Township of Carling

Corporate Milestone 1

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1. Methodology

1.1 Greenhouse Gas (GHG) Inventory

A greenhouse gas inventory brings together data on community and municipal sources of greenhouse gas emissions to estimate emissions for a given year. Two separate GHG inventories and forecasts have been created for the Township of Carling: one for municipal corporate operations and one for community sources. As per the PCP protocol, the inventories consist of the following sources of GHG emissions.

Corporate	***Community***
-Buildings -Streetlights -Water and sewage treatment -Municipal fleet -Solid Waste	-Residential -Commercial and institutional -Industrial -Transportation -Solid Waste

1.2 Scope

This document will focus solely on ***corporate*** emissions.

1.3 Baseline Year

A baseline year of 2016 was selected because it is the year in which the most recent publicly available municipal greenhouse gas emissions data could be retrieved. 2016 also happens to be the most recent Statistics Canada Census year, providing the most recent data on population statistics. Additional data was gathered from other years as well, where relevant, and was referred to throughout the data analysis process. In the event that actual consumption data could not be collected for the baseline year, assumptions were applied from prior, or successive years where relevant. Establishing a baseline is a useful tool to identify areas for improvement, inform the development of a GHG reduction action plan, estimate cost savings from reductions, and serve as a reference point to track improvements.

1.4 Data Collection

Energy and emissions quantities were collected for Carling Township and compiled into an internal database for analysis and calculation.

1.5 Data Sources

Corporate energy usage, and emissions were calculated for 2016 and reported by sector (buildings and facilities, fleet vehicles, streetlight, water and wastewater, and corporate solid waste) as well as by emissions source (electricity, natural gas, propane, fuel oil, gasoline, diesel, waste, and wastewater). In some cases, data sources varied depending on the type of expenditure required to calculate emissions. Some of the corporate data was obtained from the Government of Ontario's open data catalogue, 'Energy use and greenhouse gas emissions for the Broader

Public Sector[1],' as reported by each municipality under *O. Reg 397/11*[2]. If the data was unavailable on BPS 2016, Carling staff provided the missing data. For a detailed summary of corporate data sources, please refer to Table 1.

Table 1: Corporate Data Sources

Emission Sector	***Municipality***	***Source***	***Quality of Data***	***Notes***
Building/ Facilities	Carling	BPS, 2016	High	Actual energy consumption per source, per building.
Streetlights	Carling	Municipality	Medium	Assumptions based on the number of streetlights.
Fleet	Carling	Municipality	Medium	Actual fuel consumption by vehicle for 2017 and 2018 retroacted for 2016.
Water/ Wastewater	Carling	DNE	DNE	The Township of Carling does not provide water or wastewater services.
Solid Waste	Carling	Municipality	Low	Calculation based on actual waste generated data and assumptions.

Legend for data quality:

-High: Actual usage data covering the period of the inventory year, from a credible data collector/ provider
-Medium: Actual usage data provided, with some assumptions from within or around the geographic boundary, inventory year, or otherwise to fill in data gaps
-Low: Usage data provided, but mainly based on assumptions
-DNE: Does not exist

1.5.1 Buildings and Facilities

Actual energy consumption data by each emission source for each municipal building and facilities was obtained from the Government of Ontario's open data catalogue, 'Energy use and

[1] https://www.ontario.ca/data/energy-use-and-greenhouse-gas-emissions-broader-public-sector
[2] https://www.ontario.ca/laws/regulation/110397

greenhouse gas emissions for the Broader Public Sector[3],' as reported by each municipality under *O.Reg 397/11*.

1.5.2 Water and Wastewater

Carling Township does not provide water or wastewater services. This is because the township's expansive geographic size in relation to its small, spread out population makes it economically infeasible to provide these services.

1.5.3 Streetlights

Energy consumption in kWh was estimated using day length data retrieved from timeanddate.com[4] and information provided by Carling Township staff.

1.5.4 Fleet Vehicles

Actual fuel consumption in litres for the years 2017 and 2018 was provided by Carling Township staff. Staff also provided a complete inventory of municipal vehicles and equipment to assist with developing assumptions for calculation.

1.5.5 Solid Waste

GHG emissions from solid waste are unique emissions typically quantified by local governments. As a result, this presented difficult reporting, and calculation challenges. These emissions reflect the impact of methane released through the decomposition of organic matter in landfills and can be calculated based on total waste deposited in a landfill. With waste generation data pertaining solely to corporate operations being unavailable, Georgian Bay Biosphere Reserve (GBBR) estimated the quantity of solid waste generated at corporate buildings and facilities based on approximations of the size of garbage bins used, their average fullness, and the frequency of their pickup per the PCP protocol. This was used in combination with actual tonnage of waste sent to the McDougall landfill and information gathered from municipal staff on waste management practices and policies.

2. Calculation Process

2.1 Buildings and Facilities

There is only one formula for calculating building emissions from municipal operations. Fortunately, these emissions have already been calculated and made publicly available as per *O. Reg 397/11*. For reference, a simplified version of the formula for calculating building and facility emissions as per the PCP protocol is as follows.

[3] https://www.ontario.ca/data/energy-use-and-greenhouse-gas-emissions-broader-public-sector

[4] https://www.timeanddate.com/sun/@6098747

2.1.1 Formula

$$\sum(FC * Cef) + (FC * CHef * CHwp) + (FC * Nef * Nwp)$$

Where:

FC = Amount of fuel by type consumed

Cef = Emission factor for Carbon Dioxide (CO_2)

CHef = Emission factor for Methane (CH_4)

Nef = Emission factor for Nitrous Oxide (N_2O)

CHwp = Global warming potential of Methane

Nwp = Global warming potential of Nitrous Oxide

2.1.2 Assumptions

No assumptions were made in calculating GHG emissions produced by corporate buildings and facilities because actual consumption data was available.

2.1.3 Outcome

Carling Township's buildings and facilities produced **23** tonnes of CO^2e in 2016. These emissions were produced by consuming **688** GJ of energy.

2.2 Water and Wastewater

Carling Township does not provide water or wastewater services to its residents because of geographic and economic limitations. As a result, no GHG emissions are generated through this category and no calculation is warranted. However, for reference, a simplified version of the formula for calculating water and wastewater as per the PCP protocol is as follows.

2.2.1 Formula

$$\sum(FC * Cef) + (FC * CHef * CHwp) + (FC * Nef * Nwp)$$

Where:

FC = Amount of fuel by type consumed

Cef = Emission factor for Carbon Dioxide (CO_2)

CHef = Emission factor for Methane (CH_4)

Nef = Emission factor for Nitrous Oxide (N_2O)

CHwp = Global warming potential of Methane

Nwp = Global warming potential of Nitrous Oxide

2.3 Streetlights

There are multiple formulas that can be used to calculate the emissions produced by streetlights. Since actual electricity consumption in kWh was unavailable, electricity consumption was estimated by multiplying the installed wattage of bulbs found in the streetlights by the number of hours they operate in a year. Once known, the electricity consumption could then be inputted into the standard PCP formula for calculating GHG emissions produced by streetlighting. For reference, a simplified version of both formulas for calculating electricity consumption and GHG emissions produced by streetlights as per the PCP protocol is as follows.

2.3.1 Formula

$$x = \frac{W * O * 366\ days}{1000\ watts\ per\ kWh}$$

Where:

X = Estimated annual electricity use (kWh)

W = Total installed wattage (watts)

O = Average annual daily operating hours

$$\sum (FC * Cef) + (FC * CHef * CHwp) + (FC * Nef * Nwp)$$

Where:

FC = Amount of electricity consumed

Cef = Carbon Dioxide (CO_2) emission factor for electricity

CHef = Methane (CH_4) emission factor for electricity

Nef = Nitrous Oxide (N_2O) emission factor for electricity

CHwp = Global warming potential of Methane

Nwp = Global warming potential of Nitrous Oxide

2.3.2 Assumptions

Multiple assumptions were needed to complete the estimate for electricity consumed by streetlights in Carling Township. First, based on initial research, it was assumed that the average streetlight contains an 80 watt bulb, and each streetlight was therefore allocated an 80 watt bulb. In conversing with Carling Township staff, it was mentioned that the municipality only has 2 streetlights, one at the Blind Bay Boat Launch, and another at the Carling Bay Road East and Bayview Intersection. However, some Carling staff expressed their belief that the later of the two was on a resident's property. Despite this belief, in a taking a precautionary approach it was believed that the township of Carling was responsible for both streetlights.

Next was the process of determining the number of operating hours which the streetlights were active. It was assumed that streetlights operate only during the hours in which their services are needed (i.e. dusk to dawn). As a result, average annual operating hours could be determined by first discovering the average amount of daylight throughout the year. Once known, it could then be subtracted from 24 hours in a day to estimate the average amount of dark hours over the year. Average annual daylight hours was then calculated for the Town of Parry Sound because it is the closest location with existing data on daylight hours. While not located in Carling Township, the Town of Parry Sound's daylight hours will be the same as Carling Township's because of their close geographic proximity. It should also be noted that 2016 was a leap year, which is why the number of days that operating hours was multiplied by was 366.

2.3.3 Outcome

Carling Township's streetlighting produced **0.03** tonnes of CO^2e in 2016. These emissions were produced by consuming **2** GJ of energy.

2.4 Fleet

There are multiple methods to calculating the amount of fuel consumed by the fleet. Once determined, a standard formula for calculating the GHG emissions produced by a corporate fleet can be applied. For reference, a simplified version of this formula, as per PCP protocol is as follows.

2.4.1 Formula

$$\sum (FC * VTC) + (FC * VTCHef * CHwp) + (FC * VTNef * Nwp)$$

Where:

FC = Amount of fuel by type consumed

VTC = Emission factor by vehicle type for Carbon Dioxide (CO_2)

VTCHef = Emission factor by vehicle type for Methane (CH_4)

VTNef = Emission factor by vehicle type for Nitrous Oxide (N_2O)

CHwp = Global warming potential of Methane

Nwp = Global warming potential of Nitrous Oxide

2.4.2 Assumptions

Actual fuel consumption data for the year 2016 was unavailable. However, actual fuel consumption data was available for the years 2017 and 2018. As a result, actual fuel consumption data from these years was used to estimate the amount of fuel for the year 2016. To estimate the amount of fuel consumed by the Carling fleet in 2016, the growth rate of fuel consumption between 2017 and 2018 was first calculated using the following formula.

$$\frac{Present - Past}{Past}$$

This calculation revealed that between the years 2017 and 2018, gasoline and diesel consumption rose by approximately 28% and 13% respectively. However, it should also be noted that the number of vehicles in the fleet increased during this time period as well, which can largely be attributed to the increase in fuel consumption. As a result, the increase in fleet size must also be considered when determining fuel consumption for the year 2016. Therefore, it was assumed that the growth of the number of vehicles in the fleet was directly equivalent to the growth rate of fuel consumption. For example, the number of gasoline trucks in the fleet rose by 25% between 2017 and 2018. This amount was then subtracted by the fuel growth rate to illustrate the increase in solely fuel consumption, or approximately 3%. The same process was applied to diesel vehicles. The number of diesel vehicles in the fleet increased by approximately 14% between 2017 and 2018. Subtracting this amount from the growth rate in diesel consumption revealed that diesel consumption actual decreased by approximately 1%.

It was then assumed that growth rates remain relatively stable given the nature of municipal operations and the 2017 to 2018 growth rates can therefore be applied for the period 2016 to 2017. The outcome, using the following formula, yielded fuel consumption data that is credible given known fuel consumption data. Since actual fuel consumption for each vehicle was known for 2017, these growth rates (3% and -1%) were then applied to the reported fuel consumed in 2017 using the following formula. Completing this calculation would then arrive at an estimate for the amount of fuel consumed by each vehicle in 2016.

$$FV = PV\ (1 + g)^n$$

Where:

FV = Future value

PV = Present value

g = Growth rate

n = Number of years apart

Rearranging the formula then creates the following formula.

$$PV = \frac{FV}{(1 + g)^n}$$

It should also be noted that some vehicles in the fire department were replaced in 2017, having the potential to skew the calculation as a result of the emission technology found within each vehicle. However, each vehicle was replaced with another vehicle considered to be in the same classification of emission potential as per the PCP protocol, and thus having no effect on the GHG outcome from a calculation perspective. For example, a heavy duty diesel truck was replaced with another heavy duty diesel truck.

Finally, it also became apparent when inputting data into the PCP tool that no category exists for boats to be reported by corporate fleets. As a result, boats in Carling's fleet were classified under 'off-road vehicles' in the PCP tool.

2.4.3 Outcome

Carling Township's fleet produced an estimated **130** tonnes of CO^2e in 2016. These emissions were produced by consuming **1,831** GJ of energy.

2.5 Solid Waste

Since actual data on corporately generated waste is not available, local governments can estimate the quantity of solid waste generated at corporate buildings and facilities, as well as community produced waste that is diverted as part of municipal operations (i.e. parks and sidewalk garbage receptacles). This estimate is determined on the size of garbage bins used, their average fullness at pickup, and the frequency of pickup (PCP Protocol, Approach #2, p.22)[5].

The type of landfill is another determinant of the formula used for estimating emissions from corporate solid waste. For reference, a simplified version of this formula, as per the PCP protocol is as follows.

2.5.1 Formula

$$\sum 21 * (GBC * BF * PU * 2.136) * \left(\left(\frac{16}{12}\right) * MCF * DOC * DOCF * F\right)(1 - MR)(1 - OX)$$

Where:

GBC = garbage bin capacity (m^3)

BF = Approximately how full the bin is when it is emptied (%)

PU = Frequency of pickup (times per month)

MCF = Methane correction factor

DOC = Degradable organic content

DOCF = Fraction of DOC dissimilated

F = Fraction of methane in landfill gas

MR = Methane recovery at landfill (%)

OX = Oxidation Factor

2.5.2 Assumptions

Data on the actual corporate solid waste generated by Carling Township in 2016 does not exist. Gaining an understanding of solid waste practices and policies can help to determine some of the

[5] https://data.fcm.ca/Documents/reports/PCP/PCP_Protocol_Canadian_Supplement_EN.pdf

factors and coefficients of the formula that are determinant on landfill management and operations.

When solid waste is generated, it is sent to the various transfer stations located throughout the municipality. Once transfer stations have reached capacity, solid waste is then diverted to the McDougall landfill. However, this waste is mixed in with community generated waste as part of the solid waste service the transfer station provides to residents. As a result, the tonnage of solid waste from the transfer station reported by the McDougall landfill can only be used as a reference to determine the accuracy of the solid waste estimate.

Staff from the McDougall landfill informed GBBR that no emission capture technology exists. This is because a feasibility study was undertaken, which determined that it was economically unfeasible to purchase the technology and embark on installation. While this technology does not exist, the landfill is still being actively managed. Garbage is compacted daily to reduce its volume and then buried to allow for additional landfill space, and to deter wildlife. The landfill is also classified as engineered. The landfill is lined to capture leachate, which is then removed and sent to an offsite treatment facility for processing. These factors helped to determine assumptions on several of the values required by the formula.

Next was the process of determining the quantity of solid waste produced. It was assumed that buildings with a relatively small number of daily occupants (classified as minor buildings) had a single bin for garbage, sized at $0.08m^3$, and was removed weekly to eliminate any odours. While this assumption may seem to be unrepresentative, $0.08m^3$ is equivalent to 2 large-sized garbage bags being produced per week. Additionally, this represents an average across buildings with a smaller number of daily occupants. For example, the Municipal Office may produce twice this amount in a given week, however, the Fire Hall may each produce half this amount. Additionally, the Outdoor Rink was given the assumption as well. The Outdoor Rink is used for ice skating and hockey in the winter months, and for the Carling Market during the summer months. While waste produced will fluctuate between the two seasons, as well as within a season, the $0.08m^3$ represents an estimated average across all seasons.

2.5.3 Outcome

Carling Township's solid waste produced an estimated **5** tonnes of CO^2e in 2016.

2.6 Business as Usual

In calculating the business-as-usual (BAU) forecast, the year 2030 was chosen as the forecast year.

2.6.1 Assumptions

In their 2016 Population Census, Statistics Canada reported that Carling Township experienced a 9.9% decline in population between the years 2011 and 2016. However, given that the BAU forecast is determined by annual population growth, it was determined that the reported decline in population would be unrepresentative of corporate operations and the projected BAU for the following reasons.

Geographically positioned on the Eastern shoreline of Georgian Bay and in the heart of cottage country, Carling Township is a major tourist destination. In addition to the numerous cottages and resorts that attracts tourists, Carling Township is home to one of Ontario's busiest provincial parks; Killbear Provincial Park (KPP). As a result of this tourism, a massive increase in population occurs during the warmer months, raising the population from 1,125 permanent residents to include tens of thousands of seasonal residents. Yet Statistics Canada only accounts for the 1,125 permanent residents in their 2016 Population Census. As a result, Statistics Canada's population decline is derived from permanent residents, failing to account for the major seasonal population influx. This is problematic and unrepresentative in producing a BAU forecast because the services and amenities provided by corporate operations are not restricted for permanent resident use only. For example, Carling Township provides the numerous cottages, resorts, and KPP with emergency services, and seasonal residents utilize roads and other local infrastructure, causing additional wear-and-tear that requires Carling staff to maintain and repair. Therefore, as seasonal population grows, so too will corporate operations, and the associated GHG emissions. Essentially, using Statistics Canada's population decline would demonstrate that there would be a natural decrease in GHG emissions as population shrinks, a situation which can logically be assumed to be untrue, given that municipal operations are conducted on behalf of all residents residing in the jurisdiction, not just the permanent ones. As a result, the following methodology and assumptions were considered in producing a growth statistic that would factor seasonal population in producing a BAU forecast.

Data was first retrieved from the Municipal Property Assessment Corporation (MPAC). This data was referenced because it classifies each property in Ontario according to its functional purposes. For example, data entries categorized as a 300 series property are classified as a residential property, including both permanent residences and seasonal residences.

It can be difficult to assume the number of people that are staying at a seasonal residence at any given time. For example, it is common for numerous different families to rent a single seasonal residence throughout the summer. This produces a high degree of variability in the population of any single seasonal residence, as one week could have 3 residents occupying the premises and the following week could have 8. From a calculation perspective, the most appropriate response would be to use a provincial statistic, such as the average number of residents per household. However, using a statistical average such as the average number of residents per household results in a static number, and shifts the aspect of variability to the object it represents, which in this case is the household. Therefore, accounting for seasonal population in an annual population growth rate would require calculating the growth rate of the number of residential properties as determined by MPAC.

Based on the static nature of the number of residents per household, it was assumed that the growth rate of the number of residential properties would be the same as population, and that municipal operations would grow at a similar rate to match the added demand of municipal services. As a result, the annual growth rate of residential properties was used to determine the BAU forecast.

Given that the BAU forecast was determined by annual residential property growth, multiple years of data was used to eliminate the possibility of an outlier skewing the calculation result. With this consideration, the residential property growth rate was calculated for each year from 2010 to 2016, and then averaged. This resulted in an average annual residential property growth rate of 0.63%. Following the PCP protocol, this 0.63% growth rate was used to determine the forecasted emissions for the year 2030.

2.6.2 Outcome

Given a 0.63% residential property growth rate forecasted to the year 2030, Carling Township is expected to produce 173 tonnes of CO_2e in 2030, representing a 9% increase from baseline levels, if business is to continue as usual.