Memo

To: Ash Raichura, P.Eng. Project Coordinator, City of Winnipeg

From: Alida Kusch, Partner, Project Manager, Dillon Consulting Limited (Dillon)

Date: April 19, 2024

Subject: City of Winnipeg – Residential Green Cart Program: Curbside Cart Collection Scenario Analysis

Our File: 24-7515

1.0 Introduction

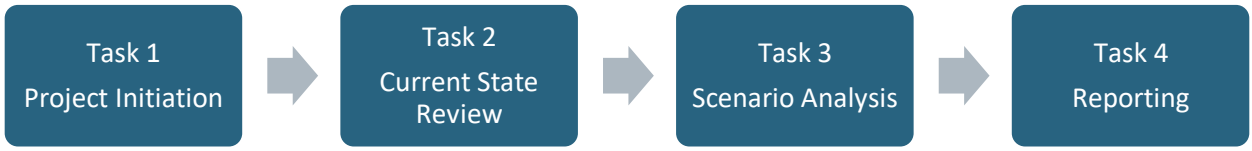
The City of Winnipeg (City) currently provides garbage (grey cart) and recycling (blue cart) curbside collection to residents on a weekly basis and leaf and yard waste (LYW) collection on a seasonal bi-weekly basis. On October 26, 2023, City Council approved a green cart program for residential food waste to help keep food waste out of the landfill and reduce greenhouse gas (GHG) emissions. Dillon was retained to complete an analysis on how best to integrate a future curbside residential green cart collection service with the current curbside collection service. It is anticipated that the green cart program could be initiated as early as 2030.

The curbside cart collection analysis includes reviewing potential scenarios to integrate the upcoming curbside residential green cart collection service with the existing collection operations to potentially provide operational and financial efficiencies. The analysis reviews and summarizes the GHG, financial, and additional considerations for changes to collection operations from the existing system.

1.1 Project Approach and Methodology

The project was completed via four key tasks as highlighted in **Figure 1**.

Figure 1: Project Methodology



1.1.1 Project Initiation

The project kick-off meeting was held on February 2, 2024, and was attended by representatives from the City and Dillon. During the meeting, the project scope was presented, and requests for waste management data and reports relevant to this analysis were made by Dillon.

1.1.2 Background Review

Dillon staff completed a background review of available information, including a review of:

- Current waste collection contract, including operating costs;
- Projected waste tonnages and housing information to assess the number of stops per waste collection route;
- GHG emissions data and collection vehicle fuel usage; and
- Additional reports from the City's green cart pilot.

A summary of the background review is provided in **Section 2.0.**

1.1.3 Scenario Analysis

Four scenarios for a future curbside residential green cart collection service for residential food waste were considered for analysis. The four scenarios include:

1. Baseline scenario (weekly grey and blue cart, no green cart);
2. Baseline scenario with weekly green cart;
3. Bi-weekly grey cart and weekly blue and green cart; and
4. Bi-weekly grey cart, weekly blue cart, and weekly-summer/bi-weekly winter green cart.

The scenarios are described in more detail in **Section 3.1.** Each scenario was also analyzed for the following three variations:

1. Collection Vehicle Fuel Type:
    a. Diesel;
    b. Compressed natural gas (CNG); and
    c. Electric.
2. Green Cart Processing Facility Location:
    a. Brady Road Resource Management Facility;
    b. Facility within 50 km of Winnipeg;
    c. Facility within 100 km of Winnipeg; and
    d. Facility within 150 km of Winnipeg.
3. Green Cart and LYW Collection:
    a. Collect green cart and LYW separately; and
    b. Co-mingle LYW collection with food waste in larger green carts. Manual seasonal LYW collection for extra LYW that does not fit into the green cart.

The scenario variations are described in more detail in **Section 3.2.**

Dillon developed a 'menu of options' that contained factors and assumptions for rolling out a cart-based curbside residential food waste collection program. Dillon held a scenario and assumptions workshop on February 6, 2024 to discuss the 'menu of options' and refine assumptions. The factors discussed included the following:

- Green Cart Program Planning:
    - Determination of cart sizes (e.g., several options or all one size, specifically if co-mingling food waste with LYW);
    - Determination of collection contract and vehicles (e.g., manual, automated, semi-automated or hybrid approach, and spare ratio); and
    - Cart management (e.g., Radio Frequency Identification (RFID) tags/inputting addresses).

- Promotion and education:
  - Determination of type of promotion and education materials to be implemented ahead of and during program roll-out (e.g., mail outs and advertising); and
  - Staffing required to develop and coordinate implementation of the promotional and education materials.
- Program Roll-Out:
  - City or contracted services for delivery, staging areas and storage of green carts, building of green carts, increased 311 call volume management; and
  - Costs for cart exchanges, if applicable.
- Program Establishment and Management:
  - Specific scenario and variation assumptions;
  - City or contracted services for cart delivery, repairs, storage of carts, cart exchanges (if various sizes); and
  - Amount of carts for stockpiling for annual replacement/recovery and new developments.

Based on the outcome of the workshop, a standard list of assumptions applicable to all scenarios (e.g., tonnages, number of households) was developed. Dillon completed waste collection modelling using Dillon's in-house integrated curbside collection model (CCM). This CCM was designed as a tool to assist municipal staff in developing curbside collection options and/or new policies. The model permits input of information such as the following for a municipality's baseline scenario:

- Number of households serviced;
- Materials collected;
- Vehicle compartment parameters and utilization;
- Collection frequency; and
- Collection factors.

The calibration process involves fine-tuning the model using the City's data such as 2023 tonnages and the current contractor's truck complement. This allows for the model to reflect the City's existing waste management operations. Further, the CCM incorporates changes in the City's population and waste generation trends to project future scenarios.

The model output estimated the total collection truck hours and number of trucks for the collection of organics in each of the four scenarios and their variations. The estimated truck costs were amortized over seven years, which is the average life of a waste collection vehicle, to determine the potential impact on 2030 costs. Dillon used the collection hours to estimate truck hours, truck purchase, and maintenance costs. The number of trucks required were used in a GHG emissions and financial model to estimate the potential financial impact and GHG analysis. For each scenario, the following was included in the financial and GHG assessment:

- Description of the scenario;
- Capital operating costs (implementation year and on an annual basis);
- Operating costs (annual);
- Comparison of costs to the baseline scenario;
- Resources required (e.g., staffing, equipment, trucks, carts);
- GHG emissions relative to current emissions, including the value of emissions;
- Analysis and impacts for each of the three variations; and
- Additional considerations and/or requirements for implementation.

Scenario summaries and assumptions relating to each specific scenario and scenario variation are provided in **Section 3.0**. A comparative summary of the GHG emissions analysis is presented in **Section 3.3** and the financial analysis is presented in **Section 3.4.**

1.1.4 Reporting

This letter report captures the comprehensive insight into potential green cart program collection scenarios for residential food waste. The analysis provides a comparative overview of the potential GHG emissions, financial implications, and operational considerations for each curbside collection scenario.

2.0 Current State

Properties that receive curbside garbage and recycling services include single-family residential, multi-family residential, small businesses, charities, and places of worship. Multi-family homes are residential properties assessed at eight or more dwelling units. Curbside collection services include weekly garbage and recycling collection. These materials are collected in carts by two different contractors. The City also offers seasonal yard waste collection.[1] Recently, the City implemented and completed a pilot for collection of residential food waste.

2.1 Waste Collection System

This section provides an overview of the current waste collection system for single-family households, including information regarding the following:

- Curbside set out;
- Curbside collection;
- Waste disposal and processing;
- Annual waste tonnages; and
- Capital and operating budgets.

2.1.1 Curbside Set Out

The City's designated cart size for a standard residential dwelling unit is a 240 L cart for garbage and a 240 L cart for recyclables. Recycling is collected single stream and includes paper, plastic, metal, and glass. A residential dwelling unit may increase their cart size and number of carts to a maximum of 600 L for each garbage and recycling collection for a fee[2]. The City can provide the following cart combinations: a 360 L cart in lieu of 240 L cart(s), two 240 L carts, or one 240 L cart plus one 360 L cart. Two 360 L carts cannot be offered as this would put the dwelling unit over the 600 L maximum. The contractor performs curbside collections between 7:00 AM and 6:00 PM on collection days, Monday though Friday.

For an additional fee that ranges from $16.00 to $51.00, extra garbage and/or large items, also known as bulky waste, can be collected curbside. Extra garbage pickups are limited to no more than three

[1] City of Winnipeg. 2024. Recycling and garbage, Residential services, Introduction. https://myutility.winnipeg.ca/UtilityPortal/RecyclingGarbageYardWaste/sp/curbsidecollection

[2] City of Winnipeg. 2024. Recycling and garbage, Residential services, Modify services. https://myutility.winnipeg.ca/UtilityPortal/RecyclingGarbageYardWaste/sp/modifyexistingservices#upgrade

standard sized garbage bags. Large item pickups are limited to 10 items per pickup. Large items in curbside pickup include but are not limited too: large appliances, lawn mowers with fuel/oil removed, barbeques, furniture, and mattresses.[3]

2.1.2 Curbside Collection

Curbside recycling and garbage are collected every week of the year, using either automated or semi-automated trucks. LYW is collected once every two weeks from spring to fall (seven months). The start and end dates being weather dependant and typically run from early May to mid-November**.** Area 1 is the area inside the City Limits, primarily to the West of the Red River that runs North-South dividing the City. Area 2 is inside the City limits, primarily the area East of the river. Area 1 and Area 2 are collected by separate contractors.

2.1.3 Waste Disposal and Processing

Curbside collected garbage, surplus waste, and LYW are received at the City's Brady Road Resource Management Facility located at 1777 Brady Road. Recyclables are received at a Material Recovery Facility (MRF) that is owned and operated by GFL Environmental Inc located at 195 Discovery Place. For food waste, it is assumed in this report that it will also be received at the City of Winnipeg's Brady Road Resource Management Facility (except for the three variations where it could be 50, 100 or 150 km out of the City's boundary). In addition to the Brady Road Resource Management Facility, the City also operates four community recycling depots and two 4R depots.

2.1.4 Annual Waste Tonnages

The total tonnages of garbage, LYW, and recycling collected from residential stops (single-family only) and small commercial properties from 2020 to 2023 are shown in **Table** 1 and **Figure 2.** Tonnages for garbage have been increasing consistently over the last four years. LYW has been relatively stable from a processing quantity and there has been a decrease in recycling tonnages. A recent breakdown of monthly waste tonnages was provided for the LYW stream only. The monthly LYW tonnages were considered to determine the peak periods (and number of trucks required) for LYW collection for the CCM.

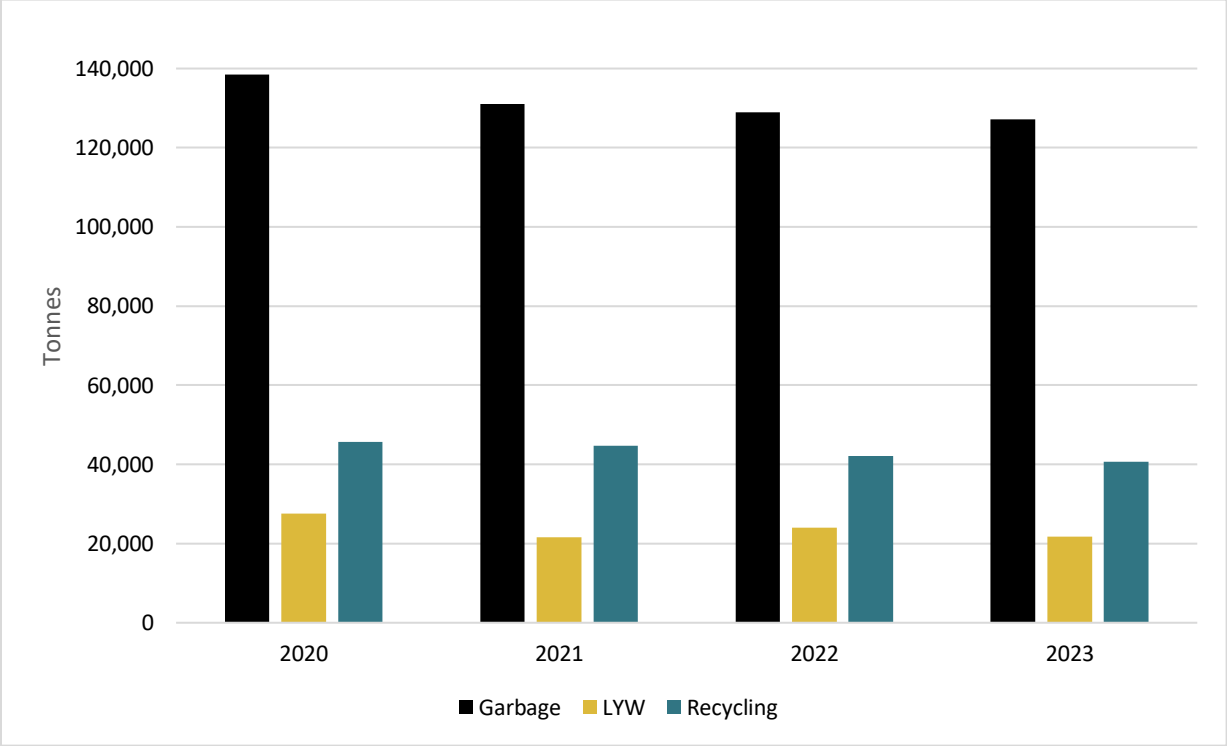
Table 1: Total Tonnes of Garbage, LYW, and Recycling for Single-Family Households and Small Commercial Properties from 2020 to 2023

Year	Garbage	LYW[1]	Recycling
2020	138,420	27,545	45,694
2021	131,097	21,514	44,736
2022	128,939	24,072	42,084
2023	127,208	21,820	40,690

[1] City Online Data Portal

[3] City of Winnipeg. 2024. Utility Bill, Rates, fees & service charges. https://myutility.winnipeg.ca/UtilityPortal/UtilityBilling/rates?section=recyclinggarbagecharges#SPLCOLLSRVCS

Figure 2: Total Tonnes of Garbage, LYW, and Recycling for Single-Family Households from 2020 to 2023



2.1.5 Capital and Operating Budgets

The City provides waste collection services via two collection contractors for the residential collection areas. Capital and operating costs specifically for waste collection from curbside residential customers, including single-family properties and properties with four to seven dwelling units, were not readily available for analysis. Estimated capital and operating costs for 2030 are provided in **Section 3.4**. These costs do not include cart maintenance costs and City staffing costs for garbage, recycling, and LYW. The estimated baseline scenario cost is strictly to act as a comparison for potential green cart scenario program costs.

2.2 Population and Households

The City's current population is approximately 796,100 (2023)[4]. From 2010 to 2020, the City has had a 1.2% median increase in population. For the purpose of this analysis, only curbside residential customers were examined. In 2023, collections contractors provided service to up to approximately 211,600 residential dwelling units.

2.3 Residential Food Waste Pilot Program

In 2020, the City implemented a pilot program for the collection of residential food waste. The pilot study ran for approximately two years in five neighbourhoods and included approximately 4,000 single-

[4] Provided by City. Spreadsheet "Curbside Cart Material Projections Email – Winnipeg Organics Strategy Projections".

family households. Every participant received a 120 L green cart and a 7 L kitchen pail to use for transferring food waste from their kitchens to their green carts. Communication and education included a pilot study specific City website with instructional videos and a welcome package provided to residents that included a user guide, list of acceptable materials, and resources for additional information.

Residential food waste was collected weekly in 120 L green carts. Collected materials were hauled to the Brady Road Resource Management Facility for processing. Participation in the program was voluntary. As part of the pilot study, data on waste composition and set-out and participation rates were collected. Public participation and satisfaction with the program were also evaluated using a three-phase public engagement strategy.

3.0 Scenario Development and Analysis

The following subsections outline the list of assumptions considered in the development of each scenario, scenario variation, and results of the analysis. To estimate the potential financial and GHG impacts of each scenario, a model was developed and provided to the City as a Microsoft Excel file. The City can continue to use this tool if the City moves forward with a residential green cart program and if any changes are required. A summary of the methodology and additional assumptions for the GHG emissions and financial analysis are provided in **Appendix A**.

The estimated GHG emissions and costs for the scenarios serve as preliminary projections. The estimated GHG emissions and costs should be compared relative to one another and not be considered as absolute values. The model was not intended to predict, estimate, or otherwise infer the exact emissions, costs, contractor vehicle, and labour requirements for servicing or any other results to change existing collection options or policies. The GHG emissions and costs will emerge as the City initiates the procurement process and engages with collections contractors and industry supplies. At this stage, competitive bidding, negotiations, and the current market context will come into play, leading to the determination of actual emissions and costs.

Assumptions for the development of the scenarios are presented in **Section 3.1.1** and the assumptions for the development of the scenario variations are presented in **Section 3.2.1**. The description, resourcing, and additional considerations for the four scenarios are presented in **Section 3.1.2**. The description, resourcing, and additional considerations for the scenario variations are presented in **Sections 3.2.2** to **Section 3.2.4**. A comparative summary of the GHG emissions analysis is presented in **Section 3.3**. The comparative summary of the financial analysis is presented in **Section 3.4**.

3.1 Scenarios

Four scenarios for a future curbside residential green cart collection service were considered for analysis. The four scenarios include:

1. Baseline scenario (weekly grey and blue cart, no green cart);
2. Baseline scenario with weekly green cart;
3. Bi-weekly grey cart with weekly blue and green cart; and
4. Bi-weekly grey cart, weekly blue cart, and weekly-summer/bi-weekly winter green cart.

The results of the analysis of the four scenarios (excluding the variations) are presented in **Sections 3.3** and **3.4**.

3.1.1 List of Assumptions for the Development of Scenarios

Table 2 outlines the standard assumptions applicable to all scenarios (excluding variations) that were initially considered during development. **Section 3.2.1** provides an outline of the assumption deviations for the scenario variations.

Table 2: List of Standard Assumptions Common for All Scenarios (Excluding Variations)

Category	Assumptions
Number of Households/Stops	• The number of households collected from is based on 2030 projections.[5] • The analysis includes waste collection from curbside residential customers including single-family properties and properties with four to seven dwelling units. The analysis does not include waste collection at multi-residential buildings (eight or more dwelling units), commercial, industrial, and institutional properties. • The analysis does not include bulky waste or extra garbage pick-up.
Type of Collection	• Hybrid (fully/semi-automated) for grey cart, blue cart, and green cart materials. • Manual collection of LYW. • Contractor to determine where fully/semi-automated collection needed noting that assumed fully-automated would be used unless it could not be collected by fully-automated.
Collection Vehicle Fuel Type	• Diesel
Collection Vehicle Capacity	• 9 tonnes and 23 m^3.
Green Cart Processing Facility	• For purpose of analysis, Brady Road Resource Management Facility was assumed as the processing facility for green cart materials. This assumption could include any processing facility located along the perimeter of the City. • Assume processing facility can accept both food waste and LYW.
Green Cart Contents	• Food waste.
Program Pre-consultation	• Pre-consultation activities include tasks required before the roll-out of a new green cart program and include promotion and education (P&E) activities. Pre-consultation resources will include cost of advertising, educational materials and admail, and an additional full time equivalent (FTE) staff member. • It is assumed that the new program would begin in 2030. • A separate bidding process and contract will be issued for green cart collection. The contractor will select the number of trucks and labour required to meet the operating specifications and contract requirements.
Green Cart Roll-Out	• 120 L carts. • Assume kitchen catchers provided to each household. • Roll-out across City all at one time. • The City will stockpile 9,000 additional carts for the initial cart roll-out for extra cart requests and replacements.

[5] HDR, July 18, 2022. Organics Planning Study, Technical Memorandum #1 – Current System – Final.

Category	Assumptions
Cart Upgrade	• Residents would be able to request an additional 120 L cart, not exchange for a larger or smaller cart size.
Management During Roll-Out	• A contractor will manage roll-out, delivery and building of carts, and initial storage of carts.
Ongoing Management	• A contractor will provide green cart collection services for residential curbside customers. • The City will manage ongoing cart maintenance, delivery and storage, stockpiling, and issuing to new developments once implemented. • It is assumed a new City Organics Division Branch will be formed to oversee and manage the green cart program. The City Organics Division Branch will include a program supervisor, labour for cart maintenance and cart delivery, waste audit and education personal, and other program support (e.g., bylaw officers). • The City will stockpile 9,000 additional carts for new developments, extra cart requests, and replacements on an annual basis. • The City will stockpile replacement parts for approximately 3,300 carts which includes spare wheels, spare lids, and spare bars.

A GHG emissions analysis was completed on the baseline scenarios. A summary of the methodology and additional assumptions for the GHG emissions and financial analysis are provided in **Appendix A**.

3.1.2 Scenarios 1 Through 4

Table 3 provides a summary of the program waste streams and collection schedule for each of the four future curbside residential green cart collection service scenarios. Additional considerations for the four scenarios are noted below.

Table 3: Summary of Scenario Waste Streams and Collection Schedule

	1 - Baseline Scenario	2 - Baseline Scenario with Weekly Green Cart	3 - Bi-weekly Grey Cart with Weekly Blue and Green Cart	4 - Bi-weekly Grey Cart, Weekly Blue Cart with Weekly-Summer/Bi-weekly Winter Green Cart
Garbage (Grey Carts)	Weekly	Weekly	Bi-weekly	Bi-weekly
Recycling (Blue Carts)	Weekly	Weekly	Weekly	Weekly
Organics (Green Carts)	N/A	Weekly	Weekly	Weekly-Summer/ Bi-weekly Winter
LYW	Bi-weekly Seasonal[1]	Bi-weekly Seasonal	Bi-weekly Seasonal	Bi-weekly Seasonal

[1] Bi-weekly seasonal refers to collection once every two weeks from spring to fall (approximately seven months).

Additional Considerations

- For scenarios with bi-weekly collection of grey carts, it may be difficult for some households to limit garbage to bi-weekly collection. The City may see an increase in contamination in recycling and organics recycling streams. Implementing an ongoing communication, education, and inspection program will support a successful green cart program and minimize contamination;

- Bi-weekly collection of grey carts can incentivize diversion of materials and increase participation in recycling and organic programs. For the purposes of this analysis, some incentivization was factored into the bi-weekly grey cart collection; however, the actual impact will coincide with ongoing P&E and enforcement activities; and
- It is anticipated that Scenario 2 will result in a greater number of resources from the contractor due to a greater number of trucks and truck hours to service customers on a weekly basis for grey, blue, and green cart collection.

3.2 Scenario Variations

Each of the four scenarios were analyzed for the following three variations:

1. Collection Vehicle Fuel Type:
   - Diesel;
   - Compressed natural gas (CNG); and
   - Electric.
2. Green Cart Processing Facility Location:
   - Brady Road Resource Management Facility;
   - Facility within 50 km of Winnipeg;
   - Facility within 100 km of Winnipeg; and
   - Facility within 150 km of Winnipeg.
3. Green Cart and LYW Collection:
   - Collect green cart and LYW separately; and
   - Co-mingle LYW collection with food waste in larger green carts. Manual seasonal LYW collection for extra LYW that don't fit into the green cart.

The impacts of the variations for each scenario were determined. It is noted that each of the four scenarios were only compared to one variation at a time. Scenarios were not analyzed using two or more variations at a time.

3.2.1 List of Assumptions for the Development of Scenario Variations

Table 4 outlines the deviation in assumptions for the scenario variations.

Table 4: List of Assumptions for Variations

Category	Assumptions					
	Variation 1 Collection Vehicle Fuel Type		Variation 2 Green Cart Processing Facility Location			Variation 3 Green Cart and LYW Collection
	1a CNG	1b Electric	2a 50 km away	2b 100 km away	2c 150 km away	3a Co-Mingle
Type of Collection	• Hybrid (fully/semi-automated) for grey cart, blue cart, and green cart materials. • Manual collection of LYW.		• Hybrid (fully/semi-automated) for grey cart, blue cart, and green cart materials. • Manual collection of LYW.			• Hybrid (fully/semi-automated) for grey cart, blue cart, and green cart materials (including LYW). • Manual collection of LYW.

Category	Assumptions					
	Variation 1 Collection Vehicle Fuel Type		Variation 2 Green Cart Processing Facility Location			Variation 3 Green Cart and LYW Collection
	1a CNG	1b Electric	2a 50 km away	2b 100 km away	2c 150 km away	3a Co-Mingle
Collection Vehicle Fuel Type	CNG	Electric	Diesel			Diesel
Green Cart Processing Facility	Brady Road Resource Management Facility		50 km outside City limits	100 km outside City limits	150 km outside City limits	Brady Road Resource Management Facility
Green Cart Contents	Food waste		Food waste			Food waste and LYW
Green Cart Roll-Out	120 L cart		120 L cart			240 L cart

Assumptions for the following categories remained consistent with the assumptions listed in **Section 3.1.1**:

- Number of households/stops;
- Program pre-consultation;
- Cart upgrade;
- Management during roll-out; and
- Ongoing management.

A summary of the methodology and additional assumptions for the GHG emissions and financial analysis for the scenario variations are provided in **Appendix A.**

3.2.2 Collection Vehicle Type Variation (Variation 1)

Each of the four scenarios were analyzed for three different collection vehicle fuel types:

- Diesel;
- CNG (variation 1a); and
- Electric (variation 1b).

Diesel is currently used in the contractor's collection vehicles. CNG consists of natural gas, primarily methane that is stored at high pressure. CNG is an alternative fuel source that can be used similar to gasoline or diesel given the right vehicle specifications[6]. Electric collection vehicles are powered by a battery instead of an internal combustion engine. Results of GHG emissions analysis are presented in **Section 3.3**. Results of the financial analysis are presented in **Section 3.4**. Additional considerations and assumptions for the three fuel variations are noted below.

[6] Canadian Natural Gas Vehicle Alliance. Natural Gas Use in the Medium and Heavy-Duty Vehicle Transportation Sector. June 2019.

Additional Considerations and Assumptions

It is assumed that should the City move forward with procuring a contract with CNG or electric vehicles, that a proponent bidding on the contract would include cost savings and increases in the unit price based on several factors. The difference in fuel cost and truck costs for CNG and electric vehicle scenarios were included in the analysis. The following factors may influence overall cost and GHG emissions; however, were not considered in the analysis:

- Lower maintenance costs associated with CNG and electric vehicles compared to other hydrocarbon-fuel vehicles[7] and long refueling times compared to diesel;
- Each of these alternative fuel types require specialized infrastructure for fueling and/or charging the vehicles prior to collection. The location of the fueling/charging station could also increase costs, depending on the distance from the City. Long distances or issues with traffic delays may result in more fuel/electricity and/or time to reach the station. Accessibility to fueling/charging stations that accommodate heavy-duty vehicles may not be readily available and require a contractor to install a fueling/charging station. This may include costs related to land, approvals and permitting, design, construction, ongoing maintenance, and labour costs;
- Potential fuel efficiencies for CNG and electric vehicles were not considered in cost or GHG emission estimates. These efficiencies may result in lower GHG emissions and operational costs;
- There are additional environmental benefits associated with CNG vehicles:
  - 94% of CNG is sourced from North America, which reduces the transportation emissions associated with other hydrocarbon fuels; and
  - Does not include lead, making it a cleaner fuel source.
- There are additional environmental benefits associated with electric vehicles:
  - No tailpipe emissions reducing pollutants like nitrogen oxides (NOx), particulate matter (PM), and volatile organic compounds (VOCs); and
  - Reduced noise pollution as electric vehicles tend to be quieter than traditional vehicles.
- Market conditions, such as vehicle cost, fueling costs, and availability of fuel stations, are subject to change and can influence the total operational costs. Similarly, variables such as grid factor and carbon intensity (GHG emissions per unit of fuel) are to change year-over-year and can influence the total carbon emission reductions derived from alternative fuel projects; and
- An alternative fuel collection fleet may assist the City in reaching targets outlined in the Winnipeg Climate Action Plan.

3.2.3 Green Cart Processing Facility Location Variation (Variation 2)

Each of the four scenarios were analyzed for four distance variations from the green cart processing facility locations:

- Brady Road Resource Management Facility;
- Facility within 50 km of Winnipeg (variation 2a);
- Facility within 100 km of Winnipeg (variation 2b); and
- Facility within 150 km of Winnipeg (variation 2c).

Results of GHG emissions analysis are presented in **Section 3.3**. Results of the financial analysis are presented in **Section 3.4**. Additional considerations and assumptions for the three fuel variations are noted below.

[7] Efficiency of Automated Collection and Performance Compressed Natural Gas Vehicles, City of Toronto, 2014

Additional Considerations and Assumptions

- A processing facility located further outside of the City limits will result in a greater resource requirement from the contractor (i.e., number of trucks and truck hours). This is associated with the increased time and distance to the facility, especially for routes requiring multiple trips to the facility in a given day;
- Tip fees were not accounted for in the financial analysis and should be considered in the overall cost-effectiveness of transporting green cart materials to a distant facility compared to closer scenarios;
- Resilience of the system to handle service disruptions should be considered when selecting a processing facility. Frequent poor weather or road conditions can result in service disruptions and/or increase time and fuel usage. Contingency plans will need to be in place to manage potential disruptions to waste disposal operations; and
- The facility's material acceptance requirements and ability to accommodate green cart materials in the long-term should also be considered when selecting a processing facility.

3.2.4 Green Cart and LYW Collection Variation (Variation 3)

Each of the four scenarios were analyzed for two different organics material collection approaches:

- Collect food waste only; and
- Co-mingle LYW collection with food waste in larger green carts (variation 3a). Seasonal bi-weekly collection of LYW would continue to be offered, but the tonnage collected would be reduced. Instead, the majority of LYW would be collected weekly with food waste in the green carts.

Results of GHG emissions analysis are presented in **Section 3.3**. Results of the financial analysis are presented in **Section 3.4**. Additional considerations and assumptions for the two variations are noted below.

Additional Considerations and Assumptions

- Co-mingled collection can lead to contamination if not managed properly, as non-compostable items might be mixed in (e.g., plastic packaging left on food waste). Separate collection typically results in higher-quality compost, as it reduces contamination;
- Acceptance of co-mingled materials will depend on the specific requirements of the organics processing facility selected. For the purpose of analysis, Brady Road Resource Management Facility was assumed as the processing facility site for green cart materials. However, co-mingled organic waste would not be processed via the existing outdoor static window composting system at the Brady Road Resource Management Facility. The City will need to locate an accepting facility and confirm the requirements of the receiving facility; and
- Both approaches require thorough public education and engagement to ensure proper sorting. Residents need to understand what can and cannot be composted and how to use the designated carts correctly.

3.3 Summary of Scenario GHG Emissions Analysis

Based on input from the City, outputs of the CCM and data gathered from the City's current collection contractors, a GHG emissions analysis was completed on the four scenarios and three scenario variations. For each of the scenarios, an analysis was completed to determine estimated total GHG

emissions related to the scenario differences (i.e., changes in the truck numbers and truck hours) related to collections. Emissions related to diversion of organic materials from landfill was not considered in the analysis. A summary of the methodology and additional assumptions for the GHG emissions analysis are provided in **Appendix A.**

A summary of the comparative GHG emissions for the scenarios and scenario variations are provided in **Table 5.** A comparison to Scenario 1, baseline operating costs are provided in **Table 6**.

Based on the results of the analysis and excluding variations, Scenario 2 is likely to result in the highest estimated GHG emissions related to collection. This is related to the increased number of trucks required and time to collect grey, blue, and green carts on a weekly basis. Scenario 4 is likely to result in the lowest estimate GHG emissions.

For variations in vehicle type, an electric collection fleet (variation 1b) is likely to result in the lowest estimated GHG emissions due to the low carbon intensity of Manitoba's grid for Scenarios 2 through 4. Increasing the distance to an organics processing facility (variation 2a to 2c) results in increased estimated GHG emissions due to the increased number of trucks required and time required for Scenarios 2 through 4. Compared to the baseline, co-mingled food and LYW (variation 3a) is estimated to result in slightly lower total GHG emissions for Scenario 4 (1% lower). Emissions for Scenarios 2 and 3 are expected to increase by 30% and 9%, respectively.

3.3.1 Cost of Emissions

Carbon pricing is a method to place a value on the amount of GHG emitted and account for carbon reduction goals in financial decision making. It is measured in a cost per tonne of carbon dioxide equivalent (CO_2e). Based on the calculated GHG emissions, the price of emissions was estimated for each of the scenarios and scenario variations which is provided in **Table 7**. The Pan-Canadian Approach to Carbon Pollution Pricing 2023-2030[8] was used to calculate the cost per tonne on a CO_2e basis. Canada's minimum national price on carbon pollution for price-based systems is $170 per tonne of CO_2e in 2030. It is noted that this provides a proxy value only and that these estimates may not reflect a real cash value. Additionally, any potential carbon credits or grant/funding potentials have not been considered in these costs. The values should be used for comparison purposes only between scenarios.

Based on the results of the analysis and excluding variations, Scenario 2 is likely to result in the highest estimated cost for GHG emissions. Scenario 4 is likely to result in the lowest estimated cost for GHG emissions.

Comparing all scenario variations, an electric collection fleet (variation 1b) is likely to result in the lowest estimated cost of emissions.

[8] Government of Canada. 2021. Update to the Pan-Canadian Approach to Carbon Pollution Pricing 2023-2030. https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/carbon-pollution-pricing-federal-benchmark-information/federal-benchmark-2023-2030.html

Table 5: Summary of Estimated GHG Emissions for Scenarios and Scenario Variations

Variations					GHG Emissions (CO_2e)			
				Scenarios	1 – Baseline Scenario[1]	2 – Baseline Scenario with Weekly Green Cart	3 – Bi-Weekly Grey Cart and Weekly Blue and Green Cart	4 – Bi-Weekly Grey Cart, Weekly Blue Cart and Weekly-Summer/ Bi-Weekly Winter Green Cart
Variation Number	Collection Vehicle Type	Green Cart Processing Facility Location	Green Cart and LYW Collection	**Garbage**	*Weekly*	*Weekly*	*Bi-weekly*	*Bi-weekly*
				Recycling	*Weekly*	*Weekly*	*Weekly*	*Weekly*
				Organics	*N/A*	*Weekly*	*Weekly*	*Weekly-Summer/ Bi-weekly Winter*
				LYW	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*
-	Diesel	Brady Road	Separate Collection	Baseline Cost	6,113	7,392	6,094	5,669
1a	CNG	Brady Road	Separate Collection	Collection Vehicle Fuel Type – CNG	-	5,491	4,526	4,211
1b	Electric	Brady Road	Separate Collection	Collection Vehicle Fuel Type – Electric	-	59	49	45
2a	Diesel	50 km	Separate Collection	Green Cart Processing Facility Location – within 50 km	-	7,774	6,781	6,132
2b	Diesel	100 km	Separate Collection	Green Cart Processing Facility Location – within 100 km	-	8,538	7,240	6,440
2c	Diesel	150 km	Separate Collection	Green Cart Processing Facility Location – within 150 km	-	9,455	8,156	7,057
3a	Diesel	Brady Road	Co-mingle	Green Cart and LYW Collection – co-mingle LYW	-	7,927	6,655	6,056

[1] Variations were not applied to the baseline.

Table 6: Comparison to Baseline Scenario GHG Emissions for Scenarios and Scenario Variations by Percentage

Variations					Comparison to Baseline Scenario for GHG Emissions (%)			
				Scenarios	1 – Baseline Scenario	2 – Baseline Scenario with Weekly Green Cart	3 – Bi-Weekly Grey Cart and Weekly Blue and Green Cart	4 – Bi-Weekly Grey Cart, Weekly Blue Cart and Weekly-Summer/ Bi-Weekly Winter Green Cart
Variation Number	Collection Vehicle Type	Green Cart Processing Facility Location	Green Cart and LYW Collection	**Garbage**	*Weekly*	*Weekly*	*Bi-weekly*	*Bi-weekly*
				Recycling	*Weekly*	*Weekly*	*Weekly*	*Weekly*
				Organics	*N/A*	*Weekly*	*Weekly*	*Weekly-Summer/ Bi-weekly Winter*
				LYW	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*
-	Diesel	Brady Road	Separate Collection	Baseline Cost	-	21%	0%	-7%
1a	CNG	Brady Road	Separate Collection	Collection Vehicle Fuel Type – CNG	0%	-10%	-26%	-31%
1b	Electric	Brady Road	Separate Collection	Collection Vehicle Fuel Type – Electric	-	-99%	-99%	-99%
2a	Diesel	50 km	Separate Collection	Green Cart Processing Facility Location – within 50 km	-	27%	11%	0%
2b	Diesel	100 km	Separate Collection	Green Cart Processing Facility Location – within 100 km	-	40%	18%	5%
2c	Diesel	150 km	Separate Collection	Green Cart Processing Facility Location – within 150 km	-	55%	33%	15%
3a	Diesel	Brady Road	Co-mingle	Green Cart and LYW Collection – co-mingle LYW	-	30%	9%	-1%

Table 7: Summary of Estimated Cost of Emissions for Scenarios and Scenario Variations

Variations				Cost for Estimated GHG Emissions				
				Scenarios	1 – Baseline Scenario[1]	2 – Baseline Scenario with Weekly Green Cart	3 – Bi-Weekly Grey Cart and Weekly Blue and Green Cart	4 – Bi-Weekly Grey Cart, Weekly Blue Cart and Weekly-Summer/ Bi-Weekly Winter Green Cart
Variation Number	Collection Vehicle Type	Green Cart Processing Facility Location	Green Cart and LYW Collection	**Garbage**	*Weekly*	*Weekly*	*Bi-weekly*	*Bi-weekly*
				Recycling	*Weekly*	*Weekly*	*Weekly*	*Weekly*
				Organics	*N/A*	*Weekly*	*Weekly*	*Weekly-Summer/ Bi-weekly Winter*
				LYW	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*
-	Diesel	Brady Road	Separate Collection	Baseline Cost	$1,040,000	$1,255,000	$1,035,000	$965,000
1a	CNG	Brady Road	Separate Collection	Collection Vehicle Fuel Type – CNG	-	$935,000	$770,000	$715,000
1b	Electric	Brady Road	Separate Collection	Collection Vehicle Fuel Type – Electric	-	$10,000	$10,000	$10,000
2a	Diesel	50 km	Separate Collection	Green Cart Processing Facility Location – within 50 km	-	$1,320,000	$1,155,000	$1,040,000
2b	Diesel	100 km	Separate Collection	Green Cart Processing Facility Location – within 100 km	-	$1,450,000	$1,230,000	$1,095,000
2c	Diesel	150 km	Separate Collection	Green Cart Processing Facility Location – within 150 km	-	$1,605,000	$1,385,000	$1,200,000
3a	Diesel	Brady Road	Co-mingle	Green Cart and LYW Collection – co-mingle LYW	-	$1,350,000	$1,130,000	$1,030,000

[1] Variations were not applied to the baseline.

3.4 Summary of Scenario Financial Analysis

Based on input from the City, outputs of the CCM and data gathered from contractors and suppliers, a financial analysis was completed on the four scenarios and three scenario variations. For each of the scenarios, an analysis was completed to determine the estimated capital and annual operating costs for the following:

- Project planning, promoting, and educating costs;
- Quantity, and cost to manufacture, store, and distribute carts to eligible properties;
- Estimated annual price to replace damaged or lost wheeled carts and distribute wheeled carts based on the projected household growth in the region and the resources necessary to perform delivery services for the first year of implementation; and
- Estimated annual operating costs, including contractor operational costs and City staffing.

For each scenario, costs were increased to account for inflation to 2030 using the Bank of Canada's five-year current benchmark bond yields (3.25% effective August 25, 2023). All total costs are rounded up to the nearest $5,000 increment. A summary of the methodology and additional assumptions for the financial analysis are provided in **Appendix A.**

A summary of the comparative capital and annual operating costs for the scenarios and scenario variations are provided in **Table 8** and **Table 9.** A comparison to the Scenario 1, baseline operating costs are provided in **Table 10**.

There are no capital costs associated with Scenario 1, as there is no green cart collection. Capital costs are anticipated to be consistent across all scenarios and variations except for the scenario variation 3a for co-mingled LYW and food waste. A higher capital costs for co-mingled organics is related to the higher unit price for a 240 L compared to a 120 L cart.

Based on the results of the analysis and excluding variations, minimal increases to operational costs are anticipated for Scenarios 3 and 4. Scenario 2 is estimated to increase operational costs by approximately 22% compared to the baseline.

For variations in vehicle type, an electric collection fleet (variation 1a) is likely to result in higher estimated operating costs due to the higher cost of electric collection vehicles. Increasing the distance to an organics processing facility (variation 2a to 2c) results in increased operational costs due to the increased number of trucks required and time required. Compared to the baseline, co-mingled food and LYW (variation 3a) is estimated to result in a higher operational cost.

Table 8: Summary of Estimated Capital Costs for Scenarios and Scenario Variations

Variations				Capital Cost Estimate (2030 $)				
				Scenarios	1 - Baseline Scenario[1]	2 - Baseline Scenario with Weekly Green Cart	3 – Bi-Weekly Grey Cart and Weekly Blue and Green Cart	4 – Bi-Weekly Grey Cart, Weekly Blue Cart and Weekly-Summer/ Bi-Weekly Winter Green Cart
Variation Number	Collection Vehicle Type	Green Cart Processing Facility Location	Green Cart and LYW Collection	**Garbage**	*Weekly*	*Weekly*	*Bi-weekly*	*Bi-weekly*
				Recycling	*Weekly*	*Weekly*	*Weekly*	*Weekly*
				Organics	*N/A*	*Weekly*	*Weekly*	*Weekly-Summer/ Bi-weekly Winter*
				LYW	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*
-	Diesel	Brady Road	Separate Collection	Baseline Cost	$ -	$18,430,000	$18,430,000	$18,430,000
1a	CNG	Brady Road	Separate Collection	Collection Vehicle Fuel Type - CNG	-	$18,430,000	$18,430,000	$18,430,000
1b	Electric	Brady Road	Separate Collection	Collection Vehicle Fuel Type - Electric	-	$18,430,000	$18,430,000	$18,430,000
2a	Diesel	50 km	Separate Collection	Green Cart Processing Facility Location - within 50 km	-	$18,430,000	$18,430,000	$18,430,000
2b	Diesel	100 km	Separate Collection	Green Cart Processing Facility Location - within 100 km	-	$18,430,000	$18,430,000	$18,430,000
2c	Diesel	150 km	Separate Collection	Green Cart Processing Facility Location - within 150 km	-	$18,430,000	$18,430,000	$18,430,000
3a	Diesel	Brady Road	Co-mingle	Green Cart and LYW Collection - co-mingle LYW	-	$26,005,000	$26,005,000	$26,005,000

[1] Variations were not applied to the baseline.

Table 9: Summary of Estimated Operating Costs for Scenarios and Scenario Variations

Variations				Operating Cost Estimate (Annual Operating, including Annual Capital) (2030 $)				
				Scenarios	1 - Baseline Scenario	2 - Baseline Scenario with Weekly Green Cart	3 – Bi-Weekly Grey Cart and Weekly Blue and Green Cart	4 – Bi-Weekly Grey Cart, Weekly Blue Cart and Weekly-Summer/ Bi-Weekly Winter Green Cart
Variation Number	Collection Vehicle Type	Green Cart Processing Facility Location	Green Cart and LYW Collection	**Garbage**	*Weekly*	*Weekly*	*Bi-weekly*	*Bi-weekly*
				Recycling	*Weekly*	*Weekly*	*Weekly*	*Weekly*
				Organics	*N/A*	*Weekly*	*Weekly*	*Weekly-Summer/ Bi-weekly Winter*
				LYW	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*
-	Diesel	Brady Road	Separate Collection	Baseline Cost	$51,500,000	$63,540,000	$53,175,000	$51,455,000
1a	CNG	Brady Road	Separate Collection	Collection Vehicle Fuel Type - CNG	-	$68,375,000	$57,255,000	$55,590,000
1b	Electric	Brady Road	Separate Collection	Collection Vehicle Fuel Type - Electric	-	$74,350,000	$62,255,000	$60,495,000
2a	Diesel	50 km	Separate Collection	Green Cart Processing Facility Location - within 50 km	-	$66,590,000	$58,665,000	$56,035,000
2b	Diesel	100 km	Separate Collection	Green Cart Processing Facility Location - within 100 km	-	$72,685,000	$62,320,000	$59,090,000
2c	Diesel	150 km	Separate Collection	Green Cart Processing Facility Location - within 150 km	-	$80,005,000	$69,640,000	$65,195,000
3a	Diesel	Brady Road	Co-mingle	Green Cart and LYW Collection - co-mingle LYW	-	$68,110,000	$58,450,000	$56,025,000

Table 10: Comparison to Baseline Scenario Operating Costs for Scenarios and Scenario Variations by Percentage

Variations				Comparison to Baseline Scenario for Estimated Annual Operating Cost				
				Scenarios	1 - Baseline Scenario	2 - Baseline Scenario with Weekly Green Cart	3 - Bi-weekly Grey Cart with Weekly Green Cart	4 - Bi-weekly Grey Cart with Weekly-Summer/Bi-weekly Winter Green Cart
Variation Number	Collection Vehicle Type	Green Cart Processing Facility Location	Green Cart and LYW Collection	**Garbage**	*Weekly*	*Weekly*	*Bi-weekly*	*Bi-weekly*
				Recycling	*Weekly*	*Weekly*	*Weekly*	*Weekly*
				Organics	*N/A*	*Weekly*	*Weekly*	*Weekly-Summer/ Bi-weekly Winter*
				LYW	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*	*Bi-weekly Seasonal*
-	Diesel	Brady Road	Separate Collection	Baseline Cost	-	23%	3%	0%
1a	CNG	Brady Road	Separate Collection	Collection Vehicle Fuel Type - CNG	-	33%	11%	8%
1b	Electric	Brady Road	Separate Collection	Collection Vehicle Fuel Type - Electric	-	44%	21%	17%
2a	Diesel	50 km	Separate Collection	Green Cart Processing Facility Location - within 50 km	-	29%	14%	9%
2b	Diesel	100 km	Separate Collection	Green Cart Processing Facility Location - within 100 km	-	41%	21%	15%
2c	Diesel	150 km	Separate Collection	Green Cart Processing Facility Location - within 150 km	-	55%	35%	27%
3a	Diesel	Brady Road	Co-mingle	Green Cart and LYW Collection - co-mingle LYW	-	32%	13%	9%

4.0 Potential Considerations to a Residential Green Cart Program

Some potential considerations for a residential green cart program such as bi-weekly versus weekly collection for garbage and food waste, and the co-mingling of food waste with LYW are provided in the following sub-sections.

4.1 Bi-weekly Versus Weekly Garbage Collection

Collection frequency needs to be sufficient for residents to dispose of their waste to avoid complaints but also encourage diversion through limiting the amount of garbage that can be disposed. Considerations such as reducing emissions, demand, container types, and cost are important in determining collection frequency. Optimal collection frequency may reduce GHG emissions and costs if it requires fewer vehicles, collection operators, and total distance travelled.

When recycling and organics collection are provided, residents are incentivized to divert more waste and create less garbage. Further, residents may become more conscious of the amount of garbage generated and be more willing to participate in recycling and organics programs to reduce the negative consequences associated with storing garbage without diverting organics (e.g., odour and pest issues). Increased diversion of recyclable and organics may reduce costs related to garbage collection by reducing fuel, labour, and maintenance costs; however, this should not be considered cost savings as there are costs associated with collecting additional streams.

Changes in collection frequency often face public resistance as people are used to having their garbage removed on a weekly basis. Rather than focusing on the expanded service that green carts provide, they may perceive it as a decrease in service level and associate the change with a decreased value for their utility fees. Residents may also express concerns regarding odour and pest issues associated with waste storage. This may lead to an increase in negative feedback from residents. Lack of or insufficient public education before implementing bi-weekly collection can lead to backlash and increased resistance. To address community resistance, the City can implement mitigation strategies, such as public awareness and education campaigns, providing guidance on waste storage and management, and actively engaging with residents to address concerns.

Fewer garbage collection pickups for residents could also potentially lead to an increase in illegal dumping as people may dispose of their garbage improperly due to the long wait times. Improper garbage disposal could include: 1) illegal dumping into ditches, back lanes, private dumpsters; and/or 2) improper cart use such as diverting garbage (contamination) into green and blue carts.

Implementing a program with ongoing communication, education, and inspections may assist in reducing illegal dumping issues. For municipalities, such as the City of Calgary and City of Guelph, that offer bi-weekly collection of garbage, the standard cart size offered to residents was either 240 L or larger to account for two weeks of waste generated. This may assist with mitigating a potential increase in illegal dumping.

4.2 Bi-weekly Versus Weekly Food Waste Collection

Similar to bi-weekly garbage collection, a reduced collection frequency for food waste collection may reduce costs and emissions if it requires fewer vehicles, collection operators, and total distance travelled. Depending on the collection frequency of garbage and recycling, bi-weekly food waste collection decreases the incentive to participate in the green cart program as there is less motivation to divert food waste from the garbage stream.

Bi-weekly collection of organic waste will result in waste sitting for longer periods between collection. Especially in warmer seasons, this can lead to odour and pest issues. Similar to garbage, this may lead to complaints from residents. Although it is common for municipalities to adopt bi-weekly pickup for garbage and weekly pickup for organics, some municipalities, such as the Cities of Calgary and Edmonton, reduce organics collection from weekly to bi-weekly during the colder months.

4.3 Co-mingled LYW Versus Separate Food Waste Collection

Co-mingling LYW with food waste offers certain collection efficiency advantages which can reduce costs and GHG emissions if it requires fewer vehicles, collection operators, and total distance travelled. Residents do not need different collection containers for each stream or to be aware of differing collection schedules and seasons. The potential cost savings will depend on the collection frequency of co-mingled LYW versus separate food waste.

Co-mingled collection can lead to contamination if not managed properly, as non-compostable items might be mixed in (e.g., plastic packaging left on food waste). This is an important consideration when selecting a technology (or negotiating a service contract) to process the organic waste. Separate collection typically results in higher-quality compost and a higher value product.

The City currently owns and operates a passive windrow composting system at the Brady Road Resource Management Facility to process LYW. However, if LYW is mixed with food waste (co-mingled), it necessitates the use of a more advanced (organic waste) processing facility, leading to higher processing costs. Additionally, the requirements of a local organics processing facility, including its ability to accept co-mingle materials and/or a certain percentage of contamination, will influence the choice of collection method. Diverting the quantity of LYW received at the Brady Road Resource Management Facility will also reduce the compost generated to serve the City's needs.

If the City supports processing organic waste to renewable natural gas (RNG), there are considerations for a co-mingled feedstock facility. Food waste typically has a higher energy content and biodegradability compared to mixed organics or yard waste alone. Co-mingling yard waste with food waste can increase the biogas yield and provide a balanced nutrient profile compared to yard waste alone. Alternatively, an RNG facility that uses food waste as the primary feedstock can produce higher biogas yields and quality compared to a co-mingled feedstock. A single-stream feedstock facility may result in more streamlined operations and lower logistical complexities; however, biogas production is more susceptible to disruptions related to feedstock availability.

5.0 Conclusions and Next Steps

Based on the City's current state and the results of the scenario analysis, there are many benefits that outweigh challenges and initial capital costs and annual operating costs of introducing a residential green cart program.

The GHG emissions analysis results indicated that Scenario 4 (bi-weekly grey cart with weekly-summer/bi-weekly winter) would result in the lowest estimated GHG emissions associated with waste collection compared to the baseline. When considering scenario variations, implementing an electric vehicle fleet is anticipated to generate considerably lower estimated GHG emissions. The price of emissions is analogous to the quantity of GHG emissions generated. Scenario 4 appears to result in the lowest estimated cost for GHG emissions compared to the baseline. An electric vehicle fleet for all scenarios appears to result in the lowest estimated cost for GHG emissions.

The financial analysis results indicated that there would be no difference in capital costs for the Scenarios 2 to 4. When considering scenario variations, co-mingled LYW and food waste results is a higher anticipated capital cost compared to food waste only. Estimated operating costs are anticipated to be the lowest for Scenario 4 with no variations.

To further consider the residential green cart program collection scenario that the City could implement, several additional steps should be completed:

- The scenarios should be reviewed relative to the City's other strategies and plans (e.g., Climate Action Plan, GHG emission reduction targets) to confirm alignment with the long-term vision for the City. Scenarios that do not align with the City's goals and targets should be considered for elimination to streamline subsequent evaluation steps;
- Assumptions and costs should be refined through a competitive bidding process to reduce the uncertainty to overall costs and emissions. The pricing mechanism established by potential service providers are subject to variations in a number of external market factors (e.g., cost of fuel and availability of alternative fueling stations). Confirmation on the requirements and proximity of local organics processing facilities would be beneficial to eliminate scenarios that are not feasible;
- Selection of a local organics processor will need to consider the facility technology and material requirements, including ability to accept co-mingle materials and/or acceptable percentage of contamination. This will influence the choice of collection method (i.e., co-mingled LYW versus separate food waste) selected by the City. A co-mingled organics waste stream will require a more complex and often more expensive processing technology than the current passive windrow composting system at the Brady Road Resource Management Facility;
- Implementing a robust communication and education program prior to program roll-out will support a successful green cart program and minimize contamination. Additional consideration should be given to implementing an ongoing communication, education, and inspection program to maintain awareness and provide program results to residents; and
- The market for High Density Polyethylene (HDPE) is volatile and there have been recent fluctuations in global polymer resin supply chains which has led to dramatic price increases, with one jurisdiction reporting a price jump of 14% based on how their contract was written. Including an adjustment factor for HDPE price changes is a common best practice and some

jurisdictions suggested the addition of caps on these fluctuations to reduce budget overages. Another factor that can drive increased costs during cart procurement is delays in production or delivery. During planning, some flexibility in delivery scheduling should be considered.

Appendix A – GHG and Financial Analysis Methodology

Dillon completed waste collection modelling using Dillon's in-house integrated curbside collection model (CCM). This CCM was designed as a tool to assist municipal staff in developing curbside collection options and/or new policies. It is based in Microsoft Excel and permits input of household information, materials collected per tonne, vehicle compartment parameters and utilization, collection frequency, and collection factors for a municipality's baseline scenario. The CCM was calibrated for 2023 tonnages with the current truck compliment used by contractors in the current waste collection contract based on the data provided by the City. The CCM was updated to reflect 2023 estimated population and tonnages with projected 2030 values.

The model output estimated the total collection truck hours and number of trucks for the collection of organics in each of the four scenarios and their variations. The model's outputs are based on the maximum output required to service seasonal peaks in waste collection (e.g., LYW collection). The model did not account for any changes to the City's waste system through additional waste diversion and reduction initiatives to allow for comparison to status quo (at 2030 tonnages).

These values were input into the GHG model and financial model to estimate GHG emissions and capital and operating costs. The waste collection modelling and subsequent GHG emissions analysis and financial analysis methodologies are outlined in this Appendix.

GHG Analysis

Dillon's CCM was used to support the GHG emission outcomes of this assignment. To estimate the impacts of adding an additional green cart collection program, the annual fuel consumed by the collection fleet for garbage, recycling, organics, and LYW was estimated. Fuel consumption was estimated based on an assumed fuel efficiency for diesel that was derived from fuel consumption and vehicle runtimes provided by the City's contractors. The number of collection vehicles and estimated truck hours from the CCM were used to estimate the potential 2030 GHG emissions per scenario and scenario variation. For variations in fuel type (variation 1a to 1b), a conversion factor was used to convert diesel consumed by fleet to CNG consumed and electricity consumed by fleet.

Assumptions and Notes

- Emission factors to convert fuel consumed to GHG emissions in carbon dioxide equivalent reference the emission factors provided in June 2023 Canada's Greenhouse Gas Offset Credit System, Emission Factors and Reference Values;
- Values provided in the Canada Energy Regulator's online Energy Unit Conversion Tables were referenced to convert fuel consumption. Fuel consumed by CNG and electricity collection vehicles does not factor in fuel efficiencies for CNG and electric vehicles. Distance to fueling stations not also accounted for in the GHG emissions;
- For simplicity, an average fuel efficiency for diesel was assumed for all collection vehicles;
- The cost of GHG emissions was determined using the minimum national carbon pollution price schedule for 2023 to 2030 developed by the Government of Canada. Canada's minimum

national price on carbon pollution for systems that directly set a price on emissions is $170 per tonne of CO_2e in 2030. This carbon pricing is not specific to a fuel type or emission source. The cost of carbon is expected to increase at a pre-determined rate prescribed in federal regulation that is not linked to inflation; and
- The provided cost of GHG emissions for a residential green cart program provide a proxy value for the estimated price of carbon to assist the City with including environmental goals in financial decision making. These values may not reflect the real cost of emitting GHG.

Financial Analysis

For each of the scenarios and scenario variations, a financial model was developed to estimate the financial impacts of carts (initial purchase and ongoing repair and maintenance for year 1) and waste collection operations (annual cost for year 1).

Pre-consultation and Advertising Costs

Pre-consultation activities include tasks required before the roll-out of a new green cart program and include promotion and education (P&E) activities. Pre-consultation resources will include cost of advertising, educational materials and admail, and an additional full time equivalent (FTE) staff member.

Assumptions and Notes

- It is noted that the City has completed a pilot green cart program. It is assumed a focus group or public survey is not required;
- Pre-consultation includes the cost for one FTE to develop and distribute educational materials regarding program roll-out, cart sizes, and new program parameters; and
- Advertising includes the cost to print and mail education materials and any additional advertising that may be needed.

Estimated Green Cart Costs

Scenarios 2 through 4 include the purchase of green carts and a kitchen catcher for curbside residential customers.

The financial model includes the estimated financial impacts of purchasing green carts (initial purchase and ongoing), cart shipping and distribution (initial and ongoing), initial cart storage prior to program, and a roll-out cart maintenance program (including repair tools and a cart transport vehicle). The model considers the estimated number of households in 2030 and estimated cart costs obtained from manufacturers.

Assumptions and Notes

- A 3.25% inflation cost per year has been applied to represent 2030 costs. This does not factor in any other changes such as the market rates of resin which have been increasing significantly over the past several months; and
- Co-mingled green cart and LYW collection (variation 3a) is assumed to use a 240 L cart size. All other scenarios and scenario variations are assumed to use a 120 L cart size. A larger cart size results in a higher overall capital cost.

Waste Collection Estimated Costs

The City currently pays for their waste collection services on a unit price per stop through two designated contractors. Dillon's CCM was used to support the financial outcomes of this assignment. To estimate the impacts of adding an additional green cart collection program, the current contractor costs were used as a base to apply cost adjustments for each of the scenarios and scenario variations.

The number of collection vehicles and estimated truck hours from the CCM were used to adjust the base 2030 operational costs to estimate the potential financial impact per scenario and scenario variation. For variations in fuel type (variation 1a to 1b), the difference in the cost of fuel and vehicle cost were also factored into the cost adjustment.

Costs for a new Organics Diversion Branch was also included in the overall operational cost estimate for each scenario and scenario variation.

Assumptions and Notes

- It is assumed that the base unit cost for green cart collection is equal to the cost of grey cart collection;
- For operational cost estimates for variations in fuel type, the estimated truck costs were amortized over seven years, which is the average life of a waste collection vehicle, to determine the potential impact on 2030 costs. Fuel costs were estimated based on inflated present day cost per fuel unit. Market conditions are subject to change and can influence the vehicle costs and fueling costs;
- Potential fuel efficiencies for CNG and electric vehicles were not considered in cost estimates. Costs for installing fill stations and distance from fill station were not accounted for in the cost estimate; and
- It assumed that the Organics Division Branch will consist of a program supervisor, program support staff (e.g., bylaw officer), labour staffing for cart maintenance and delivery, and educational and waste audit staff.