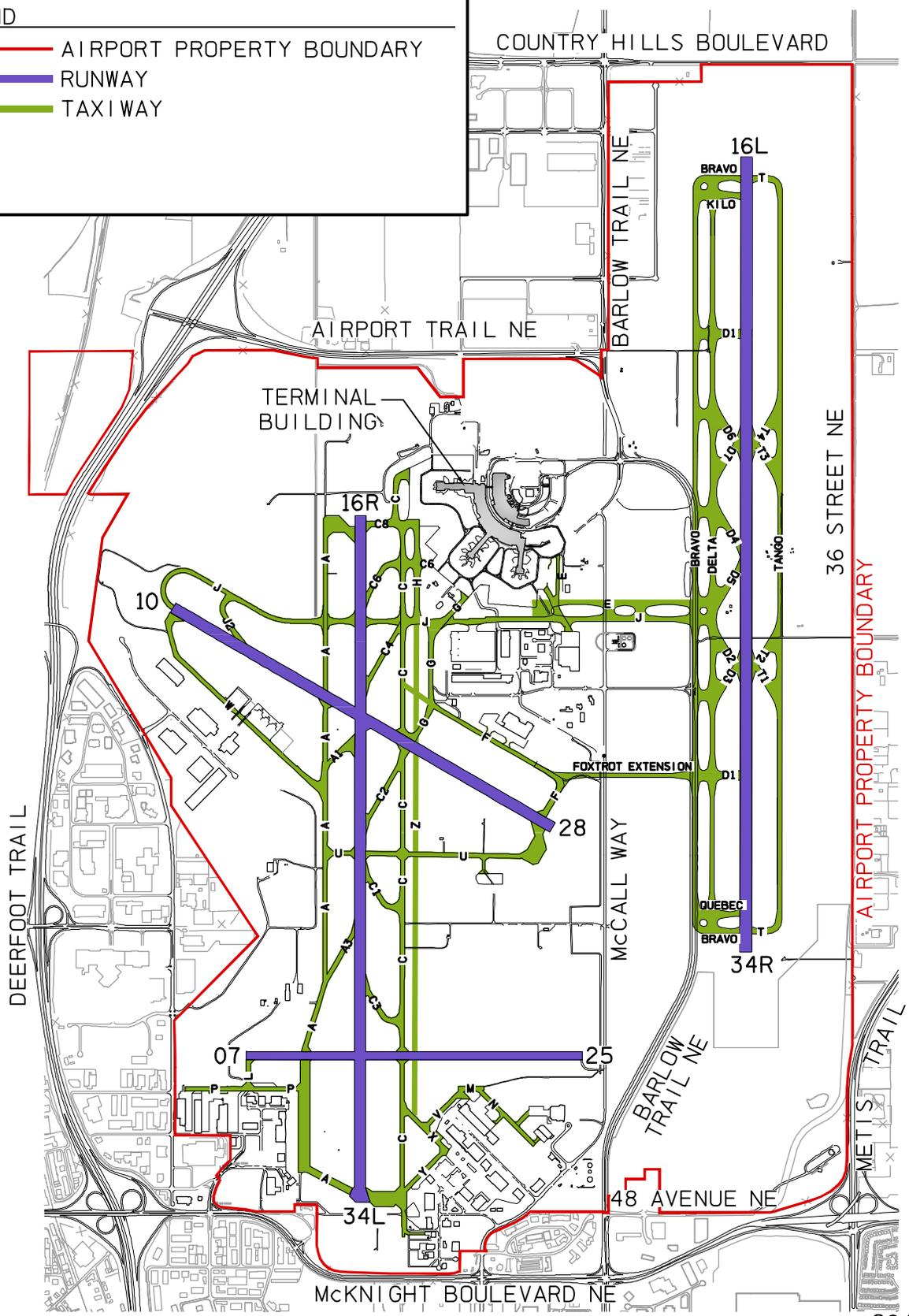
2015 DS Taxiways and Runways

Figure 11-2

ISS/REV: A  
 YYC FILE NAME: 09c16c392\_RX.dwg  
 Saved By: BANE, ALISON  
 PLOT: 10/05/21 9:01:39 AM  
 A SIZE 8.5" x 11" (215.9mm x 279.4mm)

**LEGEND**

- AIRPORT PROPERTY BOUNDARY
- RUNWAY
- TAXIWAY



SCALE: NTS

**YYC** CALGARY AIRPORT AUTHORITY

The Calgary Airport Authority  
 Runway Development Program  
 Parallel Runway Project

**AECOM**

2025 DS Taxiways and Runways

Figure 11-3

THIS DRAWING, IN ALL FORMS, ELECTRONIC OR HARD COPY, IS THE EXCLUSIVE PROPERTY OF THE CALGARY AIRPORT AUTHORITY AND MUST NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION.

### 11.6.3 Assumptions and Limitations

Emissions factors were used for the GHG emission calculations in this study. These emission calculations form the foundation of the GHG assessment. Uncertainty due to the emissions calculations is associated with the variability in activities or conditions and the use of default emission factors. The GHG calculations developed for the assessment study incorporate a variety of assumptions concerning the airport 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. However, the predicted emission rates are calculated based on the 90<sup>th</sup> percentile busiest operating day. In reality, the actual emission rates will vary from hour to hour and day to day, and actual annual operations will be less than those used in this study, thus providing a conservative estimate of GHG emissions. As a result, the uncertainty in the calculations and the results of the calculations are not considered to significantly affect the results. In summary, the results of the GHG calculations are considered to be biased high due to 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, which are used to estimate GHG emissions. Any change of airport configurations and taxi pathways from the reports published by Airbiz in 2009 will alter the estimated GHG emissions.

The sequence modelling was employed in EDMS to determine aircraft ground modelling. 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 ground travel to the arrival gates; as such, ground delays that may be experienced in landing are excluded. Therefore, improvements in operational efficiency that may be realized from the PRP may directly improve activities including improvements on landing delays. These improvements could lead to benefits in the form of reduced GHG emissions for the operation of the parallel runway. 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 as outlined by FAA. The exclusion of this improvement leads to a more conservative assessment between the DN and DS scenarios.

Additionally, potential improvements to congestion in the air are not covered by calculations through the EDMS software. The reason is that responsibility for emissions is divided between airports and airlines and the demarcation point is at an altitude of 3,000 ft on descent to arrival. So potential delays on arrival in the air, which may involve one or more circuits of the airfield are assigned to airlines and not included in GHG inventories and assessments of airports. However, an environmental assessment normally considers all effects of a project. In this case, that would include changes in emissions related to changes in airfield congestion on arrival. Unfortunately, it is impossible to produce a reliable quantitative estimate of airfield delays on arrival. Firstly, the future operating scenario for operating the airport and managing the airspace will be determined by NAV CANADA and this is not yet available. Secondly, there is no basis for predicting the response of NAV CANADA, pilots, or airlines to delays. Some aircraft will circle until allowed to land, some aircraft will be diverted to other airports, some will be held at their points of departure until congestion at YYC clears, and some flights will be cancelled. All that can be asserted is that the new runway may reduce potential airfield congestion as it allows more aircraft movements per

hour. As such, potential increases of GHG emissions due to potential increased airfield congestion caused by delays on arrival are expected to be less with the new runway in place than without it. As this currently cannot be quantified, this emission source cannot be added to the GHG inventory and we cannot say whether it will make a significant difference to the net change in emissions.

Furthermore, the runway use in the assessment assumed only the use of the existing north-south runway and the parallel runway. A 50% split between the use of the existing north-south runway and the parallel runway was used. 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 that it is more likely that aircraft will use runways that are closer to their assigned gates. By assuming a 50% split, the GHG calculations account for a larger amount of taxiing that would be used for the DS scenarios than in reality.

For the DN scenarios, the model used a maximum capacity of 30 arrivals and 30 departures. For the DS scenarios, the model used a maximum capacity of 50 arrivals and 50 departures to account for the addition of the parallel runway. This data was obtained from Airbiz, which was based on nautical miles separation. 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 study. Therefore, an average GHG emissions factor was employed to determine GHG emissions from road traffic.

Other sources assessed in the study include warehouses, office buildings and airside vehicles. GHG emissions from these sources were used from the existing YYC GHG emission inventories and were assumed to be the same for the proposed scenarios. It is not anticipated that the GHG emissions would vary significantly unless a large amount of new warehouses and offices are added.

Boiler fuel usage is estimated 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. The boiler fuel usage does not differ between the DN and DS scenarios.

APU are small jet 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. CO emissions from GSE and APUs were estimated through the use of EDMS. CO emissions are results of incomplete combustion and CO<sub>2</sub> dissociation. Also, both CO and CO<sub>2</sub> emissions are based on fuel consumption and due to the carbon mass balance, the carbon in the fuel will be oxidized to either CO or CO<sub>2</sub>. As such, the CO<sub>2</sub> emissions were estimated using the ratio of CO:CO<sub>2</sub> using the published emissions factors for CO and CO<sub>2</sub> in the AP-42 (US EPA 1995). GSE can be powered by diesel or gasoline engines. In efforts to remain conservative, the CO<sub>2</sub> emission factor for diesel was used, as it was higher than the emission factor for gasoline.

Materiality refers to an error, omission, or misrepresentation that would affect the GHG assertion for the PRP. As outlined by Alberta Environment's publication, Specified Gas Emitters Regulation: Offset Credit Verification Guidance Document, omissions are considered material if they result in greater than 5% change of the total reported GHG emissions assertion. As such, the GHG emissions from the engine run-ups, airside vehicles, the stand-by generators, and N<sub>2</sub>O emissions were not included in this study as they collectively contribute to less than 5% of the CO<sub>2eq</sub> and this omission is considered immaterial.

The loss of GHG sinks due to the loss of soil is not included in this study as all disturbed soils will be reused on-site. Therefore, no substantial emissions from this source are anticipated. Volume III, Chapter 3 in this assessment presents further discussion on soil disturbance mitigations.

#### 11.6.4 Effects Assessment by Project Phase

The GHG effect is caused by absorbing gases that trap solar radiation within the atmosphere. These absorbing gases (known as GHGs) include CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. GHGs are emitted from both anthropogenic and biogenic sources. Major anthropogenic emissions including fossil fuel combustion and industrial sources are adding to the biogenic concentration of GHGs in the atmosphere.

The science of climate change has not been advanced to the point where a clear and direct relationship can be determined for specific (or even regional) GHG emissions and global climate change. Although incremental increases in global emissions of GHGs are believed to be a significant driver for changes in future climate change trends, it is not possible to conclude with certainty that a given source of GHGs has a measurable effect on local, regional or global climate. Therefore, the expected increased GHG emissions from the PRP cannot be linked to specific changes to climate change. As such, project effects on climate change are not discussed further in this EA. Instead, project effects on GHG emissions are discussed. For the effects assessment, the project GHG emissions are placed in context with total regional emissions provincially and nationally. The potential project effects on existing GHG levels are assessed below for the key indicator CO<sub>2eq</sub>.

##### 11.6.4.1 Construction Phase

###### Effects Analysis

The proposed runway will result in emissions of GHGs during the construction phase. Potential effects 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 GHG emissions. The construction activities involved in the PRP, which have the potential to contribute to existing GHG levels include:

- construction of and use of temporary facilities and construction staging areas;
- 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 including CO<sub>2</sub> and N<sub>2</sub>O. In addition, the use of vehicles will also generate CO<sub>2</sub> and N<sub>2</sub>O emissions as they travel to and from, as well as on, the construction site. Furthermore, land clearing activities will result in a reduction of carbon sinks for emissions of GHGs. As a result, it is expected that the construction phase will result in effects on existing GHG emission levels by increasing the annual emissions of CO<sub>2eq</sub>.

###### Mitigation

A number of mitigation measures will be implemented to protect the climate and limit the emissions of GHGs. As GHG emissions are directly linked to fuel consumption, the mitigation measures outlined focus on reducing fuel consumption in efforts to increase fuel efficiency. Mitigation of the effect on GHG emissions from the operation of heavy diesel vehicles and equipment 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.

These mitigation measures will be implemented as deemed appropriate by the construction contractor.

Additionally, land clearing for the project site and access roads will be carried out in efforts to revegetate appropriate areas quickly and to the greatest extent possible. Efforts will be taken to minimize land disturbance and land clearing.

### Residual Effects

With effective mitigative measures implemented, significant residual effects on GHG levels from construction activities are unlikely. The construction activities will be of a short to medium term duration and will likely be of low magnitude for the RSA. As the emissions of GHGs will be short term and of low magnitude, no significant adverse residual effects on the GHG levels and the climate are likely to occur.

#### 11.6.4.2 Operational Phase

### Effects Analysis

#### **Provincial and National Emissions**

Total GHGs emissions by sectors for Alberta in 1990 and 2007 are presented in Table 11-6.

**Table 11-6 Alberta GHG Emissions**

	<b>1990 Emissions (kt CO<sub>2eq</sub>)</b>	<b>% of 1990 National Emissions</b>	<b>2007 Emissions (kt CO<sub>2eq</sub>)</b>	<b>% of 2007 National Emissions</b>
Energy	146,900	45%	210,400	51%
Transportation	1,100	1%	1,600	1%
Industrial Processes	8,200	15%	12,900	25%
Solvent and Other Product Use	16	9%	34	11%
Agriculture	14,000	29%	19,000	32%
Waste	1,300	7%	1,600	8%
<b>Total</b>	<b>171,000</b>	<b>29%</b>	<b>246,000</b>	<b>33%</b>

Source: Environment Canada 2009.

In Alberta, energy is the leading source for GHG emissions. There is an overall increasing trend in energy GHG emissions in Alberta. In the table above, emissions from energy represent emissions from a combination of both stationary combustion sources and transportation sources. Stationary combustion sources, dominated by the power generation and fossil fuel industries, contributed 65% and 64% of 1990 and 2007 total energy sector GHG emissions, respectively. Transportation emissions contributed 15% and 18% of total provincial transportation sector GHG emissions in 1990 and 2007, respectively.

In 2007, the province of Alberta was the second largest GHG emitter in Canada, generating 33.2% (245.7 Mt) of CO<sub>2eq</sub>. Alberta's total GHG emissions and its relative contributions to national emissions are both trending upwards. As shown in Table 11-6, total GHG emissions increased by 74 Mt CO<sub>2eq</sub> between 1990 and 2007. Alberta's contribution to the national total GHG emissions increased from 28.9% to 32.9%. Per capita emissions are also on the rise. Since 1990, Alberta's population has grown by 36.4%, while its GHG emissions have grown by 43.7%. The increased per capita emissions were predominantly

driven by increases from the mining and fossil fuel industries (35.2 Mt), electricity and heat generation (15.1 Mt), and road transportation (7.7 Mt) sectors. Alberta's per capita GHG emission rate was 70.7 t GHG per person in 2007, making Alberta the highest per capita GHG emitter in Canada (Environment Canada 2009).

Emissions from civil aviation accounted for 1.04% of the national GHG emissions for 2007. Civil aviation accounts for all GHG emissions from domestic air transport (commercial, private, military, agriculture, etc.). However, the civil aviation emissions reported by EC do not include emissions from associated ground transport and stationary combustion applications. These emissions are reported under separate categories in EC's national pollution reporting inventory (NPRI). In addition, emissions arising from fuel sold to foreign airlines and fuel sold to domestic carriers but consumed during international flights are considered to be international bunkers and are not reported as civil aviation emissions by EC.

The Alberta and Canadian total GHG emissions forecasted for 2020 are presented in Table 11-7. These data were published by Natural Resources Canada (NRCAN 2010) and are currently the most complete projections for GHGs in Canada.

**Table 11-7 Alberta Projected GHG Emissions**

	2020 Emissions (kt CO <sub>2eq</sub> )	% of 2020 National Emissions
Alberta GHG Emissions	264,630	31%

### Project Site GHG Emissions

The following sources were considered in the GHG emissions inventory calculations:

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

LTO operations are the major GHG emitting activities at airports. The LTO operations that were considered included takeoff, climb, approach, and taxi/idle time. The LTO time for each of these operations were determined by using the Sequencing Module within the EDMS software. The Sequencing Module models the movement of aircraft along the taxiways (as prescribed by the taxi paths) between runways and gates for both arriving and departing aircraft. In addition, modelling of taxi queuing is then done for departing flights, but not arriving aircraft, which are assumed to have unimpeded taxi in to their gate. The departing aircraft are sequenced in order to provide the duration that each aircraft spends on each taxiway segment. Additionally, the module accounts for the aircraft forming queues along the taxiways that feed into the corresponding runway-ends.

CO<sub>2</sub> was calculated for each emission source identified previously. Emission factors were used to calculate the amount of CO<sub>2</sub> emitted from each source. The emissions of CO<sub>2</sub> were then used as total CO<sub>2eq</sub> from the airport, as previously discussed.

Table 11-8 summarizes the GHG emission inventory by the source category or each scenario assessed.

**Table 11-8 YYC GHG Emissions for the Proposed Cases**

Airport-Related Emission Sources	2015 DN (kt CO <sub>2eq</sub> )	2015 DS (kt CO <sub>2eq</sub> )	2025 DN (kt CO <sub>2eq</sub> )	2025 DS (kt CO <sub>2eq</sub> )
Aircraft	184	192	287	267
Air Terminal Building	16	16	16	16
APU	4	4	5	5
GSE	97	97	140	140
Vehicle Traffic	28	38	28	38
Glycol Use	2	2	2	2
Other Sources <sup>1</sup>	13	13	13	13
<b>Total</b>	<b>344</b>	<b>362</b>	<b>491</b>	<b>481</b>

Notes:

<sup>1</sup> Other sources include fire training, offices, and warehouses.

Aircraft movements account for approximately 52% to 58% of the operational CO<sub>2eq</sub> emissions, followed by CO<sub>2eq</sub> emissions from aircraft GSE, which accounts for approximately for 27% to 29%. As such, CO<sub>2eq</sub> emissions from aircraft activities are the major source of GHG emissions from the PRP.

The GHG emissions from the operational phase for the proposed 2025 operations increased compared to those for 2015 operations. The increase is attributed to the increase in aircraft traffic and the associated activities, such as emissions from GSE and APUs. The projected GHG emissions for the operational phase with the proposed runway are slightly higher than those without the runway for 2015. The total GHG emissions from the 2015 DS scenario were 5.2% higher than those for the 2015 DN scenario. Similarly, the total GHG emissions from the 2025 DS scenario were 6.6% higher than those for the 2025 DN scenario.

It is important to understand the contribution of YYC's GHG emissions to the RSA. Table 11-9 summarizes YYC's GHG emission levels in context with the national and provincial GHG emissions.

**Table 11-9 YYC GHG Emissions in Context with Provincial and National GHG Emission Levels**

Airport-Related Emission Sources	2007	2015 DN	2015 DS	2025 DN	2025 DS
% of Provincial Emissions	0.08	0.13	0.14	0.19	0.18
% of National Emissions	0.03	0.04	0.04	0.06	0.06

The 2007 National Emissions Inventory Report summarized the GHG emissions for Canada and for Alberta. In 2007, Canada was responsible for 747,000 kt of GHG emissions, while Alberta was reported as emitting 246,000 kt of GHGs. In relation to the provincial and national GHG emission, the 2007 YYC operations contributed to approximately 0.08% of Alberta's annual GHG emissions and 0.03% of the national annual GHG emissions.

The 2015 and 2025 scenarios show increased effects on the RSA in comparison to the 2007 GHG emissions.

Guidelines for the GHG emissions inventory for airports were prepared by the Airport Cooperative Research Program (ACRP). The recommended sources to be considered in a GHG emissions inventory are aircraft, APUs, GSE, ground access vehicles, and stationary sources. All of these sources were considered in the GHG emission calculations for 2015 and 2025. As such, for the 2015 and 2025 scenarios, GSE allocations for each aircraft and associated emissions have been calculated in

accordance with the GHG guidelines by the ACRP. However, it appears that emissions from GSE that are associated with each aircraft were not included in the EBA study for the 2007 GHG emissions (EBA 2008). As such, the reported 2007 emissions do not include GSE allocations for each aircraft. This omission leads to the difference seen for the effects on the RSA between 2007 and the future scenarios. If GSE are accounted for in the GHG 2007 emissions, the difference between 2007 and 2015 effects on the RSA will only be 0.01 - 0.06%.

The projected emissions for 2020 from Natural Resources Canada forecasts that GHG emissions from Alberta and Canada will be 264,630 kt and 853,645 kt, respectively. The 2015 DS operational phase contributed to approximately 0.13% of Alberta's forecasted annual GHG emissions and 0.04% of Canada's forecasted annual GHG emissions. Similarly, the 2025 DS operational phase contributed to approximately 0.19% of Alberta's annual GHG emissions and 0.06% of the national annual GHG emissions, respectively. Therefore, the contribution of the YYC operations to the provincial and national GHG emission inventory is considered to be very small.

The minor increases in the RSA's GHG emissions that are predicted for the future operating 2015 DS scenario is only 0.01% more than the DN scenario. However, in the long term, the 2025 DS scenario contributes 0.01% less than the 2025 DN scenario. As such, the PRP is expected to reduce GHG emissions in the future. As discussed above, this is the level at which changes in GHG are considered insignificant. However, in developing these predictions of GHG emissions for the various scenarios, several conservative assumptions have been made, including the exclusion of landing delay improvements. Additionally, the expected improvements in stack congestion by the airport have not been considered as part of the GHG boundary for this assessment. There are improvements in operational efficiency that may be realized from the project that may directly improve activities such as landing ground delays and stack congestion. These improvements could lead to benefits in the form of reduced GHG emissions during these events. These effects have not been included in the quantitative assessment of GHG emissions since this is the accepted protocol used when calculating GHG emissions with EDMS and the FAA.

Furthermore, the runway use in the assessment assumed a 50% split between the use of the existing runway and the parallel runway. 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 that during other operating periods, it is more likely that aircraft will use runways that are closest to their assigned gates. By assuming a 50% split for the runway use, the GHG computations account for a larger amount of taxiing than would be used for the PRP scenario than in reality.

The net effect is that GHG emissions will, in the most conservative case, increase by an insignificant amount. If the reductions in GHG emissions associated with the expected reduction in stack congestion and landing delays attributable to the parallel runway are considered, the net effect of the project on GHG emissions would be less. At the moment, we do not have sufficient information to conclude that the parallel runway would increase or decrease overall GHG emissions or what the direction of change would be. We can say that the difference will not be significant based on the criteria described above.

### **Mitigation**

A number of mitigation measures will be implemented to limit the emissions of GHGs. As GHG emissions are directly linked to fuel consumption, the mitigation measures outlined focus on reducing fuel consumption in efforts to increase fuel efficiency. Mitigation of the effect on GHG emissions from the operation of the GSE fleet, APUs and associated road traffic may include:

- minimization of vehicle idling and turning off equipment when not in use;
- implementation of best practices to ensure GSE are properly tuned and maintained; and
- 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. Some 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. As such, these mitigation measures will be implemented as appropriate.

In consideration of the increased air traffic volumes in the future, the purpose of the PRP is to add an additional runway to alleviate air traffic congestion in the study area. By implementing the PRP, air traffic congestion is expected to be reduced in the RSA in the future. As such, the PRP is a mitigation measure that is expected to help alleviate air traffic congestion and mitigate GHG emissions for the long term.

### **Residual Effects**

With effective mitigative measures implemented, significant residual effects on GHG levels from the PRP's operational phase are unlikely. The PRP is not expected to generate GHG emissions that are more than 10% of the baseline scenarios. Additionally, the project is expected to only contribute a maximum of 0.06% to national GHG levels and 0.18% of provincial GHG levels. The potential GHG effect of the PRP on the RSA is negligible in consideration of the change in the baseline levels to the project levels.

As such, the emissions of GHGs during the operational phase are low in magnitude for the RSA. Therefore, no significant adverse residual effects on the GHG levels during the operational phase are likely to occur.

## **11.7 Cumulative Effects Assessment**

The PRP's 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 RSA 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 the individual interaction of the PRP may be determined to be not significant, the combined effects of various other activities with project activities 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.

The PRP's potential effects on GHGs 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 GHGs will have residual effects, GHGs are considered for the CEA assessment.

The PRP involves the following time frames:

- Construction: 2011 - 2014
- 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 GHGs 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 had an overlap with the PRP concerning the geographic extent of potential GHG effects and the temporal boundary of potential GHG effects. Projects that did not overlap with the project in these areas were screened out of the CEA. As such, for the CEA, the other projects considered included:

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

The gaseous emissions generated from the construction and operational phases of the PRP project will include GHGs. Several sources during the construction and operational phases will have the potential to create GHG emissions that will interact with those road network projects, the Deerfoot North development project, and residential and commercial development. The GHG emissions from these projects may overlap spatially and temporally, and may result in residual cumulative adverse effects. During the construction phase, cumulative effects of GHG 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 GHGs may occur with emissions from the identified projects. However, the cumulative effects from the operational phase are expected to be low in magnitude in the context of provincial and national GHG emissions.

In consideration of the mitigation measures outlined previously in the project effects assessment, the project contributions during the construction phase and operational phase are not expected to significantly increase GHG levels in the RSA. Furthermore, by implementing the mitigation measures outlined in the project effects assessment, it is expected that the potential residual cumulative adverse effects on GHGs are likely to be low in magnitude and reversible.

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.

## **11.8 Follow-Up Programs and Monitoring**

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

## **11.9 Summary**

### **11.9.1 Summary of Results**

The proposed construction of the runway will result in emissions of GHGs during the construction phase. Potential effects may occur from increased fuel consumption during the construction phase due to the increased use of vehicles and diesel powered equipment. However, the construction phase is of relatively short duration and, therefore, the effects are expected to be limited in overall significance when viewed in terms of long term climate effects.

The GHG emissions from the proposed operational phase will contribute to the GHG levels in the study area. Aircraft movements, which include LTOs and APUs, account for approximately 53% to 58% of the PRPs GHG emissions, followed by GHG emissions from GSE associated with aircraft, which account for approximately 27% to 29%. Therefore, GHG emissions from aircraft activities are considered to be the most significant source of GHG emissions from the PRP.

The GHG emissions from the operational phase that were calculated for the proposed 2025 operations scenario are greater than those for the 2015 operations. The increase is attributed to the increase in aircraft traffic and the associated activities such as emissions from GSE and APUs. The total GHG emissions from the 2015 scenario with the PRP were 5.2% higher than those for the 2015 scenario without the PRP. However, in the long term, the 2025 DS scenario contributes 0.01% less than the 2025 DN scenario. As such, the PRP is expected to reduce GHG emissions in the future.

In the context of the RSA, the 2015 DS operational phase contributed to approximately 0.14% of Alberta's forecasted annual GHG emissions and 0.04% of Canada's forecasted annual GHG emissions. Similarly, the 2025 DS operational phase contributed to approximately 0.18% of Alberta's forecasted annual GHG emissions and 0.06% of the forecasted annual GHG emissions for Canada, respectively. The contribution of the project operations to the provincial and national GHG emissions inventory is considered to be very small and the differences between the DN and DS scenarios are negligible for the RSA.

### **11.9.2 Summary of Mitigation**

During the construction phase, mitigation of the effect on GHG emissions from the operation of heavy diesel vehicles and equipment 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.

These mitigation measures will be implemented as deemed appropriate by the construction contractor.

Mitigation of the effect on GHG emissions during the operational phase for the GSE fleet, APUs and associated road traffic may include:

- minimization of vehicle idling and turning off equipment when not in use;
- implementation of best practices to ensure GSE are properly tuned and maintained; and
- on-site speed limits.

In addition, the operational phase mitigation measures for aircraft operations may include the following:

- reducing engine use during taxiing and idling reduces the associated emissions substantially;
- de-rating takeoff power;
- reducing use of reverse thrust; and
- measures to reduce time awaiting landing, such as holding at airport of origin and scheduled peak spreading.

The mitigation measures for aircraft operations may not be feasible in all weather conditions and especially at times where safety considerations are the priority. As such, these mitigation measures will be implemented as appropriate by NAV CANADA. Mitigation related to delays on arrival is implemented by airlines and are not under the Authority's control.

Finally, the purpose of the PRP is to add an additional runway to alleviate air traffic congestion in Calgary and to allow for efficient future increases to air traffic. By implementing operations of the PRP, future air traffic congestion may be reduced in Calgary for future scenarios. For arriving aircraft, runway occupancy time may be reduced and taxi time through efficient design of high speed exits and direct taxi routes may also be reduced. For departing aircraft, some improved design features include dual taxiways reducing conflict points between arriving and departing aircraft. As such, the PRP is itself a proactive mitigation measure that may help to prevent future air traffic congestion and help reduce fuel consumption by aircraft.

### 11.9.3 Summary of Cumulative Effects

The residual project effects of construction and operation of the PRP are expected to be low in magnitude. However, the GHG emissions from PRP and the other planned and future projects may overlap spatially and temporally, and may result in residual cumulative adverse effects. In consideration of the mitigation measures outlined previously in the project effects assessment, the project contributions during the construction phase and operational phase are not expected to drastically increase GHG levels in the RSA and are reversible. Therefore, in consideration of the mitigation measures and potential cumulative effects associated with the PRP and the other planned and future projects, no significant adverse environmental effects are expected.

### 11.9.4 Summary of Residual Effects

If the identified mitigation measures are implemented, significant adverse residual effects are unlikely to occur. There will be GHG emissions throughout the life of the project. However, the overall effect of GHG emissions on the RSA is predicted to be very small. As such, the GHG emissions are expected to be low in magnitude and no significant adverse residual effects are expected.

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

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

In consideration of the mitigation measures and GHG emission results, significant adverse residual effects are unlikely to occur. There will be an increase of GHG emissions throughout the life of the project from existing conditions. The overall effect of the GHG emissions is predicted be a maximum increase of 5% from baseline conditions for the year 2015. As such, the GHG emissions are expected to be low in magnitude and are reversible.

Table 11-10 provides a summary of the residual environmental effects and recommended mitigation for GHGs.

**Table 11-10 Assessment of Project Effects on GHGs**

Project - Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation Measures	Residual Environmental Effect				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Significance
<b>Construction Phase</b>							
Alterations in GHG baseline levels associated with: <ul style="list-style-type: none"> <li>• Road traffic emissions</li> <li>• Site clearing and grubbing</li> <li>• Operation of construction equipment</li> </ul>	A	<ul style="list-style-type: none"> <li>• Implement a “No Idle” policy on-site</li> <li>• Use of Best Available Technology that is Economically Achievable</li> <li>• Implement on-site speed limits</li> <li>• Ensure that engines are tuned and maintained</li> <li>• Proper route selection to reduce travel distances</li> </ul>	Low	Regional	Short-Term to Medium Term / Regular	Reversible	Not Significant
<b>Operational Phase</b>							
Alterations in GHG baseline levels associated with: <ul style="list-style-type: none"> <li>• Changes in aircraft operations</li> <li>• Changes in air space time for aircraft in the Calgary airshed</li> <li>• Use of ground service vehicles</li> <li>• Stationary combustion sources</li> </ul>	A	<ul style="list-style-type: none"> <li>• Reduced engine taxiing during taxi and idle</li> <li>• De-rate takeoff power</li> <li>• Reduce use of reverse thrust</li> </ul>	Low	Regional	Long Term	Reversible	Not Significant

Project - Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation Measures	Residual Environmental Effect				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Significance
<b>Cumulative Effects</b>							
Gaseous emissions from the construction and operational phases of the project may interact with those emitted from the following: <ul style="list-style-type: none"> <li>• The Deerfoot North development project</li> <li>• Extension of Métis Trail / Country Hills Boulevard</li> <li>• Extension of Airport Trail</li> <li>• Residential and commercial development</li> </ul>	A	<ul style="list-style-type: none"> <li>• Same as identified above for construction and operational phases</li> </ul>	Low	Regional	Long Term	Reversible	Not Significant

### 11.10 Issues Raised by Stakeholders

**Issue:** Alteration of GHG baseline levels during construction and/or operation of the project.

**Issue:** Changes in the transportation network in and around the airport leading to a change in GHG levels/carbon footprint.

**Response:** The GHG emissions for the project have been assessed for the construction and operational phases. This assessment compared the potential effects of the project activities on GHG baseline levels which were termed as DS scenarios throughout this report. Additionally, GHG emissions as a result to changes in the transportation network, have been assessed.