City of Ottawa
GHG Analysis of Actions in the Draft Solid Waste Master Plan

September 2023

Disclaimer

This technical memo has been prepared on behalf of the City of Ottawa by HDR Corporation. The information presented is based on data available and current at the time this document was prepared, which includes information acquired for previous reports. Forward looking statements are based upon expectations, estimates and projections at the time the statements were made and involve risks and uncertainties that could cause actual events to differ from those anticipated. This technical memo is an estimate of the potential greenhouse gas impact of the Draft Solid Waste Master Plan for high level planning purposes and is not intended to be an official GHG verification or quantification of City emissions.

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1. Introduction

In 2019, the City of Ottawa declared a Climate Emergency and approved its first Climate Change Master Plan (CCMP) in January 2020. The CCMP is the City's overarching framework to reduce greenhouse gas (GHG) emissions and respond to the current and future effects of climate change. It includes the Energy Evolution Strategy (EE), which aims to take unprecedented collective action to transition Ottawa into a clean, renewable, and resilient city by 2050, meaning a 100 per cent reduction in emissions in comparison to 2012 emissions levels. For community emissions, this includes an emissions reduction of 43 per cent by 2025, 68 per cent by 2030 and 96 per cent by 2040.

Landfill gas (LFG) emissions are included in the makeup of corporate emissions and have already met the target of a 30% drop by 2025 and will need to realize a 50% drop by 2030 and a 100% drop by 2040. This technical memo will show how the Solid Waste Master Plan (SWMP) will support the realization of achieving the corporate emission targets of 100% by 2050.

Within the first 5 years of implementation, the recommended actions in the draft SWMP are expected to reduce GHG emissions generated by the City's management of solid waste and support the CCMP by:

1. Increasing organics waste diversion and by changing the current landfill gas management strategy.

Beyond the first 5 years, additional actions are recommended to be considered to further support the lowering of GHGs. For the medium term (5-10 years) the SWMP includes:

1. Additional landfill diversion Actions;

2. Using Anaerobic Digestion to process household organic waste;

3. Implementing a zero-emissions fleet strategy;

4. Reviewing the feasibility of Mixed Waste Processing; and,

5. Reviewing the feasibility of a Waste to Energy Facility.

The intent of this technical memo is to assist the City in understanding the GHG impact that the draft SWMP will have on Ottawa meeting its climate goals and GHG reduction

targets. The estimates included in this memo are high-level estimates for planning purposes and may change over time.

2. SWMP alignment with the Energy Evolution Strategy and the Climate Change Master Plan

Energy Evolution developed a scenario which modeled the most efficient and feasible way for Ottawa, as a community, to do its part to ensure no more that 1.5°C of global heating. This is commonly referred to as the 'EE model'. The EE model projected that Solid Waste Services (SWS) could cut 454,000 tonnes of CO2e by 2050 with 82% of that being achieved by 2030. Of the overall emission reductions projected to be achieved by 2050, 162,000 tonnes (36%) would be from residential waste sources, and 292,000 tonnes (64%) would come from the IC&I (Industrial, Commercial, and Institutional) sector, which the City has very limited legislative tools available to influence. SWS is responsible for the management of residential waste only and the IC&I sector is managed by the Province. Given this, the SWMP explores only what it can impact directly, which is residential emissions.

The 2023 CCMP Progress Report[1] identifies key performance indicators that include natural gas, fleet, and landfill gas emissions reductions. To achieve the CCMP goals, the EE recommends:

- Using LFG to generate renewable natural gas (RNG); and,
- Diverting organics to anaerobic digestion (AD) which also produces RNG).

The EE explains that the use of RNG produced by LFG capture or AD should be used to offset fossil fuel natural gas for home heating (community emissions), but RNG can also be used to fuel City fleet vehicles (corporate emissions). This technical memo describes how the RNG produced from waste could be used in **Section 3.6 (Anaerobic Digestion)** and **Section 4.1 (Fleet).** It is important to note that these sections are mutually exclusive; the City must select its preferred use for the RNG it generates, whether that be for home heating or fuel for the City's fleet. Home heating would be in line with the EE, while using RNG for fleet would need to be contemplated in the wider corporate fleet or Solid Waste fleet strategy.

[1] https://documents.ottawa.ca/sites/documents/files/CCMPProgressReport2023_en.pdf

Goals in the CCMP and EE, and how the proposed Actions included in the SWMP will contribute toward meeting these goals, are included in **Table 1**.

Table 1 - SWMP Alignment with CCMP and EE Goals

Goals and Projects	SWMP Actions that Support the CCMP and EE Goals
CCMP: A 50 per cent reduction in corporate emissions by 2030.	Several Actions identified in the SWMP will reduce methane-generating waste from entering the landfill by increasing the diversion of food waste, leaf and yard waste, textiles, and pet waste.
CCMP: A community emissions reduction within the residential buildings sector, reducing from 1,316 kt CO_2e down to 390 kt CO_2e by 2030.	Generating RNG using anaerobic digestion will reduce community emissions if the City elects to use generated RNG to supply customers in Ottawa.
EE: Removing 98 per cent of organics from the landfill and processing organic waste using anaerobic digestion to produce RNG.	The SWMP alone will not remove 98 per cent organics from the landfill, but it does recommend several actions intended to increase organics diversion. The SWMP also recommends AD for processing organic waste.
CCMP: An updated plan to continue the conversion of City fleet vehicles to hybrid and electric vehicles where possible is listed as one of the twenty priority projects of the CCMP.	The SWMP action of Working Toward a Zero Emissions Solid Waste Fleet is in alignment with this project.

The next sections describe in more detail how the SWMP Actions support the goals of the CCMP and EE.

3. Short-Term (Years 0-5) GHG Reductions from the SWMP

In the earliest stages of the SWMP, the plan will focus on landfill emissions and diversion of organics from landfill for GHG reduction. By 2050, the estimated reduction in GHGs realised from these early actions is estimated to be 138,620 tonnes, which is approximately 23,000 tonnes short of the goal established by the EE. The EE aims for a near total elimination of organics from landfill (in line with a potential Provincial ban of organic waste in landfills), but this will not be achieved in the short-term, partly due a subsequent delay in the Provincial ban and the magnitude of community behaviour change required to limit organics waste going to landfill. However, additional diversion actions that will be reviewed in the medium-term (5-10 years) have the potential to further reduce GHG emissions and bring them more in line with the EE goals. These actions are explained in section 4.

3.1 Landfill Emissions and Diversion

The emissions from the landfill in 2018 were 32,600 tonnes CO_2e, according to the CCMP. In the 2020 GHG inventories, emissions from the landfill were reported at 27,600 tonnes of CO_2e, noting a 15 per cent reduction over 2018. Assuming steady state conditions (i.e., no significant increases in methane generating waste deposition), the SWMP Actions are projected to reduce the emissions further to an estimated 24,970 tonnes of CO_2e in 2030, or a reduction of 23.4 per cent over 2018. By 2040, emissions are expected to be reduced further to 21,960 tonnes of CO_2e, or a 32.6 per cent reduction in emissions over 2018, based on implementation of the short-term actions described below.

It should be noted that landfill operations are dynamic, and several factors can influence emissions at a landfill, including the rate that waste is generated by residents, quantity and type of materials disposed in the landfill, landfill gas capture rates, leachate circulation, and types of cover used. The waste diversion and reduction actions listed below are primarily focused on decreasing the quantity and type of materials disposed in the landfill, thereby decreasing GHG emissions.

3.2 Methodology - Landfill

Landfill gas for the City of Ottawa's Trail Waste Facility Landfill (TWFL) was modeled for the waste projections developed for the SWMP. Historical modelling of landfill gas was not completed. This analysis only includes the waste projections modeled for, and that can be controlled by, the recommended actions identified in the SWMP. GHG emissions reductions for the TWFL were calculated based on estimates for diversion and reduction of waste from those actions listed in the SWMP that are recommended for implementation within the first 0-5 years.

Landfill gas generation at the TWFL was modeled with the first order decay model in the National Inventory Report (NIR) Volume 2 (2022). According to City data, the TWFL is currently realizing a 90 per cent landfill gas capture rate, which is significantly higher than the industry average of 75 per cent.

3.3 Short-Term Goals for Landfill Emissions

The following Actions are planned to be implemented in the first 0-5 years of the SWMP and will continue for the duration of the SWMP planning period (30 years):

- Action 1: Waste Avoidance, Reduction, and Reuse Initiatives
- Action 4: Enhanced Source Separation of Waste
- Action 5: Supporting Additional Diversion in Multi-Residential Buildings
- Action 6: Waste Diversion Initiatives and Strategies at City Facilities
- Action 7: Waste Diversion in Parks and Public Spaces

The SWMP provides the framework for how the City will manage solid waste and its GHG emissions and impacts over the next 30 years. The calculations and projections included in this GHG technical memo are based on the City's current waste management system and anticipated changes to the City's population and materials managed. As referenced in the SWMP's Long-term Waste Management Needs Technical Memo, the City's population is anticipated to increase 40 per cent by 2046. It is assumed that landfilled material will be sent to either the TWFL or another local, privately owned landfill.

Table 2 – Initial Net landfill GHG reductions of the SWMP (tonnes CO_2e)

Year	Action No.1 (Reduction and Reuse)	Action No.4 (Curbside)	Action No.5 (Multi-residential)	Action No.6 (City facilities)	Action No.7 (Parks & Public Spaces)	Total Reductions
2025	0	0	-70	0	0	-80
2030	-40	-1,070	-930	-450	-140	-2,630
2040	-100	-2,280	-1,700	-1,250	-320	-5,650
2050	-140	-2,770	-2,020	-1,630	-380	-6,940
Total (30 year)	**-2,600**	**-55,730**	**-42,380**	**-30,240**	**-7,670**	**-138,620**

Note:
The 30-year total is cumulative over the SWMP planning period, and therefore is not the sum of the emission reduction for the years listed on this table.

The total emissions reduction increases over time as actions are implemented. Over the course of the 30-year SWMP, the actions shown in the table above are expected to reduce Ottawa's landfill GHG emissions by an estimated cumulative 138,620 tonnes of CO_2e, or an average of 4,620 tonnes of CO_2e per year.

3.4 Landfill Gas Management Strategy

The Landfill Gas Management Strategy (LGMS) is being developed concurrent to the SWMP. Staff are currently assessing the feasibility and business case of an renewable natural gas (RNG) project which would use the landfill gas produced at the TWFL to generate RNG. This would represent a shift away from the current electricity generation model and a move toward the production of a new valuable renewable resource: RNG. In addition to being a requirement of the Energy Evolution model included in the EE, this change could provide other environmental and economic co-benefits to the City.

The reduction in GHGs that can be achieved is larger when landfill gas is used to create RNG because RNG can be used to replace fossil fuel natural gas consumption, whereas landfill gas that produces electricity has a much lower potential impact given that Ontario's electricity mix is already quite clean (from around 90% clean energy). The move to RNG is in-line with Ottawa's climate change goals and reflects the significant increase in effort at all levels of government to GHGs.

RNG is functionally identical to fossil natural gas and can be transported via the current natural gas distribution pipelines to heat homes, city facilities, businesses and industry. All options present extremely favourable environmental, social, and economic outcomes.

The Federal Government created a Market Snapshot: Two Decades of Growth in Renewable Natural Gas in Canada which explains the drivers of the growth in Canada which is being used to inform the strategy.

4. Further GHG Reductions Beyond the First 5 Years

The SWMP recommends planning and implementing several Actions that have potential to reduce GHGs in the medium-term (5-10 years) and long-term (10+ years) timeframes of the SWMP. Many of these Actions can be planned in the first five years of SWMP roll-out but their impact may not be realised until beyond 5 years. These Actions are as follows:

- Additional landfill reduction and diversion efforts, including:
    - C&D Waste Diversion Strategy;
    - Bulky Waste Diversion Strategy;
    - Municipal Hazardous Solid Waste Strategy Development;
- Anaerobic Digestion (AD) to process household organic waste and generate RNG;
- Using either RNG or electricity to fuel SWS fleet and work toward net-zero solid waste collection vehicles;
- Waste To Energy (WTE), specifically mass-burn incineration/thermal combustion;
- Mixed Waste Processing (MWP), to further divert materials to their designated stream;
- Identifying curbside collection efficiencies; and,
- Innovation and Technology Strategy.

The GHG impacts of these actions will be quantified as the various strategies are developed, largely within the first 5 years of SWMP roll-out. The following sections describe some of these Actions and their potential to reduce GHG reductions.

4.1 Anaerobic Digestion

Anaerobic digestion (AD) is the process of organic matter decomposing without oxygen in a bioreactor. The decomposition process produces biogas. The biogas is approximately 60 per cent methane and can be further refined into renewable natural gas (RNG) by removing the oxygen, carbon dioxide, and trace gases. RNG can be injected into a pipeline and used as a zero-carbon-intensity substitute for fossil fuel natural gas. The life cycle emissions for RNG are over 90% lower than fossil fuel natural gas.

4.2 Methodology

The benefits of using RNG instead of fossil fuel natural gas can be evaluated by comparing the carbon intensity of each fuel. Carbon intensity is the life cycle carbon emissions per unit of fuel combusted. **Figure 1** shows an average carbon intensity for renewable natural gas produced from municipal source separated organics of 26 grams of CO_2e per megajoule of RNG, or 26 g CO_2e/MJ, based on the life cycle emissions generated to produce the fuel. In contrast, fossil fuel derived natural gas has a carbon intensity of 51 g CO_2e/MJ.[2]

[2] Carbon intensity for natural gas derived from emissions factors as presented in ECCC's National Inventory Report 1990-2019, Volume 2, Table A6.1–1.

Figure 1 - Table 73, taken from ECCC's "Fuel LCA Model Methodology", March 2020[3]

Table 73. Carbon intensity results for RNG produced from MSW organics, expressed in g CO_2 eq. per MJ of RNG (HHV).

Life Cycle Stage	Amount	Unit
Feedstock transport to RNG facility	6.6	g CO_2 eq./MJ
Anaerobic digestion	10	g CO_2 eq./MJ
Biogas upgrading	8.1	g CO_2 eq./MJ
Transport & Distribution	0.6	g CO_2 eq./MJ
Combustion	0.3	g CO_2 eq./MJ
Total	**26**	**g CO_2 eq./MJ**

The *net* carbon intensity for RNG is the difference in carbon intensity between fossil fuel natural gas and renewable natural gas. Net carbon intensity is calculated by subtracting the carbon intensity of fossil fuel natural gas from the carbon intensity of the alternative RNG fuel. This calculation results in a net carbon intensity of -25 g CO_2e/MJ, or 0.93 kg CO_2e/m³, for RNG, which demonstrates that RNG has a lower carbon intensity than fossil fuel natural gas. The actual net carbon intensity of a potential anaerobic digestion processing facility for organics will vary depending on the facility type, feedstock, and other factors. For planning purposes, a net carbon intensity of -25g of CO_2e/MJ (0.93 kg CO_2e/m³) for RNG was used for this analysis.

The feasibility analysis of AD is already underway, in line with the Council-approved Energy Evolution Strategy, which called for all organic matter to be digested and converted to RNG. The feasibility report on AD will be available by Q3 2024. Any new facility would be required by the year 2030 because that is when the current organics processing contract ends.

As mentioned, the City is currently evaluating the feasibility of a new AD facility. For this analysis, it was assumed that the facility will process approximately 50 per cent of the

[3] Fuel lifecycle assessment (LCA) model methodology, Accessed at https://publications.gc.ca/site/eng/9.893160/publication.html

organics collected in Ottawa during in its first year of operation (estimated 2030; see **Table 3**). The facility would generate approximately 2 million m^3 of RNG in 2030, which would offset 1,840 tonnes of CO_2e. By 2050, it is anticipated that the facility will produce 4.7 million m^3 of RNG, offsetting 4,390 tonnes of CO_2e. These 4,390 tonnes of CO_2e are equivalent to the CO_2 emissions from 1,300 passenger vehicles in one year, or emissions from using 1.87 million litres of gasoline.[4]

Table 3 - GHG emissions offsets for RNG produced from anaerobic digestion

Year	Organics Processed (tonnes)	RNG (GJ)	RNG (m^3)	Emissions Offsets (tonnes reduced of CO_2e/year)
2030	37,400	73,660	1,974,720	-1,840
2035	77,800	153,260	4,108,820	-3,830
2040	82,100	161,750	4,336,320	-4,040
2045	85,800	169,070	4,532,620	-4,230
2050	89,000	175,480	4,704,410	-4,390

One of the key performance indicators (KPIs) for the CCMP is a community emissions reduction within the residential buildings sector, reducing from 1,316 kt CO_2e (2023) down to 390 kt CO_2e by 2030 (70.4 per cent reduction). Although a potential AD facility would not produce RNG any earlier than 2030, estimated emission reductions associated with an AD facility were compared to this KPI for planning purposes. RNG from anaerobic digestion would reduce the annual emissions for natural gas by approximately 3,800 tonnes of CO_2e per year, or 3.8 kt CO_2e. While this represents a small contribution toward the larger goal, 3,800 tonnes of CO_2e reduction per year is still a significant offset of GHG emissions.

4.3 Potential GHG Reductions in Waste Fleet

The City's CCMP states that the transportation sector was responsible for 48 per cent of Ottawa's corporate emissions in 2018. The City's solid waste collection fleet contributes to the transportation emissions. SWMP Action: Working Towards a Zero Emissions Solid Waste Fleet addresses emissions from collection vehicles. This Action includes reviewing

[4] https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/calculator/ghg-calculator

emissions from the City's current solid waste fleet vehicles and researching vehicles that use low-carbon fuels. The following vehicles were analyzed to estimate the GHG emissions from the City's solid waste collections fleet:

- Residential waste collections vehicles;
- Multi-residential and City Facility waste collection vehicles; and,
- Mini-packer and F550 trucks used for Parks and Public Spaces collection.

Direct fuel usage data was used whenever possible, as it is more accurate for estimating emissions. Where fuel usage was available, the emissions were calculated using the emissions factors found in Environment and Climate Change Canada's National Inventory Report Volume 2, Table A6.1-14, released in 2022. Data was not available regarding on-street waste and OC Transpo waste collection vehicles, which are collected under contract, and therefore the fleet collecting this waste is not accounted for in this GHG analysis.

Waste Collections Vehicles

The City reported that 136 solid waste collection vehicles were used to service the City's residential collection areas in 2021. Information regarding fuel usage and mileage for contractor vehicles was not available. Based on a recent report by the Ontario Waste Management Association[5] (OWMA), it was estimated that the average annual emissions for one waste collection vehicle in Ontario using diesel is 95.9 tonnes CO_2e, which was used as a high-level estimate for this analysis.

Parks Collection

GHGs for Parks waste collection vehicles were calculated using fuel usage data supplied by the City, and the emissions factors from Environment and Climate Change Canada's National Inventory Report (NIR) Volume 2, Table A6.1-14. All vehicles used for Parks collection fall under the classification for Heavy Duty Diesel Vehicles (HDDVs).

[5] Greenhouse Gas Emissions and the Ontario Waste Management Industry, OWMA, December 2015

Table 4 summarizes the GHG emissions analysis for the City's waste fleet. The anticipated quantity of organics processed (in tonnes) is based on populations projections for the City of Ottawa over the planning period. Quantity estimates for each type of material, including organics, were calculated using statistical software. Based on direction from City staff, the calculations assume that assumed that leaf and yard waste is diverted for composting, and that source-separated organics would be split 50/50 between the existing Convertus composting facility until 2030. After 2030, it was assumed that all SSOs would be processed in an AD facility.

The estimated total amount of GHG emissions from City-owned or contracted waste collection vehicles is 13,040 CO_2e using the OWMA methodology for waste collections vehicles. Using the information provided by the City, Parks and Public Spaces emissions are estimated at 100 CO_2e, for a total estimated emissions of 13,140 tonnes of CO_2e.

Table 4 - GHG Emissions Results for Waste Collections (2021)

Vehicle		Fuel Type	2021 Emissions tonnes CO2e
Waste Collections	Curbside Residential (Contracted)	Diesel HDDV	6,330
	Curbside Residential (City-owned)		4,600
	Multi-Residential & City Facilities		2,110
Parks & Public Spaces		Diesel HDDV	100
Total Emissions (tonnes CO_2e)			**13,140**

Low emission fleet technologies are rapidly developing and therefore the City's plan may change as new technologies or fuel sources become available. Roadmap 2.0, prepared by the Natural Gas Use in Transportation Implementation Committee[6] for Natural Resources Canada, estimates that utilizing compressed natural gas (CNG) can result in an emissions reduction of approximately 17.6 per cent. This number is used in this analysis for high level

[6] https://natural-resources.canada.ca/sites/nrcan/files/oee/pdf/transportation/alternative-fuels/resources/pdf/NRCan_NGRoadmap_e_WEB.pdf

planning purposes. The actual emissions reductions will vary based on the vehicles being used and the vehicles and technologies being investigated by the City. Based on this report, switching all 136 vehicles to CNG could reduce the City's emissions by an estimated 2,310 tonnes of CO_2e per year. If the City elects to use the RNG produced by the proposed AD system, fleet emissions could be reduced by 7,730 tonnes of CO_2e per year. Electric waste collections vehicles are currently undergoing testing in several Canadian jurisdictions and could offer further GHG reductions. The City will monitor these ongoing efforts and include them in its planning and procurement processes.

Table 5 - Theoretical annual GHG reductions based on fuel type

Fuel Type	Waste Collections Emissions (tonnes CO_2e)	Parks & Public Spaces Emissions (tonnes CO_2e)	Total Emissions (tonnes CO_2e)	Tonnes CO2e/year per truck	Potential Annual Difference (tonnes CO_2e)
Diesel	13,040	100	13,140	95.9	0
CNG	10,750	80	10,830	79.0	-2,310
RNG	5,370	40	5,420	39.5	-7,730

The CCMP has a goal to reduce corporate fleet emissions from the current 2,000 kt CO_2e, to 910 kt CO_2e by 2030 (54.5 per cent reduction). This analysis is based on the estimates in Table 5. The analysis indicated that switching to CNG from diesel could reduce City emissions by up to 2,310 tonnes CO_2e/year (18 per cent emission reduction). Switching to RNG could reduce the City's waste fleet emissions by up to 7,730 tonnes CO_2e/year (59 per cent emission reduction). However, the emissions savings of using RNG can only be realized if the City elects to use RNG to fuel their fleet rather than using it to lower community emissions. The GHG savings associated with RNG use for fuels are mutually exclusive with the emissions offsets shown in **Table 3**, as the City must decide to use RNG either for vehicle fuel or for home heating via the existing natural gas grid. Optimal fuel sources for the City's waste collection fleet will be further explored in Action 25: Working Towards a Zero Emissions Solid Waste Fleet.

4.4 Waste to Energy

Waste to Energy (WTE) is an umbrella term that is used to describe processing waste by adding either heat or chemicals, or by processing biologically, and capturing the fuel that is

produced as the waste breaks down. In Canada, and the most common WTE process is thermal combustion, also known as Mass-Burn Incineration.

Most typically, WTE facilities burn the mass of mixed solid waste to produce steam, which powers an electric generator turbine. The combustion process reduces the volume of the waste by approximately 73 per cent, and the remaining ash material is landfilled. For Ottawa's waste, by preliminary calculations, it is estimated that approximately 185,000 tonnes per year of waste could be eligible for incineration in a WTE system. Environment and Climate Change Canada's (ECCC) Organic Waste GHG Calculator was used to estimate emissions for the following alternative scenarios:

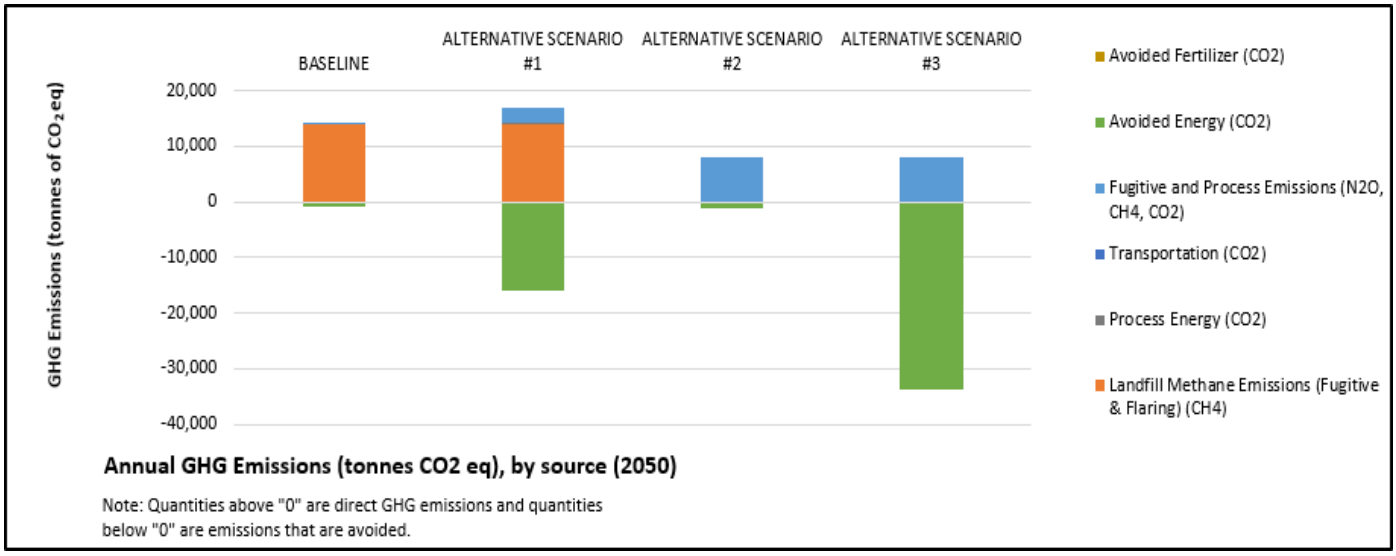
- Baseline: Landfill gas to electricity
- Alternative Scenario 1: Landfill gas to RNG
- Alternative Scenario 2: WTE to electricity
- Alternative Scenario 3: WTE to natural gas offset through steam (district energy heating system)

As shown in **6** and **Figure 2**, Alternative Scenario 3: WTE to natural gas offset through steam, offers the most significant emissions reduction compared to the baseline scenario.

Table 6 - Annual GHG Emissions for WTE Scenarios (tonnes of CO_2e per year)

	Baseline	Alternative Scenario #1	Alternative Scenario #2	Alternative Scenario #3
Landfill Methane Emissions (Fugitive & Flaring) (CH_4)	13,953	13,953	0	0
Fugitive and Process Emissions (N_2O, CH_4, CO_2)	28	2,791	8,020	8,020
Process Energy (CO_2)	32	177	0	0
Transportation (CO_2)	0	0	0	0
Direct Emissions (CO_2e)	14,012	16,920	8,020	8,020
Difference from Baseline (Direct) (CO_2e)	-	2908	-5,993	-5,993
Avoided Energy (CO_2)	-732	-15,868	-1,147	-33,667
Avoided Fertilizer (CO_2)	0	0	0	0
Avoided Emissions (CO_2e)	-732	-15,868	-1,147	-33,667
Difference from Baseline (Avoided) (CO_2e)	-	-15,136	-415	-32,936
Total	**13,281**	**1,053**	**6,873**	**-25,647**

Figure 2 - Annual GHG Emissions for WTE Scenarios (2050)



4.5 Mixed Waste Processing (MWP)

MWP facilities mechanically further separate garbage set out for collection by residents into materials that can be diverted and materials that can be landfilled. MWP would extend the life of the landfill by removing additional material from the waste stream that are not being diverted by residents and filter them to their appropriate streams for processing.

In Ottawa, MWP has the potential to divert approximately 30,000 tonnes of organics per year from the landfill to an AD facility. The impacts of this were evaluated using the ECCC's Organic Waste GHG calculator which showed that MWP would contribute an additional net negative 973 tonnes of CO2 per year.

Emissions were compared for the following alternative scenarios:

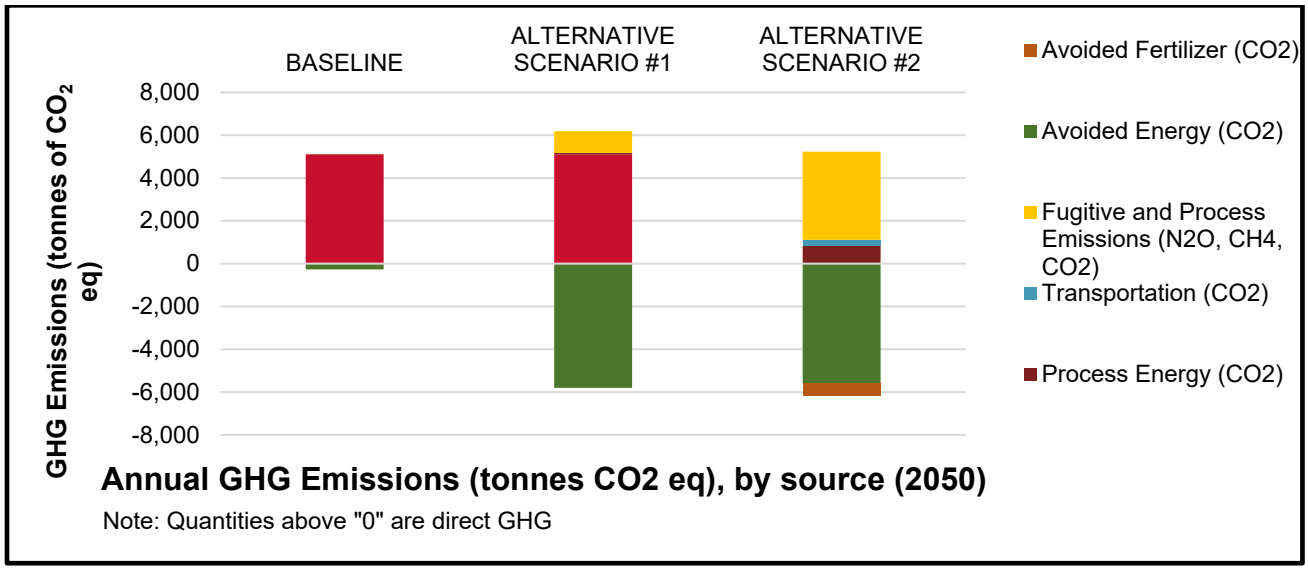
- Baseline: Landfill gas to electricity
- Alternative 1: Landfill gas to RNG
- Alternative 2: AD to RNG

As shown in **Table 8** and **Figure 3**, Alternative Scenario 2: AD to RNG, offers the most significant emissions reduction compared to the baseline scenario. The GHG emissions benefits of MWP are due to diverting more material from the landfill and using AD rather than LFG capture to generate RNG.

Table 7 - Annual GHG Emissions for MWP Scenarios (tonnes of CO_2e per year)

	Baseline	Alternative Scenario #1	Alternative Scenario #2
Landfill Methane Emissions (Fugitive & Flaring) (CH_4)	5,104	5,104	0
Fugitive and Process Emissions (N_2O, CH_4, CO_2)	10	1,021	4,113
Process Energy (CO_2)	12	65	845
Transportation (CO_2)	0	0	270
Direct Emissions (CO_2e)	5,126	6,190	5,228
Difference from Baseline (Direct) (CO_2e)	-	1,064	102
Avoided Energy (CO_2)	-268	-5,805	-5,600
Avoided Fertilizer (CO_2)	0	0	-602
Avoided Emissions (CO_2e)	-268	-5,805	-6,201
Difference from Baseline (Avoided) (CO_2e)	-	-5,537	-5,934
Total	**4,859**	**385**	**-973**

Figure 3 - Annual GHG Emissions for MWP Scenarios (2050)



5. Conclusion

The City's GHG reduction goals identified in the CCMP and EES were considered when developing the SWMP, and several Actions identified in the SWMP were selected to reduce the City's GHG emissions. The Actions identified in the SWMP will reduce methane generating materials in the landfill, divert organics to an AD facility, generate RNG using AD, and work toward a zero-emissions solid waste fleet.