2010 CORPORATE GREENHOUSE GAS INVENTORY

INCLUDING: BUILDINGS, OUTDOOR LIGHTS, WASTEWATER PUMPING STATIONS, VEHICLE FLEET AND CORPORATE WASTE

Prepared by the City of Kitchener
Community Services Department – Planning Division
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Respectfully,

Carrie Musselman, Senior Environmental Planner

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INTRODUCTION

Municipal governments are in direct or indirect control of almost half of Canada's greenhouse gas (GHG) emissions, and their decisions on public transit, waste management, building energy performance, and land use planning greatly influence the amount of emissions produced in Canada.

Climate change touches every sector of the Canadian economy, and municipal governments are no exception (ICLEI – Canada, 2009)

In 2009, the Federation Canadian of Municipalities (FCM) with ICLEI - Local Governments for Sustainability Partners for Climate Protection (PCP) gathered and analyzed data on initiatives implemented by municipal governments in Canada to reduce GHG emissions at the corporate and community levels and compiled them in a National Measures Database. The initiatives range from education campaigns to complete building retrofits for energy efficiency.

PCP collected data from 16 communities, including Canada's largest cities, represented by the Big City Mayors Caucus, and a select group of PCP members. ICLEI also gathered data from various sources on 26 other municipal governments' activities and added this information to the database for analysis. The 42 municipalities that contributed to the database represent 38 per cent of the Canadian population. The database now includes more than 350 initiatives.

Energy and GHG emission reductions, direct costs, and cost savings were included in the analysis (ICLEI – Canada, 2009).

Local governments operate many municipal facilities, have large vehicle fleets, control waste removal services and provide street lighting to their communities. These activities use a significant amount of energy and generate a large amount of GHG emissions.

CLIMATE CHANGE

Climate change is a long-term shift in climate measured by changes in temperature, precipitation, winds, snow cover and other indicators. Climate change can involve both changes in average conditions and changes in variability, including, for example, changes in extreme conditions. When we speak of climate change on a global scale, we are referring to changes in the climate of the earth as a whole.

Climate change is one of the most important environmental issues of our time, requiring urgent action on the part of all governments and citizens. (Canada E.)

The potential impacts of climate change are far-reaching, affecting our economy, infrastructure, and health, the landscapes around us, and the wildlife that inhabit them.

The build-up of greenhouse gases in the atmosphere is the

primary cause for concern about climate change now and into the immediate future. Particularly important is the increase in atmospheric carbon dioxide, which is released through the combustion of fossil fuels. In Canada, 80 percent of total national greenhouse gas emissions are associated with the production or consumption of fossil fuels for energy purposes. Globally, Canada accounts for about two percent of total annual greenhouse gas emissions (Government of Canada, 2010).

While the earth's climate is naturally variable, its average state is regulated by factors such as the earth's orbit around the sun and the natural greenhouse gas effect. In fact, the earth would not be warm enough to sustain life without the natural greenhouse gas effect. The atmosphere is like a blanket, or greenhouse, trapping heat escaping from the earth's surface. The principal natural greenhouse gases are water vapour and carbon dioxide. By burning fossil fuels such as coal, oil and natural gas, we release more carbon dioxide into this blanket. Changing land use, such as deforestation and the conversion of land to agricultural use, has also contributed carbon dioxide to this blanket.

IMPACTS OF CLIMATE CHANGE

Over the period 1948 to 2010, the average annual temperature in Canada has warmed by 1.6 °C, a higher rate of warming than in most other regions of the world.

Increased winter and spring temperatures have contributed to this warming trend to a greater degree than other seasons. Warming trends are seen consistently across Canada, but the regions showing the strongest warming trends are found in the far north. Strong warming in high-latitude regions is a robust characteristic of projections of future climate change as well. This indicates that the climate of Canada, particularly in the North, to which Canadians have been accustomed and to which we have adapted our activities, is expected to undergo substantial change in the future.

Future warming will be accompanied by other changes, including the amount and distribution of rain, snow, and ice and the risk of extreme weather events such as heat waves, heavy rainfalls and related flooding, dry spells and/or droughts, and forest fires. (Canada, 2012)

In Ontario, we can expect average temperatures to rise by as much as 3 to 8 degrees Celsius over the next century. Warmer temperatures may result in milder winters, longer growing seasons and a higher frequency of severe weather events such as record-breaking storms, floods, droughts and heat waves. The expected changes in our climate will have a significant impact on Ontario’s ecosystems and our communities. (Ontario Ministry of the Environment, 2011)

Some specific outcomes of climate change in Ontario may include:

- more extremely hot days (above 35°C), increasing the risk of heat stress-related illness among the old, the young and those with chronic lung diseases such as asthma.
- less snow but more freezing rain – which can down transmission lines and presents safety risks to road and air traffic.
- changes in wildlife habitats, which would adversely affect Ontario’s species and biodiversity.
- longer growing seasons, which can affect crop selection and yields.

- increased risk of warm-climate diseases such as Lyme and West Nile diseases and malaria which can spread through insects taking advantage of warmer winters.
- a drop in Great Lakes water levels by as much as one metre by 2050, jeopardizing shipping, fisheries, water quality and supply.
- increase in gas and home heating prices in order to cope with temperature extremes. (Ontario Ministry of the Environment, 2011)

GREENHOUSE GAS INVENTORIES

Greenhouse Gas (GHG) inventories quantify the amount of GHGs a company emits into the atmosphere and are critical management tools for corporations of all sizes and sectors. GHG inventories enable corporations to identify their emission sources and track changes over time.

Information presented in a GHG inventory can help inform corporate strategies and prioritize actions to reduce emissions, as well as provide benchmarks against which the success of these activities can be measured (World Resources Institute, 2008).

An inventory can be used as a management tool to:

1. **Save money:** The inventory helps track dollars spent on energy. What can be measured can be managed. An inventory can reveal opportunities for investment in energy efficiency improvements.

2. **Provide valuable information:** An emissions inventory is a useful first step in the development of a Local Action Plan. Identifying significant sources of GHG emissions will help a municipality implement appropriate emissions reduction measures and develop an effective Local Action Plan.

3. **Provide a valuable reference point:** Selecting a baseline year, and completing an emissions inventory for that year, is essential to track reductions in GHG emissions.

GUIDING STRUCTURE

ICLEI – LOCAL GOVERNMENTS FOR SUSTAINABILITY

ICLEI - 'Local Governments for Sustainability' is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. More than 1,200 cities, towns, counties, and their associations worldwide comprise ICLEI's growing membership. ICLEI works with these and hundreds of other local governments through international performance-based, results-oriented campaigns and programs.

ICLEI's mission is to build and serve a worldwide movement of local governments to achieve tangible improvements in global sustainability through cumulative local actions.

INTERNATIONAL LOCAL GOVERNMENT GHG EMISSIONS ANALYSIS PROTOCOL (IEAP)

ICLEI has developed the International Local Government Greenhouse Gas (GHG) Emissions Analysis Protocol to provide an easily implemented set of guidelines to assist local governments in quantifying the greenhouse gas emissions from both their internal operations and from the whole communities within their geopolitical boundaries. By developing common conventions and a standardized approach, ICLEI seeks to make it easier for local governments to achieve tangible reductions in greenhouse gas emissions.

The development and implementation of the IEAP follows principles consistent with those used in the finance sector, to ensure accurate accounting and reporting. These principles have previously been adapted by the WRI/WBCSD GHG Protocol Initiative to apply to the accounting and reporting of greenhouse gas emissions and are followed in this Protocol. (ICLEI, 2008)

PARTNERS FOR CLIMATE PROTECTION

Partners for Climate Protection (PCP) is a program managed by the Federation of Canadian Municipalities (FCM) and ICLEI – Local Governments for Sustainability. The Partners for Climate Protection (PCP) program is a network of Canadian municipal governments that have committed to reducing greenhouse gases and acting on climate change. PCP is the Canadian component of ICLEI's Cities for Climate Protection (CCP) network.

The CCP Campaign assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability.

ICLEI's role is that of technical support, wherein they provide internet and phone-based technical assistance to members of the PCP Program as they work through the five-milestones of the program.

PARTNERS FOR CLIMATE PROTECTION PROGRAM FRAMEWORK

PCP is based on the CCP Campaign of a five milestone framework used to guide municipalities to reduce greenhouse gas emissions. The five milestone process is a performance-based model which remains flexible; milestones do not need to be completed in sequential order. Each milestone provides an opportunity for municipal capacity building.

The five milestones are:

1. Creating a greenhouse gas emissions inventory and forecast;
2. Setting an emissions reductions target;
3. Developing a local action plan;
4. Implementing the local action plan or a set of activities;
5. Monitoring progress and reporting results.

MILESTONE ONE

A greenhouse gas inventory brings together data on municipal energy use and solid waste generation in order to estimate greenhouse gas (GHG) emissions in a given year. The forecast projects future emissions based on assumptions about population, economic growth and fuel mix.

To achieve recognition for PCP Milestone 1, a municipality must quantify the GHG emissions generated from various sources within the municipality. The PCP program distinguishes between two categories of emissions: corporate emissions and community emissions.

A corporate (facilities and operations) emissions inventory consists of:

- buildings,
- street lighting,
- water and wastewater treatment,
- municipal fleet, and
- corporate solid waste.

The true value of inventories of GHG emissions becomes apparent when local governments begin to set reduction targets for local government operations and begin to develop GHG reduction plans. The emissions inventory is essential to setting realistic reduction targets. It provides an emissions baseline that a local government will strive to reduce over time through its GHG reduction plan. Without a baseline, the local government risks underestimating or overestimating its potential emissions reductions. More importantly, the local government will be unable to quantify progress toward established targets. (FCM - Partners for Climate Protection, 2012)

DEVELOPING A GREENHOUSE GAS INVENTORY

Developing a GHG inventory is a technical exercise. PCP members follow a methodology based on ICLEI's *International Local Government GHG Emissions Analysis Protocol*. Municipalities completing corporate GHG inventories are required to track energy consumption data associated with a variety of municipal services and record the results in an Inventory Quantification Support Spreadsheet. (FCM - Partners for Climate Protection, 2012)

The Inventory Quantification Support Spreadsheet is a tool created to assist municipal governments in the calculation of their greenhouse gas (eCO2) emissions. The spreadsheet calculates the corporate eCO2 emissions based on energy consumption and waste to landfill. Although the spreadsheet does not include tools to quantify eCO2 reductions from measures, it allows PCP members to successfully complete the inventory component of Milestone One.

EMISSIONS INVENTORY

An emissions inventory is comprised of separate analyses of the emissions generated by a local government's internal operations as a whole over the course of a single year. The government operations inventory is subdivided into sectors that correspond to international standards for classifying greenhouse gas emissions and which reflect government operations.

A complete emissions inventory includes careful tracking of location and degree of control over the emissions (scopes) as well as the reliability of, and methodological complexity of, the data sources (tiers). (ICLEI, 2008)

Many factors must be considered when choosing the datasets and methods to use in preparing GHG emissions inventories such as:

- **The inventories must be accurate and must inform all subsequent PCP milestones**. They must reflect actual emissions as closely as possible, and they should set out the quantity of emissions in a way that helps in setting targets, selecting emissions reduction actions, and measuring reductions for reporting purposes.
- **The inventories must be consistent and reproducible**. Consistency makes reproducing the inventory simpler into the future. Staff have an easier learning curve, which becomes more important as the local government starts to monitor and track emissions as part of Milestone Five. Further, if all local governments follow the principles, the validity of comparisons between inventory years and between local governments will be enhanced.
- **The inventories must be cost-efficient**. Inventory development must not consume resources — whether overall costs for consultants or staff time, or a combination — in an unbalanced fashion.
- **The inventories must be verifiable.** They will be reviewed when the local government reports emission reductions for recognition of Milestone Five.
  (FCM - Partners for Climate Protection, 2012)

ESTABLISHING A BASELINE YEAR

Prior to beginning data collection, local governments must examine the range of data sources available and select a year for which accurate records of all emission sources exist in sufficient detail to conduct a complete and accurate inventory. The baseline year will serve as a basis for setting an emissions reduction target and act as a point of comparison for the future. After evaluating the data available for the inventory it was determined that the most complete data available was for 2010. That year also coincides with the baseline year used for our Community Inventory.

EMISSION SOURCES

Differentiating between emissions helps to avoid the possibility of double counting emissions and misrepresenting emissions when reporting but allows all policy relevant information to be captured.

Local government emissions include two types of emissions direct and indirect. Direct emissions are those produced immediately upon consumption of energy by an end user within the boundaries of the local government. Indirect emissions are those produced by an energy utility upstream of consumption by the end user. The main sources considered are the burning of fossil fuels (direct emissions) and the production of electricity (indirect emissions) from power plants. (FCM - Partners for Climate Protection, 2012) Table 1 lists energy sources typically used in each sector.

Table 1: Energy sources typically used in local government operation sectors

	Fuel / Energy Source					
	Natural Gas	Electricity [a]	Fuel Oil	Gasoline	Diesel Fuel	Other Fuels [b]
Buildings	✓	✓	✓	✓	✓	✓
Lighting		✓				✓
Wastewater		✓				✓
Fleet [c]				✓	✓	✓
Solid waste [d]	n/a	n/a	n/a	n/a	n/a	n/a

(FCM–ICLEI (ICLEI – Local Governments for Sustainability) Partners for Climate Protection)

a. One or many fuels may be used to produce electricity; combinations are reflected in the emissions factor provided by the electricity supplier.
b. In rare cases, other fuels (see Table 2) are possible in all categories.
c. Natural gas, propane and electricity consumption by fleets is insignificant relative to gasoline and diesel fuel.
d. Solid waste creates a direct emission (methane) from landfills. No energy sources are implied.

EMISSION FACTORS

All greenhouse gases (GHGs) are not equal. In fact, each greenhouse gas has a unique atmospheric lifetime and heat-trapping potential.

Emission factors are used to convert energy usage into the associated emissions and so are central to the emissions analysis. There are a variety of emission factors available from numerous sources. The reliability and accuracy of various sources of emission factors is an important consideration.

The concept of a Global Warming Potential (GWP) has been developed to allow the comparison of the ability of each greenhouse gas to trap heat in the atmosphere relative to carbon dioxide (CO_2) over a specified time horizon.

Greenhouse gas emissions are calculated in terms of how much CO_2 would be required to produce a similar warming effect oven the chosen time horizon. This is called the carbon dioxide equivalent (eCO_2) value and is calculated by multiplying the amount of gas by its associated GWP (Environment Canada, 2011) as illustrated in Table 2.

Table 2: Global Warming Potentials

Greenhouse Gas	Global Warming Potential (100 years)
Carbon Dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous Oxide (N_2O)	298

(Global Warming Potentials: IPCC Fourth Assessment Report (2007), 2012)

KITCHENER'S CORPORATE INVENTORY

Kitchener's corporate inventory is based on ICLEI's *International Local Government GHG Emissions Analysis Protocol* (IEAP). The inventory consists of 2010 energy consumption data collected and reported on the following five sectors:

- Buildings
- Street Lights
- Wastewater Pumping Stations
- Vehicle Fleet
- Solid Waste

Data (list of city facilities, electricity and natural gas consumption, waste invoices, etc.) was obtained from staff across the corporation within various business units and from our local utilities. Data received was in the form of invoices, spreadsheets or emails. Once received the data was assessed for completeness and accuracy prior to being inputted into the Inventory Quantification Support Spreadsheet.

The Inventory Quantification Support Spreadsheet contains separate worksheets to track the data within each of the five sectors. A summary of the corporate inventory is provided in a separate worksheet and is automatically filled in as data is inputted into each sector's worksheet.

The following sections provide a summary of the data found within the Inventory Quantification Support Spreadsheet.

BUILDINGS

Buildings include all owned by the City and buildings leased or rented to others. In total 73 buildings were included in the inventory. Overall, the City's buildings consumed 7,365,331 GJ of energy and produced 7,553 tonnes of eCO_2 in 2010 as illustrated in Table 3. Approximately 56% of the emissions were produced by natural gas and 44% by electricity.

Table 3: GHG Emissions from Buildings

Sector	Energy (GJ)	Total GHG (tonnes eCO2)
Buildings	7,365,331	7,553

The buildings sector accounts for a significant proportion of our local government operations emissions, and it offers significant potential for emission reductions.

OUTDOOR LIGHTS

The lighting sector includes outdoor lighting sources such as overhead streetlights and traffic signals on or along City roads and lighting in municipal surface parking lots. Overall, lighting consumed 38,216 GJ of energy and produced 1,380 tonnes of eCO2 in 2010 as illustrated in Table 4.

Table 4: GHG Emissions from Outdoor Lighting

Sector	Energy (GJ)	Total GHG (tonnes eCO2)
Streetlights	38,216	1,380

WASTEWATER PUMPING STATIONS

Wastewater pumping stations include all sewage pumping stations that are managed and/or operated by the City. Emissions calculated are primarily associated with stationary fuel pumps and lift stations used to dispose of sewage from the community. Emissions related to wastewater may be highly variable in local government operations inventories as they may be influenced by the local topography, which may require the use of pump stations. Overall, wastewater consumed 5,708 GJ of energy and produced 207 tonnes of eCO2 in 2010 as illustrated in Table 5.

Table 5: GHG Emissions from Wastewater Pumping Stations

Sector	Energy (GJ)	Total GHG (tonnes eCO2)
Wastewater Pumping Stations	5,708	207

VEHICLE FLEET

The fleet sector includes direct emissions from vehicles used by employees of the municipality in the exercise of their duties. This includes fire trucks, golf course mowers, snowplows, maintenance vehicles, and heavy equipment used for operations. In total five 565 vehicles were included in the inventory. Overall, the vehicle fleet consumed 52,961 GJ of energy and produced 3,094 tonnes of eCO2 in 2010 as illustrated in Table 6.

Table 6: GHG Emissions from Vehicle Fleet

Sector	Energy (GJ)	Total GHG (tonnes eCO2)
Vehicle Fleet	52,961	3,094

CORPORATE WASTE

Even though the City does not own or operate a solid waste disposal facility, it must still account for the solid waste generated as a result of local government operations. In this case, the Corporate Waste sector must include all employee-generated solid waste, as well as waste generated at public facilities, such as community centers, parks or recreation buildings. Facilities that have waste pick-up at the curb have not been included within this inventory as those emissions would be included within the Community GHG Inventory.

The solid waste sector is the only sector in the inventory in which emissions are not calculated based on burning fuel directly or indirectly in the generation of electricity. The Corporate Waste sector only includes emissions associated with the decomposition of solid waste.

Corporate waste generated by the City is responsible for 824 tonnes of eCO2 as illustrated in Table 7.

Table 7: GHG Emissions from Corporate Waste

Sector	Total GHG (tonnes eCO2)
Corporate Waste	824

ECO2 EMISSIONS BY SECTOR

In 2010, the City of Kitchener produced 13,058 tonnes of eCO_2. These emissions are equivalent to the annual greenhouse gas emissions from approximately 2,720 passenger vehicles or the CO_2 emissions from the energy use of approximately 672 homes for one year. (EPA, 2013)

Figure 1 illustrates the contribution of each corporate sector relative to the City's total equivalent CO_2 emissions.

Figure 1: Corporate eCO_2 Emissions by Sector (2010)

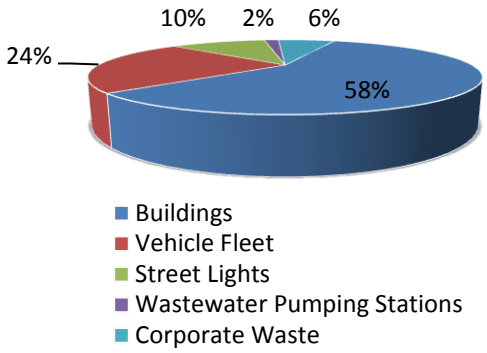


Table 8 is a summary of the total energy consumed and the equivalent CO_2 for each corporate sector.

Table 8: Energy and Emissions by Sector (2010)

Sector	Total Energy (GJ)	Total eCO_2 (t)
Buildings	7,365,331	7,553
Vehicle Fleet	52,961	3,094
Street Lights	38,216	1,380
Wastewater Pumping Stations	5,708	207
Corporate Waste	-	824

ECO2 EMISSIONS BY SOURCE

The greatest source of corporate emissions is the consumption of electricity (36 % of total emissions) closely followed by the combustion of natural gas (31% of total emissions).

Figure 2 illustrates the relative contribution of each fuel type by source to the total equivalent CO_2 emissions.

Figure 2: Corporate eCO_2 Emissions by Source (2010)

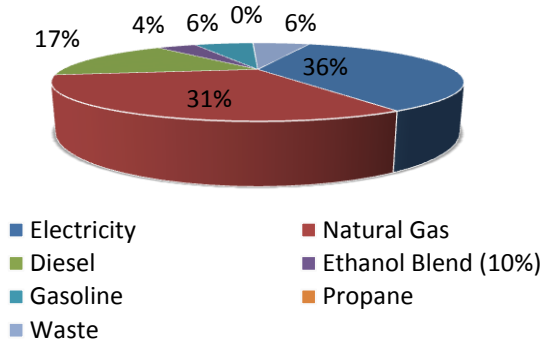


Table 9 is a summary of the amount of fuel consumed, energy used and the equivalent CO_2 for each corporate sector.

Table 9: Energy Consumption and Emissions by Fuel Type (2010)

Fuel Type	Total Use	Energy Use (GJ)	Total eCO_2 (t)
Electricity	37,551,556	135,186	4,882
Natural Gas	2,252,525	86,565	4,259
Diesel	831,075	31,830	2,230
Ethanol Blend (10%)	257,677	8,725	566
Gasoline	350,773	12,277	856
Propane	5,083	129	8
Waste	-	-	824

BUSINESS AS USUAL FORECAST

The final step for obtaining Milestone One recognition under the PCP program is to complete a business as usual (BAU) forecast for the next ten years. The purpose of the BAU is to predict how future emissions levels will change in the absence of any intervention, modifications or policy changes.

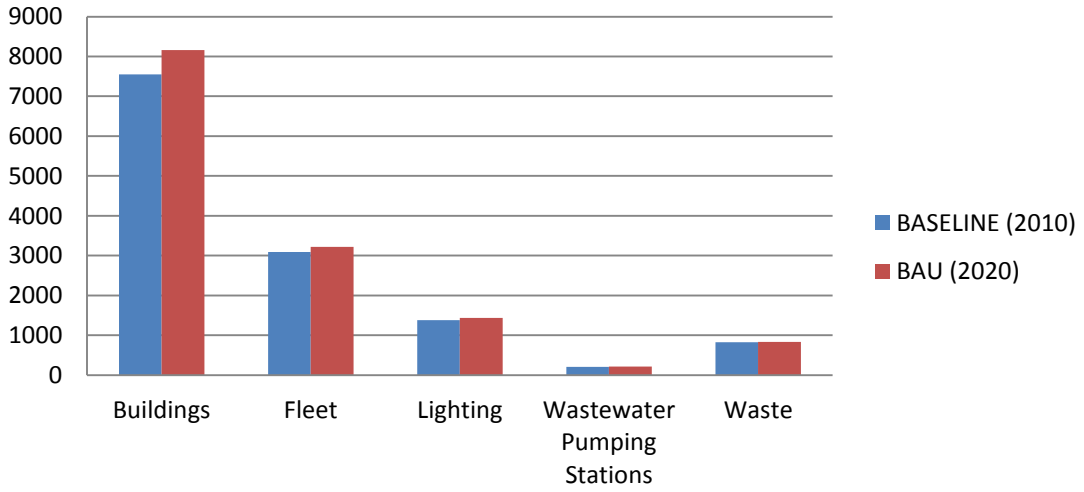
In developing the BAU forecast, the capital budget and growth management plan were reviewed to determine which projects and/or initiatives such as new construction, additions, vehicle fleet expansions, etc. have been planned that may increase energy/fuel consumption. Expected changes in emissions are noted in Table 10.

Table 10: Forecasted Emission Changes by Sector

	Forecasted Changes (assumes that the emission factor for electricity does not change)	**Change in Emissions**
Buildings	• The construction of approximately two community centre expansions, a library expansion and the development of a central operations facility are proposed.	8%
Streetlights	• New developments will require streetlights, therefore an increase consistent with growth projections	4%
Wastewater	• New developments will require access to the sewage operations. Requiring the construction of approximately two new lift stations and approximately five existing stations being upgraded.	2.5%
Vehicle Fleet	• Expected to mirror population growth at 2% annually • No major purchases or changes to the current fleet expected	4%
Waste	• Expected to increase at same rate as building expansion, therefore a 1% increase annually is likely	1.5%

Based on the BAU forecasted change in emissions an approximate increase of 800 eCO_2 is expected over the next ten years. Figure 3 illustrates the change in emissions for each sector.

Figure 3: Change in Emissions by Sector (tonnes eCO_2)



NEXT STEPS

The next step will be to complete Milestone two and update our Milestone three at the same time. In this scenario, the target will be based on Councils willingness to endorse implementation of the action items set out in a Corporate Action Plan.

Like many other municipalities, the Corporation has already undertaken a significant number of actions over the last decade to reduce emissions. The Corporate Action Plan will note programs and projects that have resulted in GHG emission reductions but will focus on how our corporation can further reduce greenhouse gas emissions by expanding or enhancing existing actions or by developing additional actions. Those actions will then facilitate the development of a corporate reduction target.

DEFINITIONS AND LIST OF ACRONYMS

"CO2 Equivalent" means the universal unit of measurement to indicate the global warming potential (GWP) of each of the six greenhouse gases, expressed in terms of the GWP f one unit of carbon dioxide. It is used to evaluate releasing (or avoiding releasing) different greenhouse gases against a common basis.

"Emission Factors" ("EF") means the rate at which a pollutant is released into the atmosphere (or captured) as a result of some process activity or unit throughput. The EFs used may be average or general EFs, or technology-specific EFs.

"Greenhouse Gases" (GHG) For the purposes of this standard, GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide (CO2); methane (CH4); nitrous oxide (N2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF6).

List of acronyms	
CH4	methane
CO2	carbon dioxide
CO2e	carbon dioxide equivalent
FCM	Federation of Canadian Municipalities
GHG	greenhouse gas
GMF	Green Municipal Fund
GWP	global warming potential
HFC	hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
LandGEM	landfill gas emissions model
N2O	nitrous oxide
PCP	Partners for Climate Protection
PFC	perfluorocarbon
SF6	sulphur hexafluoride
VKT	vehicle kilometres travelled

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