

DILLON
CONSULTING

HALIFAX REGIONAL MUNICIPALITY

T6 Cart-Based Collection Assessment

Solid Waste Strategy Review

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1.0

Introduction

Dillon Consulting Limited (Dillon) was retained by Halifax Regional Municipality (HRM) in July 2023 to support a review of HRM's Solid Waste Strategy. One of the tasks of this assignment was to complete a cart-based collection assessment. This report outlines the results of that assessment.

1.1

Purpose

On May 26, 2020, an information report titled Cart-Based Garbage and Recycling Collection was presented to HRM Regional Council regarding the potential to transition the residential curbside collection program for recycling and garbage from a bag-based system to a cart-based system, similar to the green cart program for the collection of residential organics.

The purpose of this report is to build on the informational report including the outputs specified in **Table 1**.

Table 1: T6 Cart-Based Collection Assessment Research Criteria

Research Topic	Specific Outputs
Assess key considerations	- Review and recommend changes to current contracting approach, including eight distinct collection areas and a ten-year term option. Consider daily/weekly capacity of receiving facilities. - Consider both semi- and fully automated collection. Identify challenges related to automated collection such as parking, bike lanes, urban density and tree canopy. Identify hybrid approaches (e.g., providing fully automated collection with select areas receiving semi-automated collection). - Identify method of collection for bulky items/white goods and other items (e.g., C&D bundles) that are not collectable via fully automated collection. - Assess the use of split-carts to continue collecting container and fiber recyclables separately. - Evaluate transitioning current manual curbside education/enforcement stickering program to automated video inspection program, including addressing any access, privacy and data storage concerns. - Assess impact to contamination and residue rates. - Complete a review of the feasibility of requiring future residential and condo collection contracts to use zero emission vehicles, including vehicle information and considerations for cost impacts, infrastructure challenges and impact to service providers. - Consider accessibility concerns for people with disabilities and elderly, including potential mitigation options.

Research Topic	Specific Outputs
Develop cart-based collection program options	• Transition the bag-based, bi-weekly garbage collection program to a cart-based collection program, including consideration for the collection of bulky items/white goods. • Transition the bag-based, bi-weekly recycling collection program to a cart-based collection program, including consideration for the use of a split-cart to continue collecting containers and fibers separately as this will likely be a requirement of extended producer responsibility (EPR) programs. • Maintain the bi-weekly cart-based green cart program, including weekly collection from July until September. • Consider both semi-automated and fully automated collection as well as hybrid approaches, as needed. • Review potential options using appropriate screening criteria in consultation with HRM.
Complete a full financial assessment comparing the status quo and modelled status quo to three options selected by HRM	• Develop a Class 3 financial model assessing capital, operating and life cycle costs over 25 years. Determine a net present value comparing each option. • Demonstrate the validity of the financial model by calibrating against existing HRM collection costs.

1.2 Methodology

To complete this review, Dillon completed a review of HRM's current state which included population, waste generation and program costs (**Section 2.0**). Research on Canadian cart-based collection programs and discussions with cart manufacturers were completed to analyze key considerations for cart-based programs (**Section 3.0**). Following the initial review, and in consultation with HRM, Dillon developed a menu of potential options for HRM that factor transitioning from a bag-based program to a cart-based program (**Section 4.0**).

Five potential options and a set of screening criteria were developed in consultation with HRM. Each of the five potential options were assessed against the screening criteria to determine which three options should be further assessed by Dillon. The three options were assessed based on the status quo and the estimated modelled status quo costs. The modelled status quo costs are based on current levels of service and are provided as an estimate to benchmark and calibrate the options costs. Results of the assessment are included in **Section 5.0** and recommendations are included in **Section 6.0**.

2.0

Current State

This report provides an assessment for cart-based collection for the residential sector. For HRM, this includes single-family homes and multi-residential buildings with up to six units. HRM's solid waste collection service is provided for three streams:

- Garbage (e.g., refuse, trash and discarded materials);
- Organics (e.g., food waste, leaf and yard waste); and
- Recyclables (e.g., plastic, metal, glass containers and paper and cardboard).

For the purposes of collection, HRM has been divided into eight collection areas. **Table 2** summarizes the waste collection services provided in HRM, including the acceptable items, frequency of collection and acceptable set out and limits for collection. Special collection days for leaf and yard waste run annually for six to eight weeks in the fall. Additionally, there are three weeks allocated for Christmas tree collection. These special collection events require a separate vehicle which deliver these materials to an alternative facility.

Table 2: Summary of Waste Collection Services in HRM

	Garbage	Recyclables	Organics
Materials collected	Garbage, bulky items and appliances	Plastic, metal, glass containers, paper and cardboard.	Food waste and leaf and yard waste (no grass clippings).
Frequency of collection	Bi-weekly	Bi-weekly	Bi-weekly, except for during July, August and September, when it is collected weekly.
Acceptable set out and limits – single-family	Garbage is to be set out for collection in clear bags, with one black privacy bag allowed. Bags can be placed in garbage cans. Bags cannot weigh more than 25 kg. Limited to six bags per week. Bundles of construction and demolition debris may be placed out for collection, with a limit of five bags being substituted for bundles. Bulky item and white goods collection is limited to one item per collection day.	Recyclables must be set out for collection in blue or clear bags, and corrugated cardboard should be bundled. There is no limit to the number of recyclables bags accepted.	HRM has provided 240 L carts for organics collection and additional heavy paper bags may be used for leaf and yard waste. The maximum allowed weight is 100 kg per green cart. Up to 20 leaf and yard waste bags, with a maximum weight of 25 kg are accepted each green cart collection day. Tree waste can also be bundled, with a maximum of five bundles weighing 34kg per collection day. Branches in armload-size bundles of no longer than 1.2 metres in length and 0.2 metres in diameter are also accepted.

	Garbage	Recyclables	Organics
Acceptable set out and limits – apartments up to 6 units	Garbage is to be set out for collection in clear bags, with one black privacy bag allowed per unit. Bags can be placed in garbage cans. Bags cannot weigh more than 25kg. Limited to four bags per unit per week. Bulky item and white goods collection is limited to two items per building each collection day. No construction and demolition debris allowed.	Same as single-family set outs.	Same as single-family set outs.

2.1 Population

According to HRM population projections, HRM has a population of 460,274 in 2024. This is a 12.4% increase from 2016 when the population was 403,131¹. This percent increase is higher than the percent increase in population as a whole for Canada, which was only 5.2%². Population growth in HRM is driven by a combination of natural growth (more births than deaths) and immigration, including international, interprovincial and within province migration.³ Compared to the rest of Canada, Halifax is the second fastest growing metropolitan area, following only Moncton.⁴ It is expected that over the coming years, HRM's population will continue to increase. Halifax's Inclusive Economic Strategy is targeting a population of 525,000 by 2027⁵, and the province of Nova Scotia is targeting a population of two million by 2060⁶.

2.2 Waste Generation

HRM provided Dillon with monthly collected weights from Fiscal Year (FY) 2018/2019 through FY 2022/2023 for residential and commercial garbage, recyclables and organics. A summary of total annual weights for the residential sector are provided in **Table 3**. The COVID-19 pandemic impacted waste generation in FY 20/21 as more residents were working from home which shifted waste generation to the residential sector.

¹ [Statistic Canada – 2021 Census – HRM – statscan.gc.ca](https://www150.statcan.gc.ca/n1/pub/92-627-x/2021001/article/00001-eng.htm)

² [Statistic Canada – 2021 Census – Canada – statscan.gc.ca](https://www150.statcan.gc.ca/n1/pub/92-627-x/2021001/article/00001-eng.htm)

³ [Nova Scotia – Economics and Statistics – novascotia.ca](https://www.economicdevelopment.ca/nova-scotia/economy/economic-statistics)

⁴ [Nova Scotia – Economics and Statistics – novascotia.ca](https://www.economicdevelopment.ca/nova-scotia/economy/economic-statistics)

⁵ [Halifax Partnership – People. Planet. Prosperity. Halifax's Inclusive Economic Strategy 2022-2027 – halifaxpartnership.com](https://www.halifaxpartnership.com/en/our-strategy)

⁶ [Province of Nova Scotia News Release \(2021\)](https://www2.gov.bc.ca/gov2/gov/press-releases)

Table 3: Annual Weight of Waste, Residential (tonnes)

Waste Stream	FY 18/19	FY 19/20	FY 20/21	FY 21/22	FY 22/23
Garbage	45,529	46,035	51,125	48,561	48,051
Recyclables	18,149	17,598	19,118	18,827	17,739
Organics	35,281	37,172	39,879	38,342	35,600
Total	98,960	100,805	110,122	105,730	101,389

2.2.1

Set Outs

Since 2015, HRM has completed curbside monitoring reports. The purpose of the monitoring reports is to better understand residential waste set out behaviours across HRM. It was initially launched as a baseline study for informing the residential clear bag policy and for setting educational targets. In 2023, four districts were selected for monitoring. The routes were selected to represent the socioeconomic diversity of HRM and capture a variety of urban, suburban and rural neighbourhoods.

At each household, the following data was recorded:

- The types of receptacles present;
- The number and type (privacy/clear/binning) of garbage bags set out;
- The number and type (blue/clear) of blue bag recycling bags set out;
- The number and type (blue/clear/retail) of paper recycling bags set out;
- Presence of green cart at the curb;
- The number of yard waste bags;
- The number of bulky items; and
- Additional notes.

The average participation rate for each waste stream is the percentage of households that had the specified material at the curb for collection. Overall participation rates indicate the percentage of households that had material of any type at the curb for collection.

Table 4 presents participation rates for the average across all monitored areas, weighted by number of successfully monitored collections. Overall, organics and garbage had the highest participation rates at 57% and 56%, respectively.

Table 4: Average Participation Rate, 2023

Area	Garbage	Blue Bag Recycling	Paper Recycling	Green Cart	Yard Waste	Overall Participation
Average (weighted)	56%	45%	40%	57%	7%	61%

Set out frequency is the percentage of collections that a household had material placed at the curb. Households that did not set out any of the specified material over the monitoring period are excluded from the average. The average set out frequencies were:

- Garbage: 65%;
- Blue Bag Recycling: 60%;
- Paper Recycling: 56%; and
- Green Cart: 69%.

Household weekly waste generation considers both set out size and frequency to estimate the amount of material that is generated in a residence on average per week. All streams reported have bi-weekly collection and a factor is included to account for any missed collections during monitoring. The average weekly waste generation for each bagged waste stream were:

- Garbage: 0.78 bags;
- Blue Bag Recycling: 0.35 bags; and
- Paper Recycling: 0.36 bags.

2.3 Waste Collection Contract

Waste collection in HRM is contracted to private companies. In September of 2020, HRM released a request for proposal (RFP) for the collection and transportation of source-separated solid waste. This RFP included residential waste collection services for a five-year period commencing July 1, 2021 and ending June 30, 2026. The services provided by the successful proponent for each area include curbside collection of garbage, organics and recycling. Based on the RFP results, four proponents were awarded contracts REgroup (Areas 1,2,3,5 and 6), GFL (Area 4), Miller Waste (Area 7) and Leo J Beazley (Area 8).

2.3.1 Collection Vehicle Distribution

Table 5 outlines the number of collection vehicles that each contractor uses to service each area on a daily basis (e.g., number of routes per day). Most of the collection vehicles used for garbage are also used for organics; therefore, these are not separate counts for vehicles. These numbers do not include spares. A map of the collection areas is provided in **Appendix A**.

Table 5: Waste Collection Vehicles Per Collection Area (July 1, 2023)

Area	Community	Number of Garbage Vehicles	Number of Recycling Vehicles	Number of Organics Vehicles	Number of Serviced Units
1	Halifax	7	6	6	33,272
2	Dartmouth	5	5	5	22,720
3	Bedford/Hammonds Plains	3	3	3	14,130
4	Western County	4	4	4	17,376
5	Sackville	6	5	6	24,860

Area	Community	Number of Garbage Vehicles	Number of Recycling Vehicles	Number of Organics Vehicles	Number of Serviced Units
6	Cole Harbour	3	3	3	14,349
7	Lawrencetown/N&E Preston/PL/Gaetz Brook	3	2	2	8,857
8	West Petpeswick/Ecum Secum/Musq Valley	3	2	2	8,051
Total		34	30	31	143,615

HRM provided Dillon with monthly area tonnages from April 2021 through March 2022. **Figure 1** outlines the overall distribution of tonnage for the twelve-month period. More waste is collected in Areas 1 and 5 and the least amount of waste is collected in Areas 7 and 8.

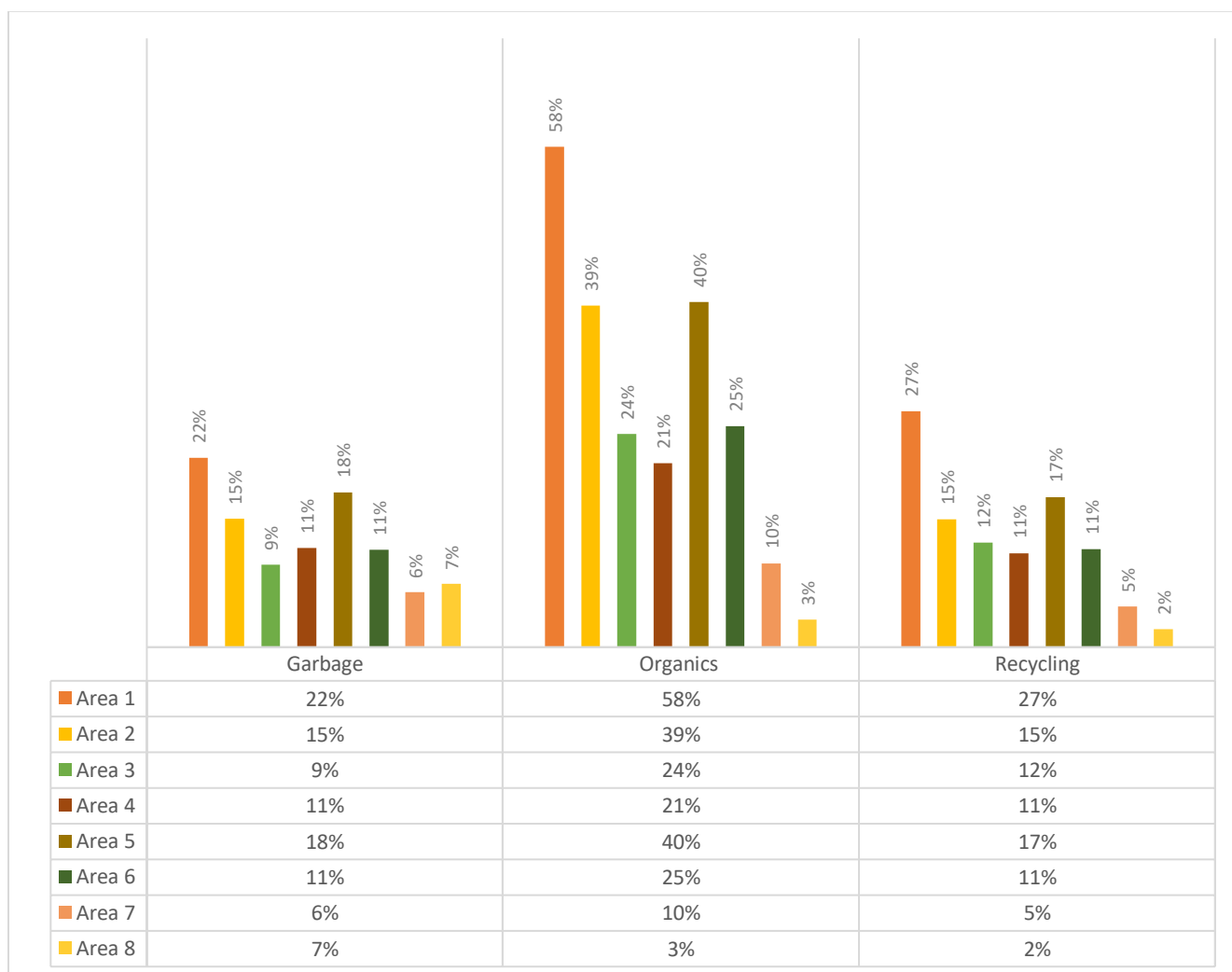


Figure 1: Tonnage Distribution Per Collection Area, FY 21/22

Figure 2 provides the average weight per household for the same time period. Overall garbage generation rates, per household, are higher in Area 8 and lowest in Area 2. The area that generates the most organics per household is Area 1 and the lowest organics generation rates per household are in Area 8. Area 3 has the highest recycling generation per household and Area 8 generates the lowest recycling tonnages.

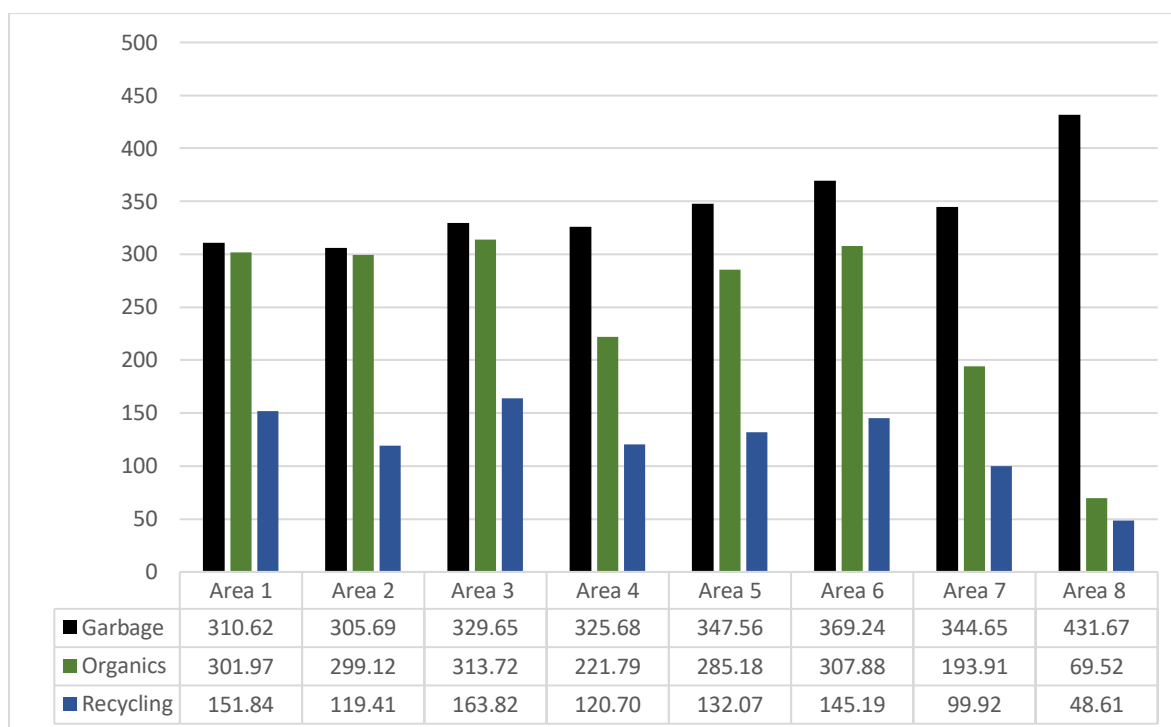


Figure 2: Average Weight (kg) Per Household, FY 21/22

2.3.2 Current Program Costs

The annual base collection cost per serviced unit by collection area is outlined in **Table 6**. Lowest annual costs are allocated to Area 2 and the highest annual costs are observed in Area 8. HRM provided Dillon with monthly costs for garbage and organics and a separate price for recycling, based on the collection contract values. Annual costs were calculated based on the provided monthly costs. **Figure 3** and **Figure 4** illustrate the cost difference per waste stream of each area over the five-year collection contract. These costs do not include summer weekly organics, seasonal peak collection or other costs related to diesel escalation.

Table 6: Annual Cost Per Serviced Unit 2022-2026

Area	Year 1 (21/22)	Year 2 (22/23)	Year 3 (23/24)	Year 4 (24/25)	Year 5 (25/26)
1	\$71.40	\$72.72	\$74.16	\$75.60	\$77.04
2	\$69.24	\$70.56	\$71.88	\$73.20	\$74.64
3	\$75.36	\$76.80	\$78.24	\$79.80	\$81.36

Area	Year 1 (21/22)	Year 2 (22/23)	Year 3 (23/24)	Year 4 (24/25)	Year 5 (25/26)
4	\$91.32	\$93.12	\$94.92	\$96.84	\$98.76
5	\$83.04	\$84.72	\$86.28	\$89.64	\$91.32
6	\$85.56	\$87.24	\$88.92	\$97.32	\$99.24
7	\$140.88	\$143.76	\$146.64	\$153.72	\$156.84
8	\$146.04	\$148.92	\$151.68	\$166.20	\$169.32



Figure 3: Annual Cost of Garbage and Organics, Per Serviced Unit

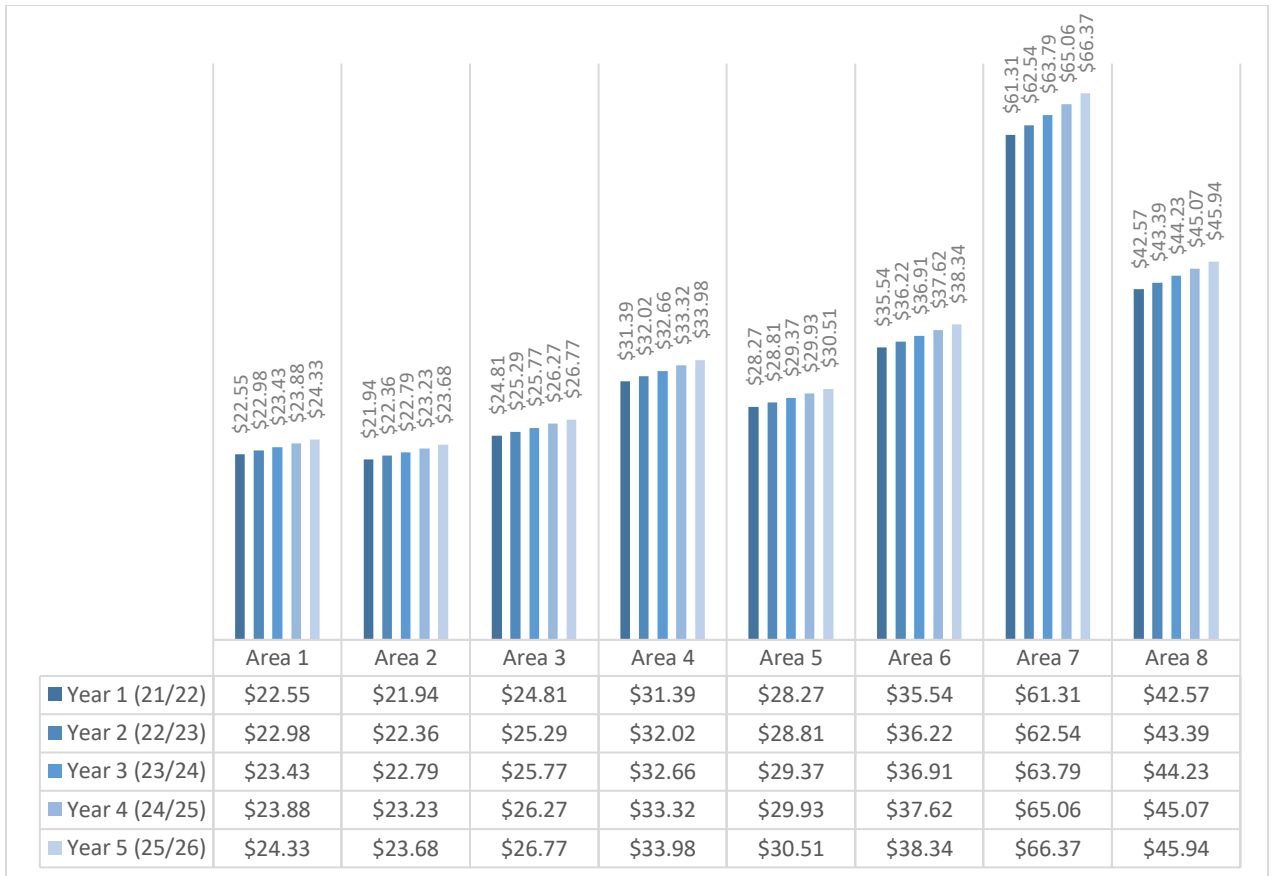


Figure 4: Annual Cost of Recycling, Per Serviced Unit

3.0

Assessment of Key Considerations

Many jurisdictions in Canada have transitioned, are in the process of transitioning or intend to transition to an automated collection system for waste streams. Key areas of industry trend development and key considerations for HRM include:

- Fully versus semi-automated cart collection systems, including the consideration of active transportation;
- Bulky waste collection;
- Types of carts and options for carts;
- Accessibility concerns;
- Enforcement;
- Contamination and residue rates;
- Contracting approach; and
- Zero emissions vehicles.

3.1

Fully Versus Semi-Automated Cart Collection

In both fully and semi-automated cart collection systems standard-sized wheeled carts are placed out for collection and an extending arm with a grabber is used to tip the carts into the collection vehicle's hopper. In a fully automated cart collection system, only a driver is required, and they remain in the cab of the vehicle and operate the extending arm and grabber. A semi-automated system requires one to two operators. With one operator, they drive the vehicle and exit the cab at each stop to position the cart from the curb to the grabber and operate the arm for tipping. With two operators, one drives the vehicle while the other operator exits the cab to position the cart from the curb to the grabber and operates the arm for tipping.

One advantage of automated cart collection is a reduction in manual labour associated with collection. With fully automated cart collection entire routes are intended to be serviced without physical labour. With semi-automated collection, although operators assist in positioning, the physical effort is still considerably less compared to manual collection as the heavy lifting is completed by the grabber.

There are some disadvantages to a fully automated cart system; carts must be positioned in a specific manner so that they can be collected by the arm and grabber. Not all residents may follow this set out requirement. This can lead to issues of not being able to collect or an operator will need to exit the vehicle to position the cart for the grabber. The standard extending arms used in fully automated systems is not always long enough or able to reach carts where they are positioned.

Additionally, automated collection services can be impacted by parked vehicles, bike lanes and other street related concerns in densely populated urban areas. Typical residential waste collection vehicles

are approximately three metres in height. Carts are required to be lifted above this height to empty the contents into the vehicle. Due to these height requirements, overhead tree canopies and utilities can become an issue or concern with automated collection.

In areas where automated waste collection may not be an option, semi-automated collection may be able to be used, including areas designated for active transportation. For the purpose of this analysis, HRM agreed to assume that 75% of the region could be collected with automated collection and the rest could be collected with semi-automated collection. Should HRM consider fully automated collection or a hybrid collection approach, these values should be reviewed with a more exhaustive analysis. This hybrid approach would allow HRM's contractors to tailor solutions to the unique needs of each of the collection zones. Although this approach can reduce the concerns related to a harmonized approach to collection, it also brings its own challenges such as increased planning time, requirements for specific types of spare vehicles and staffing related concerns.

For the purposes of this assessment, fully, semi- and a hybrid collection approach have been considered.

3.2 Bulky Waste Collection

Bulky waste includes items that are too large to be accepted in regular waste collection programs or cart-based collection programs and require special handling (e.g., furniture, mattresses, white goods, construction and demolition waste bundles). Often, these items are collected with a rear-load vehicle or a flat-bed truck. Currently, bundles of construction and demolition debris may be placed out for collection, with a limit of five bags able to be substituted for bundles, and bulky item and white goods collection is limited to one item per collection day. This approach would have to change with a cart-based system as it would be difficult for an automated collection vehicle to collect bulky waste.

Items accepted and collection methodologies vary by jurisdiction. Existing program parameters for bulky waste collection generally fall under one of the following:

1. No program to collect bulky waste: Often municipalities that do not offer any type of bulky waste collection provide educational materials regarding where these items can be taken for disposal (landfills, transfer stations, drop off depots, etc.).
2. No appointment (typically on existing waste collection day) with a rear load vehicle or flat bed truck:
 - 2.1. Without Fee: Residents put their bulky items out on their waste collection day. The costs for these programs are typically included in the solid waste collection utility fee. The jurisdiction may or may not track and/or limit how many items a household puts out per year.
 - 2.2. With Fee: Residents must pre-purchase bulky tags and affix to their bulky item for collection non their waste collection day.
3. By appointment with a rear load vehicle or flat bed truck (may or may not be on existing waste collection day):

- 3.1. Without Fee: Jurisdictions may have a telephone number (or website) where residents call-in or contact to make a bulky waste collection appointment. Under these programs, households are often limited to a specific number of bulky items per household per calendar year. The costs for these programs are typically included in the solid waste collection utility fee.
- 3.2. With Fee: Similar approach regarding the call-in appointment; however, residents are charged, at the time of making the appointment, with an item collection fee. Residents can either pay this over the phone (via credit card), be invoiced or are required to pre-purchase a collection tag/sticker for the bulky item.

The benefits of the 100% user-pay based program include:

- Only users of the system pay for the system;
- No additional taxes or utility fees for residents required; and
- HRM would agree upon set pricing with the contractor as part of the next waste collection contract.

The benefits of an HRM managed contractor collection model include:

- Increased tracking and ownership of waste generated within HRM boundaries;
- Contractor responsible for all scheduling/collection;
- Ability to determine type of items accepted for collection; and
- Increased ability to track waste and have baseline data to use as Key Performance Indicators (KPIs) for future waste diversion reporting.

For the purposes of this assessment, bulky items will be collected using an appointment-based system with no fee which will require additional collection vehicles. This approach was assumed for all options in this analysis. It is assumed HRM will create a system to handle appointments and an updated bulky item collection policy. Residents will be limited to one bulky item collected on a bi-weekly basis.

3.3 Types of Carts and Options for Carts

Some items to consider with respect to cart type and options including size, brand, resin, whether to use radio frequency identification (RFID) tags and other customizations such as promotion and education (P&E) materials, locks for wildlife and lift bars. With respect to size, jurisdictions may offer residents a choice in cart size or provide a single cart size. Within the HRM report to council, it was indicated that there would likely be 240 L and 360 L carts available for garbage and 360 L carts for recycling.

Table 7 summarizes the benefits and potential drawbacks of rolling out cart-based collection with one or multiple cart sizes.

Table 7: Cart Size Options, Benefits and Potential Drawbacks

Cart Size Options	Benefit	Potential Drawbacks
One Size Roll-Out	• Simplest of all options for delivery and operations management. • Reduction in scheduling and delivery costs.	• Not suited for all household sizes and lifestyles. • May experience resistance from households where the cart size does not work for their household.
One Size Roll-out – Options for Exchanges Post Roll-Out	• Simplicity of delivery. • Accommodating to different household sizes and lifestyle. • When there is a cost associated with the size of the cart it can incentivize households to reduce waste. • Allows residents to participate with the recommended cart size versus what size they may think is required.	• Increased complexity compared to one size roll-out. • Increased operational cost to manage exchange requests. • Some households may require a larger size and must seek other disposal options until able to exchange cart. • May have an overstock of the carts initially rolled-out due to exchanges. • May need to accommodate some exchanges early for accessibility.
Multi-Size Roll-Out	• Greatest resident autonomy. • Accommodating to different household sizes and lifestyle. • When there is a cost associated with the size of the cart it can incentivize households to reduce waste.	• Most complex compared to other options for delivery. • May still require exchange, especially for residents that may have missed the cut-off order date.

One size roll-out with options to exchange cart sizes post roll-out is one option as it allows for simple cart delivery and gives residents the option to make exchanges better suited for their household size and lifestyle post roll-out. This distributes customer service demand since initial cart roll-out is inherently demanding of staff capacity to respond to questions and cart size requests. When offering multi-size roll-out many residents may not read the information provided by their jurisdiction that indicates how and when to select their cart sizes, prompting residents to try to continue to order their carts through customer service and/or making exchanges post-roll-out.

Another consideration with respect to carts is the brand and resin selection. Most brands use a similar type of rigid resin to manufacture their carts; however, some use a slightly different flexible resin which allows the cart to flex. This provides carts some added durability compared to the rigid carts which are more prone to cracks during handling. Another option available is to include RFID tags that can be scanned to identify the address the cart belongs. This can be a requirement to implement automated enforcement and/or monitoring programs. Carts can be scanned by a RFID reader through a handheld device or a device on a collection vehicle. Additional customizations to carts are highlighted in **Section 3.3.1** to **Section 3.4**. and are sometimes necessary to optimize user experience and so that waste is contained until collection. Customization could also include locks for animal control.

For the purposes of this assessment, 240 L carts will be used for garbage during roll-out. Should residents have accessibility requirements, they can request 120 L carts. Options for exchanges will be provided post roll-out (for those without accessibility requirements that require a smaller or larger option for their household).

3.3.1 Dual Stream Recycling Carts

In 2018, the Continuous Improvement Fund (CIF) reported an update of the five-year split-body recycling cart used in Sault Ste. Marie, Ontario⁷. The implementation of the 28,000-cart program in 2013 provides realistic data on the efficacy of large-cart recycling collection in the province of Ontario. Though 360 L carts have been conventionally used in Ontario for the collection of recyclables, the City of Sault Ste. Marie, in collaboration with its private collector (GFL), introduced split-body carts for curbside collection.

As with any program modification, both residents and the contractor encountered advantages and challenges associated with the adoption of large split-body carts. The advantages of the 360 L split-body recycling carts included:

- Reduction in windblown litter on collection days when compared to recycling boxes;
- Sufficient space for accommodating lightweight containers;
- Diminished contamination levels relative to single-stream recycling carts;
- Higher diversion rates compared to alternative collection methodologies;
- The provision of permanent and clear instructions on the cart lids; and
- The dispensation from setting out the carts on a weekly basis if they are not at full capacity.

While the majority of residents expressed approval for the carts, concerns about the weight and unwieldy handling of the cart for certain residents, the space required for cart storage, and difficulties associated with placing cardboard within the cart were noted. In 2018, the CIF provided financial support for a comprehensive waste composition study aimed at evaluating the collection effectiveness of this program. Within the 100-home sample set, the average contamination level at the curb was determined to be under 13%. Notably, the leading cause of contamination was the presence of unaccepted plastics.

The study also indicated that residents generally exhibited accurate sorting into the two compartments, with cross-contamination representing approximately 1% of the total contamination at the curb. Post-collection cross-contamination increased marginally to 3%, suggesting that some cross-contamination may occur during cart loading or transit. However, contamination in this split-cart program was confirmed to be significantly lower than typical single-stream cart systems.

⁷ Continuous Improvement Fund (2018) Sault Ste. Marie and GFL Celebrated 5 Successful Years with Split-Body Cart Recycling. <https://thecif.ca/sault-ste-marie-and-gfl-celebrate-5-successful-years-with-split-body-cart-recycling/>

Instances of cardboard jammed into carts posed challenges during the emptying process, leading to frustration for both collection staff and residents, as sometimes materials had to be left behind. Consequently, the Sault Ste. Marie program, mandates that cardboard be bundled and placed beside the cart for manual collection or cut into appropriately sized pieces.

Despite a cart set-out rate of only 59%, which is below the norm for individual blue boxes, Sault Ste. Marie's diversion rate averaged 66%. The City consistently maintains the highest diversion rate among comparable municipalities. These findings suggest that the City and its contracted service provider have effectively encouraged residents to reduce collection costs by only setting out carts when they are more than half full.

For the purposes of this assessment, recycling is assumed to be collected in a split-body cart.

3.3.2 Cart Exchange

Most jurisdictions offer varying cart sizes for garbage. Due to this, cart exchange services are offered. Cart size exchanges to larger or smaller carts impact the collection costs at most jurisdictions. Most jurisdictions allow 90 days for new homeowners to choose or exchange cart sizes for free and some may also allow one free exchange per year. One-time delivery and administrative fees are usually associated with cart exchanges and can range significantly (e.g., \$20 to \$80). These fees are usually collected upfront by credit card online/phone or in person at municipal service locations when the exchange order is placed. In recent RFPs for waste collection services, it has been observed that in some instances jurisdictions are including the purchase, delivery and ongoing maintenance of all the carts in the contract.

For the purposes of this assessment, it is assumed that one standard cart size for garbage will be provided (240 L) and after 90-days exchanges will be permitted. Should a resident require a smaller cart due to accessibility concerns, the resident will be provided with a 120 L cart. For carts owned by residents prior to the transition, the resident will be responsible for managing these items themselves. HRM could provide a free drop off service for these carts once the new ones are delivered or provide a collection service for unwanted carts (residents would be provided with tags to place on the carts to indicate that they could be collected and properly disposed/recycled).

3.3.3 Damaged or Stolen Cart Repair and Replacement

Carts are generally the property of each jurisdiction; however, the resident is responsible for their care. Jurisdictions have services for repair and replacement as needed. Repairs are often provided for free to residents; however, where there are abnormally frequent cart exchange request or evidence pointing to neglect of carts this will trigger an investigation to determine ongoing eligibility of free replacements.

For the purposes of this assessment it is assumed that damaged or stolen carts will be repaired/replaced by HRM's cart-service contractor versus HRM staff.

3.4

Program Roll-Out Options

There are several different options for the roll-out of an automated waste collection program. The key considerations should include reviewing factors such as local infrastructure for storage, methods of cart delivery and staffing (internal or contractor) resources. A cart program can be rolled-out all at once or a staggered roll-out. There are benefits and drawbacks to each option as outlined in **Table 8**.

Table 8: Program Roll-Out Options, Benefits and Potential Drawbacks

Program Options	Benefit	Potential Drawbacks
One Roll-Out	- Simplest option for delivery and operations management. - Reduction in scheduling and delivery costs.	- Likely to experience higher number of resident calls and feedback on program all at once. - Delays in cart delivery can create issues in waste collection.
Staggered Roll-Out	- More complex delivery. - Allows implementing lessons learned from previous cart deliveries. - Dilutes inbound calls and complaints from residents.	- Increased complexity compared to one roll-out period. - Increased operational cost to manage program roll-out over a longer period of time.

For the purposes of this assessment, it is assumed that the program will be rolled-out in a staggered approach. The Region will be split into different collection areas for the purposes of roll out, with each collection area rolling out a different time. HRM will be responsible for coordinating the roll out; however, it is assumed that a contractor(s) will be responsible for delivery of carts. Areas for initial roll-out would be dependent on how many areas HRM determines to merge (see **Section 3.8**). If HRM proceeds with three separate contracts, each contract could roll-out with carts at a different time, or each contract could be divided into three to four areas that would roll-out at a separate time.

Several jurisdictions have had phased rollouts which include the following:

- City of Edmonton: Six phase roll-out from April 13 to August 31, 2021;
- Peel Region: Several phases over a six-month period (January to June 2016); and
- City of Guelph: Three phase roll-out from fall 2012 to 2014.

3.5

Accessibility Concerns

Some jurisdictions have special considerations for residents that cannot move their carts to the end of their driveway/alleyway for collection. These households are identified on collection routes (often by the resident completing a form and providing a medical professional's note) and the driver will exit the vehicle and bring the cart(s) to the curb for collection.

Additionally, special considerations for increased allowance of materials set out due to medical conditions, and diaper disposal is also often considered by jurisdictions. These special considerations for additional support by the waste hauler should be discussed during the planning phase of a cart transition. These special considerations are often reviewed and approved on a case-by-case basis.

For the purposes of this analysis, it is assumed that smaller carts will be available for residents with accessibility considerations.

3.6 Enforcement

Currently, HRM has a clear bag program that allows for a simpler approach to enforcement of waste set-out requirements. Current enforcement includes a stickering program administered by the contracted waste hauler. This includes enforcing bag limits and the allocation of one privacy bag. Transitioning to a cart-based system requires changing the approach to enforcement, as the entire contents of a household's set out can no longer be easily observed. However, HRM could consider continuing to require clear bags being used for garbage in carts to support ongoing enforcement.

Some municipalities manually sticker carts (garbage, organics or recycling) that have materials that should not be in the cart. Typically, an entire municipality is not manually audited at one time. Instead, routes that have been identified at the disposal/recycling facilities to contain a high number of materials that are not permitted are targeted for a manual audit. The manual audit is completed by a crew that goes ahead of the waste collection vehicle to manually lift the lid of the cart and observe the contents to identify if there are any materials that should not be in the cart. Typically, only what can be observed at the top of the cart is assessed. This can be difficult for the garbage stream if non-clear bags are used in the cart. If materials that are not permitted in the cart are observed, a tag is placed on the cart's lid. This notifies the driver that the cart should not be collected and is also used as an education tool for the resident when they go to collect their cart from the curb. On average, one person can assess 200 to 300 households in an eight-hour day. Municipalities can focus on routes that have high levels of non-permitted materials in waste streams so that every household does not need to be assessed.

Other ways to manually sticker the carts is by having the driver sticker the cart; however, to do so, the driver would need to get out of the collection vehicle and lift the lid to inspect the cart. This could be efficient in a semi-automated collection systems as the driver is already required to move the cart to the grabber. However, for fully automated collection this is inefficient and will reduce any efficiencies achieved with moving from manual to fully automated collection.

Another means of enforcement is using additional technologies, such as FleetMind⁸ to incorporate hardware and software onto waste collection vehicles such as onboard computing systems, sensors, cameras and GPS tracking devices through the collection of real-time data regarding the truck's location,

⁸ FleetMind (2023). Fleet Safety <https://www.safefleet.net/fleetmind/>

status and performance. The software analyzes data to optimize routes, monitor waste collection activities, track cart pick-ups, and provide insights into operations. One feature of fleet management systems includes taking photographs at each household for the following:

- **Container Monitoring:** Photographs of waste carts or containers are taken to track the status of collections. This helps in verifying whether carts/containers were emptied during scheduled pickups and confirming that no containers are missed or left unattended. This can also be used to verify when a resident phones in with a missed collection if they had their cart/container placed at the curb when the collection vehicle was at their household;
- **Contamination Detection:** Images might be captured to identify any contamination in carts/containers. For instance, cameras may detect non-recyclable items in carts or improper waste disposal. Currently, these cameras cannot see into bags, even if clear or transparent. Cameras can be trained to observe any specific material; however, the more materials it is trained to detect, the more funds are required for the program development
- **Route Verification:** Images of the route or surroundings could be captured to confirm that collection vehicles follow the designated path and adhere to the prescribed schedule. This verification helps in monitoring the efficiency of the collection routes; and
- **Vehicle Operations:** Cameras might be used to monitor the functioning of onboard equipment, the behaviour of the waste collectors, and the overall condition of the vehicle during operations.

Another option is using artificial intelligence to perform automated audits on each stream. Companies such as Prairie Robotics⁹ install on-board cameras that have learned to identify contamination in recycling streams. Materials are reviewed after each collection to determine a specialized education campaign for each individual household, as required. Cameras are pointed into the recycling hopper (versus at the household) to reduce issues of privacy. Other side aimed cameras are used to verify the location and originating address of the cart.

The use of technologies should be built into a new collection contract and could be included as a provisional item so that HRM understands the exact cost of adding any new technologies. However, prior to going to contract HRM may want to consider piloting one or two technologies on one collection vehicle based on the following:

- Assess if the technology is suitable for HRM's specific needs;
- Identify challenges or issues that may arise during actual implementation;
- Conduct a cost-benefit analysis to determine what options HRM would require and would be optional based on price; and
- Allow HRM staff to become familiar with the technology and the functionalities. This will help in developing the RFP by understanding what requirements to include.

⁹ Prairie Robotics (2023). <https://www.prairierobotics.com/>

The benefits and potential drawbacks of manual and automated inspection programs are included in **Table 9**. The choice between these needs to balance cost, efficiency and the level of data insights needed for optimizing waste management operations.

Table 9: Manual Versus Automated Inspection Programs

	Benefit	Potential Drawback
Manual Stickers	• Immediate identification and tagging. • May be more cost-effective initially than fully investing in an automated system. • Relatively simple and requires minimal technology or equipment.	• Can be time-consuming and slow down collection operations. • May not provide comprehensive data about collection patterns, contamination or other insights that automated systems offer.
Automated Visual Inspection Program	• Collect data on collection patterns, contamination and other metrics to aid in operational optimization. • Can potentially streamline the process leading to faster and more efficient waste collection operations.	• Implementing might require significant initial investment in technology and infrastructure. • Cannot see what is inside bags unless clear bags are continued to be used and people observe what is captured on the photos. • Setting up and maintaining may be more complex, requiring technical expertise and ongoing support. • Technical glitches or failures in the automated systems could disrupt operations until resolved.

For the purposes of this assessment, it is assumed that no enforcement technology will be used to confirm if non-permitted materials are being disposed of in the garbage. Clear bags can still be used for easier enforcement with cart inspections. While technology could be used to confirm that carts are being set out on time, properly and/or not overflowing they were not included in the costing analysis. However, it is estimated, depending on the type of technology installed, that automated visual inspection hardware is \$15,000 to \$25,000 per collection vehicle plus the cost of the annual software subscription fee.

3.7 Contamination and Residue Rates

Carts can be used as a method to reduce waste disposal rates (residue) and increase diversion rates of organics and recycling. The sizing of carts can play a role in waste disposal and diversion rates. Cart-based programs can offer variable sizes and flexibility in fees based on the size of the container selected. For instance, a user-pay approach could issue the 240 L cart as the standard size garbage cart during roll-out with the option to exchange to a 120 L for a reduced cost and to a 360 L for an increased cost. This user-pay approach based on cart size for garbage can be used to encourage diversion, as residents who select smaller garbage carts for cost savings may be encouraged to be more selective in their waste disposal habits. Smaller carts may also be preferred by residents who have special mobility and

accessibility needs. Contamination within carts is challenging to monitor, especially when compared to a clear bag program. As per **Section 3.6**, enforcement activities may need to be carried out to target contamination and reduce residue rates.

For the purposes of this assessment only one cart size will be offered unless there are known accessibility concerns. Garbage will be 240 L and recycling will be 360 L. Should HRM wish to proceed with more garbage cart sizes, additional analysis should be completed on a user pay model.

3.8 Contracting Approach

HRM's current waste collection contract timeline commenced July 1, 2021, and is expected to end June 30, 2026. However, this contract can also be extended once for a two-year period. This approach to waste collection contract is typical. Ongoing considerations for contracts should be reviewed on an ongoing basis to confirm the needs of both parties.

The current waste collection contracts have waste collected in eight distinct areas. The decision to split waste collection contracts into smaller ones or consolidate them into a single large contract depends on various factors and specific goals of a waste management operations. Considerations for each approach include the following:

Smaller Contract

- **Competition:** Smaller contracts can encourage competition among vendors, potentially leading to more competitive pricing. Additionally, some of the smaller waste collection providers may be able to bid on a smaller contract but would be unable to service one larger contract;
- **Local Engagement:** Smaller contracts could promote engagement with local or smaller businesses, fostering community involvement and potentially supporting regional economic development; and
- **Risk Mitigation:** If there is an issue with one contractor in a smaller contract scenario, it might not impact the entire waste management operations, minimizing the risk of widespread service disruption.

Larger Contract

- **Efficiency:** Consolidating contracts into one large agreement might streamline administrative processes, reducing administrative burden and providing uniformity across the waste management operation;
- **Operational Consistency:** Having one contractor managing the entire waste collection operation could lead to more standardized procedures, technologies and reporting systems;
- **Cost Savings:** A single large contract might negotiate bulk pricing, potentially resulting in cost savings due to economies of scale; and

- **Management:** Managing one large contract might be simpler from an oversight and coordination perspective, requiring fewer resources for monitoring and managing multiple waste collectors.

For this review, no changes were assumed for the current eight collection areas. However, the considerations to reduce the collection areas from eight to three would involve the following:

- **Population Density:** A review of the current number of stops per zone and how close the households are to one another;
- **Location of Existing Zones:** A review of where existing areas and collection days are within those areas and current routes;
- **Capacity of Waste Collection Vehicles:** A review of the number of waste collection vehicles required based on the number of stops within a given area/route;
- **Route Optimization:** Reducing the number of zones should also involve re-planning the routes to minimize travel time and fuel consumption and to avoid traffic congestion;
- **Distance to Disposal Sites:** A review of the daily/weekly capacity of the local receiving facilities; and
- **Number of Contracts Awarded to one Contractor:** If HRM reduces the number of collection areas/contracts it will need to consider how many contracts one contractor could be awarded with view of mitigating risk to service delivery. At a minimum there should be at least two contractors awarded the work.

Based on the considerations listed, and some initial high-level analysis, a suggested reduction of zones is outlined in **Table 10**.

Table 10: Waste Collection Area: Reduced Number of Contracts

New Area	Inclusive of Old Area:	Number of Serviced Units:	Rationale:
Area 1	Area 1 & 4	50,648	• These areas form the most westerly portion of the current collection routes. • Mixed high density and low density areas. • Mixed collection days and opportunities for route optimization.
Area 2	Area 3, 5 & 8	47,041	• Most north and eastern collection area. • Mixed high density and low density areas. • Mixed collection days and opportunities for route optimization. It may be possible for the transfer stations to be operated through their own contract.
Area 3	Area 2, 6 & 7	45,926	• Most south area for HRM. • Low density of serviced units for both zones. • Opportunities for route optimization.

3.9

Zero-Emission Vehicles

A zero-emission vehicle is a type of vehicle that either generates no tailpipe emissions or has the capability to produce no emissions, such as an electric vehicle¹⁰. Some may incorporate a traditional internal combustion engine but should also have the ability to operate without relying on it. There are three main categories of zero emission vehicles currently available:

- **Battery-Electric Vehicles:**
 - These vehicles utilize electric motors powered by rechargeable on-board batteries. They are the most energy-efficient vehicles and emit no tailpipe emissions.
- **Plug-In Hybrid Electric Vehicles:**
 - These vehicles come equipped with rechargeable batteries and gas engines.
- **Hydrogen Fuel Cell Vehicles:**
 - These vehicles use hydrogen to power an electric motor that propels the vehicle.

Electric waste collection vehicles are currently an emerging/tested technology. Truck manufacturers and waste facilities are evaluating the use of electric vehicles as an alternative to compressed natural gas- and diesel-powered vehicles. Limited case studies of this type of collection vehicle exist, especially in cold weather climates.

Requiring future residential and condo collection contracts to use zero-emission vehicles for waste collection can be a positive initiative. However, the feasibility of such a requirement depends on various factors, including regulations, the availability of technology, economic considerations, and the willingness of waste collection service providers to invest in and adopt these vehicles. A comparison of vehicle costs is provided in **Table 11** noting that this does not include any costs for fueling stations (e.g., permitting, approvals, site development, construction, equipment etc.).

The location of the fueling/charging station would also increase costs, depending on the distance from the collection area. 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.

¹⁰ Government of Canada (2023). Types of Zero Emission Vehicles. <https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/types-zero-emission-vehicles/25048>

Table 11: Comparison of Vehicle Costs

Vehicle Type	Estimated Cost (2024)
Single Stream Sideload Truck – Semi Automated	\$320,000
Single Stream Sideload Truck – Fully Automated	\$475,000
Fully Electric (Chassis and Body)	\$930,000
Diesel Chassis and Electric Body*	\$650,000

*Diesel Chassis and Electric Body vehicle typically refers to a type of hybrid or dual-powertrain vehicle where the chassis, which includes the frame, engine, transmission, and other essential components, is powered by a diesel engine. Meanwhile, the body of the vehicle, which includes the passenger cabin, exterior panels, and other non-mechanical parts, is powered by an electric motor or motors.

Other considerations for requirements to shift to zero emission vehicles include the requirements of HalifACT¹¹. HalifACT 2050 is a long-term climate action plan focused on reducing greenhouse gas emissions and developing climate resilience in Halifax, Nova Scotia, Canada. The plan aims to achieve net-zero emissions by 2050, and it also involves preparing HRM to adapt to potential future changes brought on by the climate crisis. HalifACT focuses on four main action areas that align with the municipality's primary sources of emissions: buildings and energy, transportation, solid waste and land use. The plan involves a range of strategies, including energy conservation and efficiency improvements, transitioning to renewable energy, enhancing public transit and active transportation, waste reduction and improving climate resilience.

For the purposes of this assessment diesel vehicles will be the assumed collection vehicle. Further investigation into electric waste collection vehicles is required for use in a climate such as HRM. Some Canadian municipalities are currently testing and using some electric vehicles in their collection fleets, one example is the City of Burnaby in British Columbia. Further follow up with those municipalities would be required before piloting this collection vehicle in HRM.

3.10 Additional Considerations

Within this review, some additional considerations were reviewed. These include pilot program considerations, the worker safety impacts of automated collection and the additional capital and operating costs associated with cart-based collection services.

3.10.1 Pilot Program Considerations

When piloting a program for rolling out carts, there are several key considerations to support successful and effective implementation:

- **Selecting Pilot Areas:** Choose pilot areas that represent the diversity of the jurisdiction in terms of demographics, geography and waste management needs. This allows for a comprehensive assessment of the program's suitability across the jurisdiction;

¹¹ "HalifACT 2050: Acting on Climate Together". Halifax. Retrieved from: <https://www.halifax.ca/about-halifax/energy-environment/halifact-2050-acting-climate-together>

- **Community Engagement:** Involve residents and stakeholders from the pilot areas early in the process. Gather feedback, address concerns and provide clear communication regarding the goals, benefits and changes brought by the new system;
- **Cart Design and Distribution:** Confirm that the carts are an appropriate size(s) and have appropriate features (e.g., wildlife locks) for the local context;
- **Collection Logistics:** Test the logistics of cart collection, including frequency, routes and scheduling. Assess how well the collection system aligns with waste management goals and resources;
- **Technology Integration:** If implementing technology such as RFID tagging or tracking systems on the carts, pilot their functionality, accuracy and compatibility with existing waste management infrastructure;
- **Waste System Analysis:** Consider all waste collection streams including those that may not be suitable for carts (e.g., Christmas trees, bulky items, white goods) and how they could be collected at a pilot and region-wide scale;
- **Data Collection and Analysis:** Establish methods to gather data during the pilot such as waste volume, recycling rates and operational efficiencies. Analyze this data to measure the program's success and identify areas for improvement;
- **Performance Evaluation:** Assess the environmental, social and economic impacts of the pilot program. Consider factors such as diversion rates, resident satisfaction, cost-effectiveness and any unexpected challenges;
- **Adaptability and Flexibility:** Remain open to adjustments based on feedback and data analysis. The pilot phase allows for refining the program prior to full-scale implementation; and
- **Budgeting and Resources:** Confirm adequate budget allocation and resources for the pilot program. Consider the financial implications of scaling the program after the pilot phase.

3.10.2 Worker Safety Impacts

Cart collection is generally considered to have a positively impact on worker safety. The evolution from manual to fully automated waste collection makes the job less physically demanding while also attracting drivers more comfortable with technology. Entry and exit from the vehicle remain a common source of injury from operators in semi-automated collection. Automated cart collection enhances worker safety and comfort as it minimizes injuries caused by repetitive manual lifting and exposure to hazards in the waste or from the surrounding environment. Fully automated collection also minimizes walking between set outs, hanging from the side of a vehicle, and frequent step on and off the vehicle. Reduced physical requirement increases retention and diversity of the workforce that can participate in solid waste collection.

3.10.3 Capital and Operational Costs

The transition to an automated cart collection system requires significant up-front capital costs for purchasing and delivering carts, retrofitting existing vehicles and/or procuring new collection vehicles.

Operational costs during pre- and post-implementation include costs to assemble and deliver carts, costs for ongoing cart maintenance, including replacements and storage, and the costs of operating and maintaining the vehicles. There are also P&E costs throughout, with more concentrated efforts required before the roll-out of the new system and during the first few months of implementation. Similarly, following the transition to the new system, some enforcement activities are generally required to confirm adoption and proper set out of carts for collection.

The largest savings from the shift to an automated collection system have been reported through a reduction in staff-related costs for operating collection vehicles. Jurisdictions generally saw more savings with a fully automated collection system compared to a semi-automated collection system as the fully automated system requires one less operator per route, and the time needed to collect is shorter as there is no time spent positioning the cart.

There are also cost savings realized through lower incidences of workplace injuries, including less injury time off for operators. A study completed by CIF on automated cart recycling (CIF Project 888) states that moving from manual collection to automated collection allows for a reduction in costs related to staff injuries (90%), illness rates (50%), modified job duties (90%) and reduced WSIB claims (90%)¹².

¹² https://thecif.ca/projects/documents/888-Autocarts_Study_FINALv2_Jun2016.pdf

4.0

Options Development

Based on the results of the assessment of key considerations, in consultation with HRM, four options were developed and analyzed for consideration of rolling out an automated cart collection system.

These options include the following:

1. Modelled status quo;
2. Semi-automated collection of cart materials;
3. Fully automated collection of cart materials; and
4. Hybrid collection of cart materials.

A 25-year cost model was developed for this assignment and is provided in **Appendix A**. The following outline the assumptions made for all options, descriptions of each option and the evaluation criteria developed in consultation with HRM. A standard list of assumptions applicable to all options include the following:

Estimated Capital and Operating Costs

- For each option, estimated capital and annual operating costs are included. Costs were increased to account for inflation to 2028 using the Bank of Canada's five-year current benchmark bond yields (3.5% per year effective August 25, 2023). The intent of the capital and operating costs estimates is to indicate which option(s) will have the lowest and/or highest cost impacts from the status quo should HRM select the option. All costs are rounded up to the nearest \$5,000 increment. This analysis has not included costs that are anticipated to be the same (e.g., Waste Administration costs);
- Estimated unit costs have been provided by a cart manufacturer/distributor and a representative from the trucking industry. These costs are included in further subsections;
- The estimated current status quo operating costs are based on monthly cost per serviced units as provided by HRM. These costs factor in annual inflation (3.5%) and the estimated 2028-year growth rate of 1% for serviced unit as per population projections provided by HRM;
- The estimated modelled status quo costs are based on current levels of service and are provided as an estimate to benchmark and calibrate the options costs;
- The estimated collection costs for each of the options are based on collection vehicle type, and costed per area of collection;
- In two of the options, green cart collection transitions from semi-automated to fully automated collection;
- Any form of automated collection generally optimizes resource allocation through increases in accuracy, speed and consistency as outlined in **Section 3.1**. Municipalities transitioning from manual to automated waste collection have reported an initial slowdown period. This adjustment phase is attributed to staff acclimating to the new collection methods, familiarizing themselves with new vehicle operations and adapting to any necessary route changes. Over time, efficiency

typically improves as staff become more accustomed to the updated operating procedures. The following efficiencies were assumed noting that additional efficiencies may be realized:

- Manual collection is more variable as it is impacted by weather, labour fatigue and staffing concerns more than semi-automated or hybrid collection;
- Semi-automated and fully automated collection only requires one staff member, reducing the labour required to collect the same amount of materials;
- Automated collection systems are expected to be more efficient as staff are not required to exit the collection vehicle to support moving carts for collection;
- Manual to fully automated collection system: 15% truck time efficiency. Additional inefficiencies may arise if certain areas cannot be collected with automated collection; and
- Manual to semi-automated collection system: 0% truck time efficiency. There could be efficiencies that may arise; however, this option only has one labour person per collection vehicle and for assumption purposes 0% was used.
- It was assumed that there would be some adjustments to routes when moving to a semi, hybrid or fully automated cart collection system.
- For operational costs, 32 different Performa were reviewed. Within those Performa the following has been assumed:
 - As previously noted, semi-automated and fully automated vehicles will require one staff member to operate the collection vehicle;
 - Operational costs are based on each collection area, separately, which provided minimal operational cost efficiencies;
 - Collection staff are assumed to be paid \$26 per hour with an increase of 2% cost of living each year;
 - Work weeks for staff are expected to be 40 to 45 hours;
 - An additional 39% was added to the hourly rate to cover employment insurance and employer paid benefits;
 - Contracts are expected to be ten years. It is noted that this may be variable (ex., eight years plus two years);
 - There are more spare trucks than required as bids are received per collection area. The current spare ratio is 20 to 30% based on collection area, which is higher than industry standard. This is due to bidders assuming that they may only receive one collection area and as part of their bid need to budget enough collection vehicles and spare vehicles to service those areas, separately. Costs are likely to be reduced should collection areas be reduced from eight to three as fewer spare vehicles may be budgeted per collection area;
 - All facility costs are associated with garbage and organics costs and are not included in recycling costs;
 - The lifecycle of the collection vehicles is expected to be up to ten years;
 - Maintenance costs are assumed to be \$120 per hour for 2028 and include mechanical labour and expenses; and
 - Fuel costs were determined based on market rate (13 L/km) and a cost of \$1.80/L.

Program Pre-Consultation

- HRM will consult with the public starting at least one year in advance of implementing garbage carts; and
- HRM will conduct a pilot program in any neighbourhood; however, the pilot is not included in the options or cost analysis.

Program Planning

- Costs were developed by assuming eight collection areas; however, HRM may amend the collection areas from eight to three. The recommend waste collection areas have been identified in **Section 3.8**;
- The current number of households collected per collection area is provided in **Section 3.8**. This analysis includes residential properties of six units or less, only. All properties within this description are assumed to receive carts regardless of collection style or feasibility;
- Current waste collection practices are outlined in **Section 2.0**. It is assumed that garbage, organics, dual stream recycling and bulky waste/construction bundles will be the waste streams collected for this analysis:
 - Garbage and recycling will be collected bi-weekly on alternating weeks in carts;
 - Organics is currently collected in carts; organics will continue to be collected in carts and new carts are not required;
 - Bulky waste will be collected manually with an appointment and system that does not have a fee. Additional trucks have been allocated for each option to complete this collection process; and
 - Excess leaf and yard waste (placed in paper bags and/or tied in bundles) and Christmas trees will continue to be collected on the regular green cart collection day. Additional trucks have been allocated for each option to complete this collection process.
- Current waste tonnages are outlined in **Section 2.2** and per collection area in **Section 3.8**;
- Garbage carts will be one size, 240 L. If there are known accessibility concerns, garbage carts can be reduced to 120 L;
- Recycling carts will only be one size, 360 L and will be a split-body collection cart. If accessibility concerns are noted, residents may receive two 120 L carts (one per stream); however, this could cause some collection issues as the vehicles are configured to collect from 360 L split carts. A separate vehicle(s) may be required to collect from household with 120 L recycling carts;
- Carts are assumed to have a 10-year warranty. Based on 148,528 estimated stops by 2028, the cost for carts is estimated to be \$34,410,000. This is based on the following assumptions:
 - This cost estimate is inclusive of estimated garbage and recycling carts. Green cart costs were provided by HRM and are included in the analysis for annual replacements;
 - The estimated 2028 cost per 240 L cart is \$75.39 and per 360 L recycling cart is \$121.96;
 - 2% of garbage carts will be exchanged from a 240 L to a 120 L;
 - Approximately 1,000 carts can fit in one truckload and the estimated 2028 shipping cost is \$10 per cart;

- 303 truckloads will be required for shipping carts and HRM will fully load each truck; therefore, 333,000 carts will be ordered with the intent of 5,944 carts being utilized as extra stock; and
- A contractor will manage the roll-out, delivery and building of carts. The estimated distribution cost per cart is \$6 per cart. The contractor will develop a cart delivery schedule, deliver and build carts (attach lids, wheels and bars). Based on 148,528 estimated stops by 2028, the cost for cart distribution is estimated to be \$1,817,978.
- All serviced properties will receive a cart regardless of whether automated collection is feasible for the serviced property;
- All vehicles are assumed to be diesel for the purposes of the option comparison;
- P&E will include advertising through print, digital and social media. It is assumed that existing staffing resources will be used for P&E. P&E costs are estimated to be \$200,000 during the first year;
- HRM will complete spot checks of cart deliveries using existing staffing resources; and
- HRM will provide storage space for carts for roll-out purposes, accessible to the contractor using existing HRM resources (e.g., empty lots, snow storage areas).

Program Roll-Out

- Households/buildings with six units or less will receive cart collection;
- Bag tags for garbage volumes in excess of the cart volume will not be permitted; and
- HRM will be responsible for increased call volume management.

Program Establishment and Management

- HRM will contract out the management of ongoing cart maintenance, delivery and storage, stockpiling and issuing to new developments once implemented. These costs are included in the 25-year mode provided in **Appendix A**; and
- The stockpile of approximately 5,944 additional carts based on exchanges of the roll-out will be used as part of the cart management program. The cart management contractor will use these excess carts as required.

Additional Considerations

- Due to limited mobility or weather, residents may encounter barriers to putting carts on the curb;
- HRM should also consider what service, if any, HRM will provide for the collection and disposal of garbage containers that residents no longer require. Some containers could be repurposed for leaf and yard waste collection; however, many residents will no longer want their old containers; and
- HRM should consider the future impacts of that EPR can have on recycling. A recycling cart program requires HRM to purchase wheeled carts. The capital cost for the carts and their roll-out will be the financial responsibility of HRM if this happens prior to EPR roll-out. HRM will also be responsible for the newly acquired carts asset after EPR roll-out. Producer Responsibility

Organizations are likely to not be under any obligation to purchase existing assets or take over existing municipal contracts. Procuring recycling carts prior to engaging in discussions and negotiations with Producer Responsibility Organizations could lead to HRM possessing assets that are unwanted.

4.2 Options Benefits, Challenges and Risks

Four options were considered for this analysis. These options include the following:

1. Modelled status quo:
 - This option reviews current modelled status quo costs. The updated costs are based on current levels of service and are provided as an estimate to benchmark and calibrate the options costs
2. Semi-automated collection of cart materials:
 - This option reviews an entirely semi-automated collection system for all eight collection areas within HRM. Semi-automated collection allows for areas with low overhead clearance (e.g., low overhead wires) and narrower back-alley ways to have an automated collection system.
3. Fully automated collection of cart materials:
 - This option reviews an entirely fully automated collection system for all eight collection areas within HRM. Fully automated collection is quite efficient; however, there may be concerns related to narrower alley ways and overhead obstacles.
4. Hybrid collection of cart materials:
 - This option reviews a 75% fully automated and 25% semi-automated collection system for all eight collection areas within HRM. Hybrid collection allows for individual collection approaches to each unique area of HRM.

A list of benefits, challenges, and risks for both HRM and residents are summarized in **Table 12**. Areas of focus include the following:

- Ease of use (public and waste haulers);
- Public acceptance;
- Procurement timelines for resources; and
- Estimated initial and ongoing amount of effort for the HRM.

Table 12: Summary of Waste Collection Benefits, Challenges and Risks

Option Description	Status Quo: Manual Collection/ Modelled Status Quo	Option 1: Semi-Automated Collection	Option 2: Fully Automated Collection	Option 3: Hybrid Collection
Benefits	- No change to existing collection service for customers at this time (potential impacts to recycling with EPR). - No capital purchase of carts.	- Reduction in manual labour associated with collection. Reduced physical requirement increases ability to recruit and retain employees and diversity of the workforce that can participate in solid waste collection. - Minimizes injuries caused by repetitive manual lifting and exposure to hazards in the waste. - Wheeled carts are easy to roll by most residents and may be viewed more favourable by residents.	- Reduction in manual labour associated with collection. Reduced physical requirement increases ability to recruit and retain employees and diversity of the workforce that can participate in solid waste collection. - Minimizes injuries caused by repetitive manual lifting and exposure to hazards in the waste. Least risk to collection staff health and safety compared to manual or semi-automated collection. - Wheeled carts are easy to roll by most residents and may be viewed more favourable by residents.	- Reduction in manual labour associated with collection. Reduced physical requirement increases ability to recruit and retain employees and diversity of the workforce that can participate in solid waste collection. - Minimizes injuries caused by repetitive manual lifting and exposure to hazards in the waste or from the surrounding environment. - Wheeled carts are easy to roll by most residents and may be viewed more favourable by residents. - Fully automated collection may not be suitable for all current and future service areas. A hybrid approach may be better suited.
Challenges	Similar level of labour from contractors. Physical injuries are likely to occur more frequently than semi or fully automated collection.	- Potential for collection staff injuries from entry and exit from the vehicle or from the surrounding environment. However, this may be less likely to occur when compared to manual collection. - Cart replacement program requires additional staff time. - Due to limited mobility, weather or driveway length, residents may encounter barriers to putting carts on the curb.	- Carts must be positioned in a specific manner so that they can be collected by the arm and grabber. - No allowance for extra curbside yard waste may impact organics diversion rates and may not be viewed favourably by residents. - Cart replacement program requires additional staff time. - Due to limited mobility, weather or driveway length, residents may encounter barriers to putting carts on the curb. - Fully automated collection may not be suitable for all current and future service areas. A hybrid approach may be better suited.	See option 1 and 2 challenges.
Risks	Requires manual labour and there are currently labour shortages. This may be a less desirable job than other places of employment. There are also increased health and safety risks associated with manual collection.	- Collection carts are an investment by HRM and require ongoing program maintenance. It is not currently known how EPR programs will impact recycling collection requirements. - Collection monitoring more difficult due to reduced direct handling of waste materials. May result in downstream financial impacts from contamination of waste streams with reduced visibility to observe materials. Directed P&E, continuing to use clear bags and on-vehicle cameras may help mitigate.	- Collection carts are an investment by the HRM and require ongoing program maintenance. It is not currently known how EPR programs will impact recycling collection requirements. - Collection monitoring more difficult due to reduced direct handling of waste materials. May result in downstream financial impacts from contamination of recycling and organics stream. Directed P&E, continuing to use clear bags and on-vehicle cameras may help mitigate.	- Collection carts are an investment by HRM and require ongoing program maintenance. It is not currently known how EPR programs will impact recycling collection requirements. - Collection monitoring more difficult due to reduced direct handling of waste materials. May result in downstream financial impacts from contamination of recycling and organics stream. Directed P&E, continuing to use clear bags and on-vehicle cameras may help mitigate.

5.0 Options Analysis

For each option a financial analysis was completed on capital costs and annual costs. Due to the variability in waste collection costs, including costs associated with the requirement to have a form of automated collection vehicles, the costs provided are considered Class C estimates and are variable between 15 to 30%. One option included a modelled status quo, and three new options were evaluated. All options were assessed with criteria developed in consultation with HRM that considered the economic, social and environmental impacts of the options. A 25-year cost projection is provided in **Appendix A**. A comparison of each option in comparison to HRM current collections costs are provided in **Section 5.1.4**.

5.1 Financial Analysis

The following subsections summarize the financial analysis completed for each of the four options. Detailed costs are provided in **Appendix B**. All options are exclusive of applicable taxes.

5.1.1 Modelled Status Quo

Dillon evaluated the current status quo. Assumptions and outcomes of the options analysis is presented in **Table 13**.

Table 13: Modelled Status Quo Collection Services

Option Considerations	Assumptions/ Results of Analysis
Resources Required	All program planning and resources can be sourced from existing HRM Staffing.
Timelines	No changes to current timelines
2028 Capital Costs	- Organics cart cost = \$854,000 - Total estimated capital costs (rounded to nearest \$5,000) = \$855,000
2028 Annual Operating Costs	- Area 1 = \$3,682,845 - Area 2 = \$2,925,755 - Area 3 = \$1,762,322 - Area 4 = \$2,407,205 - Area 5 = \$2,838,378 - Area 6 = \$2,083,378 - Area 7 = \$1,649,441 - Area 8 = \$2,243,085 - Total estimated operating costs (rounded to nearest \$5,000) = \$19,595,000
Cost per Household (2028)	- Capital costs: \$6 - Operating costs: \$131

5.1.2 Option 1: Semi-Automated Collection

For Option 1, HRM would contract out an entirely semi-automated side-load collection system. Assumptions and outcomes of the options analysis is presented in **Table 14**.

Table 14: Option 1: Semi-Automated Collection Services

Option Considerations	Assumptions/ Results of Analysis
Resources Required	All program planning and resources can be sourced from existing HRM Staffing.
Timelines	Planning would start at least 18 months prior to program roll-out. The program change would occur following the end of the current eight waste contractor contracts.
2028 Capital Costs	- Base cost: Recycling and garbage carts and distribution, stockpile of carts and spare parts = \$34,625,000 - Organics cart cost = \$853,875 - Pre-consultation costs = \$200,000 - Total estimated capital costs (rounded to nearest \$5,000) = \$35,680,000
2028 Annual Operating Costs	- Area 1 = \$4,240,868 - Area 2 = \$3,432,196 - Area 3 = \$2,343,437 - Area 4 = \$2,428,083 - Area 5 = \$3,432,196 - Area 6 = \$ 1,982,398 - Area 7 = \$1,757,420 - Area 8 = \$2,210,644 - Total estimated operating costs (rounded to nearest \$5,000) = \$21,830,000
Cost per Household (2028)	- Capital costs: \$239 - Operating costs: \$146

5.1.3 Option 2: Fully Automated Collection

For Option 2, HRM would contract out an entirely fully automated collection system. Assumptions and outcomes of the options analysis is presented in **Table 15**.

Table 15: Option 2: Fully Automated Collection Services

Option Considerations	Assumptions/ Results of Analysis
Resources Required	All program planning and resources can be sourced from existing HRM Staffing.
Timelines	Planning would start at least 18 months before program roll-out. The program change would occur following the end of the current eight waste contractor contracts.
2028 Capital Costs	- Base cost: Recycling and garbage carts and distribution, stockpile of carts and spare parts = \$34,625,000 - Organics cart cost = \$853,875 - Pre-consultation costs = \$200,000 - Total estimated capital costs (rounded to nearest \$5,000) = \$35,680,000
2028 Annual Operating Costs	- Area 1 = \$3,502,129 - Area 2 = \$2,57,528 - Area 3 = \$2,061,105 - Area 4 = \$2,505,541 - Area 5 = \$ 3,034,510 - Area 6 = \$2,225,489 - Area 7 = \$1,725,941 - Area 8 = \$1,812,847 - Total estimated operating costs (rounded to nearest \$5,000) = \$19,445,000
Cost per Household (2028)	- Capital costs: \$239 - Operating costs: \$130

5.1.4

Option 3: Hybrid Collection

In this option, HRM would contract out a hybrid semi-automated side-load collection system and fully automated collection system. Based on a meeting held with HRM, it is assumed that 75% of HRM would be collected using fully automated collection vehicle and 25% would be serviced with semi-automated collection vehicles. Assumptions and outcomes of the options analysis is presented in **Table 16**.

Table 16: Option 3: Hybrid Collection Services

Option Considerations	Assumptions/ Results of Analysis
Resources Required	All program planning and resources can be sourced from existing HRM Staffing.
Timelines	Planning would start at least 18 months before program roll-out. The program change would occur following the end of the current eight waste contractor contracts.
2028 Capital Costs	- Base cost: Recycling and garbage carts and distribution, stockpile of carts and spare parts = \$34,625,000 - Organics cart cost = \$853,875 - Pre-consultation costs = \$200,000 - Total estimated capital costs (rounded to nearest \$5,000) = \$35,680,000
2028 Annual Operating Costs	- Area 1 = \$3,503,385 - Area 2 = \$2,549,868 - Area 3 = \$1,988,679 - Area 4 = \$2,398,062 - Area 5 = \$3,128,645 - Area 6 = \$2,180,611 - Area 7 = \$1,640,328 - Area 8 = \$1,773,633 - Total estimated operating costs (rounded to nearest \$5,000) = \$19,175,000
Cost per Household (2028)	- Capital costs: \$239 - Operating costs: \$129

5.1.5

Options Cost Comparison

A comparison of costs is provided in **Table 17**. Options 1 through 3 all have the same capital cost since each option requires the purchase of carts, regardless of collection vehicle. Option 2, fully automated collection has the most expensive operating costs. The amortization of the selected collection vehicles was included in the collection costs.

Table 17: 2028 Comparison of Capital and Operating Costs for Status Quo, Option 1, 2 and 3

Estimated Costs	Status Quo	Modelled Status Quo	Option 1	Option 2	Option 3
Capital Costs (2028)	\$854,000	\$854,000	\$35,680,000	\$35,680,000	\$35,680,000
Operating Costs for Year 1 (2028)		\$19,595,000	\$21,830,000	\$19,445,000	\$19,175,000
Approximate Capital Cost per Household (2028)	\$6	\$6	\$239	\$239	\$239
Approximate Operating Cost per Household (2028)	\$105	\$131	\$146	\$130	\$129

The net present value (NPV) costs for 2024 and for 25 years are included in **Table 18**. Annual NPV costs for the 25-year model are provided in **Appendix C**. The overall costs as outlined in this table are in line with industry standards for this period of time. The variation in costs is due to several primary factors:

- Staffing: Manual collection requires more staff and therefore has higher labour costs compared to automated collection;
- Collection Time: Manual and semi-automated collection requires more time to collect than automated collection. Therefore, additional staff time and/or collection vehicles are required to complete collection of the same areas;
- Cart Placement and Accessibility: Automated collection requires carts to be placed curbside with specific distances between carts.
- Vehicles: There are no assumed collection efficiencies factored into the analysis with semi-automated and therefore more collection vehicles are required to complete the same areas;
- Labour: All manual collection assumes one driver and one labour support person. Semi-automated and fully automated collection assumes one person who completes both roles;
- Collection Vehicles: Semi and fully automated collection vehicles cost more than manual collection vehicles; and
- Vehicle Maintenance Costs: fully automated collection vehicles cost more to maintain than manual or semi-automated collection vehicles.

The total number of required vehicles per collection option is outlined in **Appendix B**. Details on operational cost assumptions are provided in **Section 4.0** and **Appendix B**.

Table 18: 2024 NPV Comparison of Capital and Operating Costs for Status Quo, Option 1, 2 and 3

Estimated Costs	Modelled Status Quo	Option 1	Option 2	Option 3
NPV Costs for 25 years	-\$283,544,118	\$-347,530,907	\$-313,117,192	\$-309,197,718

5.2 Options Evaluation

The four options, including current status quo were also evaluated with criteria developed in consultation with HRM that considered the economic, social and environmental impacts of the options.

5.2.1 Evaluation Criteria

Within each criterion, there are additional indicators and rankings. The higher the ranking, the more positive the outcome. Overall evaluation criteria are provided in **Table 19**.

Table 19: Summary of Evaluation Criteria and Scoring

Evaluation Criteria	Indicators	Rank
Economic Impact	Operating Cost	1 - \$5,000,000 or greater 2 - \$1,000,000 to \$5,000,000 3 - < \$1,000,000
	Capital Cost	1 - \$10,000,000 or greater 2 - \$3,000,000 to \$10,000,000 3 - < \$3,000,000
Social Impact	Public Acceptance	1 - Potential for opposition to the option 2 - No public perception of the option 3 - Option anticipated to be accepted/encouraged by the community
	Level of Effort to Develop, Implement, Operate, and Maintain	1 - High level of effort to develop and implement (e.g., more than 5 years) 2 - Moderate effort to implement (e.g., some additional resources are needed, can be implemented in 3-5 years) 3 - Easy to implement (e.g., can be done with existing staff resources)
Environmental Impact	Potential for Diversion	1 - Little to no impact on waste diversion 2 - Moderate increase in waste diversion 3 - Large scale increase in waste diversion
	*Greenhouse Gas (GHG) Emissions	1 - Little to no reduction in GHG emissions 2 - Moderate reduction in GHG emissions 3 - Large scale reduction in GHG emissions

*GHG emission reduction is anticipated based on time in motion for collection vehicles

5.2.2

Options Evaluation Results

Status Quo, modelled status quo and Options 1, 2, and 3 were analyzed based on the evaluation criteria presented in **Section 5.2.1** and ranked based on the final score for each option. The results of the options evaluation for each option and rationale for scoring are provided in **Table 20** through **Table 23**. **Table 24** presents a summary of the options scoring and ranking as a result of the analysis. The highest possible score was an 18 and the lowest possible score was a six.

Table 20: Option Evaluation – Status Quo and Modelled Status Quo

Option	Status Quo: Manual Collection/ Modelled Status Quo	Rationale
Annual Operating Cost	1	Operating costs exceed \$5 million
Initial Capital Cost	3	Capital costs are less than \$3 million
Public Acceptance at Roll-out	3	Current program is expected to have no issues with public acceptance
Level of effort to develop and implement	3	Current program is expected to have little to no effort to implement
Environmental	1	Current program would have little to no impact on waste diversion
GHG Emissions	1	Current program would have little to no impact on GHG emissions
Final Score	12	

Table 21: Option Evaluation – Option 1: Semi-Automated Collection

Option	Option 1: Semi-Automated Collection	Rationale
Annual Operating Cost	1	Operating costs exceed \$5 million
Initial Capital Cost	1	Capital costs exceed \$10 million
Public Acceptance at Roll-out	2	Likely to have some pushback from residents; however, this is a common program within Canada, and HRM would likely complete a pilot program to reduce pushback
Level of effort to develop and implement	3	Can be implemented with current staffing levels by 2028
Environmental	2	Reducing the garbage volume allowed is expected to increase waste diversion moderately
GHG Emissions	2	Semi- Automated collection can create efficiencies within the collection system that are expected to moderately reduce GHG emissions
Final Score	11	

Table 22: Option Evaluation – Option 2: Automated Collection

Option	Option 2: Automated Collection	Rationale
Annual Operating Cost	1	Operating costs exceed \$5 million
Initial Capital Cost	1	Capital costs exceed \$10 million
Public Acceptance at Roll-out	2	Likely to have some pushback from residents; however, this is a common program within Canada, and HRM would likely complete a pilot program to reduce pushback
Level of effort to develop and implement	3	Can be implemented with current staffing levels by 2028
Environmental	2	Reducing the garbage volume allowed is expected to increase waste diversion moderately
GHG Emissions	2	Automated collection can create efficiencies within the collection system that are expected to moderately reduce GHG emissions
Final Score	11	

Table 23: Option Evaluation – Option 3: Hybrid Collection

Option	Option 3: Hybrid Collection	Rationale
Annual Operating Cost	1	Operating costs exceed \$5 million
Initial Capital Cost	1	Capital costs exceed \$10 million
Public Acceptance at Roll-out	2	Likely to have some pushback from residents; however, this is a common program within Canada, and HRM would likely complete a pilot program to reduce pushback
Level of effort to develop and implement	3	Can be implemented with current staffing levels by 2028
Environmental	2	Reducing the garbage volume allowed is expected to increase waste diversion moderately
GHG Emissions	2	Automated collection can create efficiencies within the collection system that are expected to moderately reduce GHG emissions
Final Score	11	

Table 24: Summary of Option Evaluation

Option	Status Quo: Manual Collection and Modelled Status Quo	Option 1: Semi- Automated Collection	Option 2: Automated Collection	Option 3: Hybrid Collection
Annual Operating Cost	1	1	1	1
Initial Capital Cost	3	1	1	1
Public Acceptance at Roll-out	3	2	2	2
Level of effort to develop and implement	3	3	3	3
Environmental	1	2	2	2
GHG Emissions	1	2	2	2
Final Score	12	11	11	11

Based on the results of the evaluation, Status Quo and modelled Status Quo ranked the highest, while the other three options tied with a score of 11.

6.0

Recommendations

Based on the current state, the industry trends analysis, and the results of the options analysis, moving towards fully, semi-automated or a hybrid collection approach appears to not be the best collection option for HRM using the evaluation criteria and rankings. However, if HRM plans to move to a cart collection program, some form of automated collection will be required. Status Quo outperformed the alternate collection options by one point, this is due to the minimal capital costs required to maintain this program. If capital costs are removed from the evaluation, the three alternate options have higher evaluation scores than status quo. Certain areas in HRM may not be able to be serviced using fully automated collection. With this noted, Dillon recommends a hybrid approach to collection. This recommended option allows for the following benefits:

- **Ease of Use for Residents:** Wheeled carts are easy to roll by most residents and may be viewed more favourable by residents;
- **Improved Health and Safety:** Automated collection reduces the manual labour associated with waste collection. Reduced physical requirement increases the ability to recruit and retain employees and diversity of the workforce that can participate in solid waste collection. It also minimizes injuries caused by repetitive manual lifting and exposure to hazards in the waste or from the surrounding environment; and
- **Improved Operational Efficiencies:** Automated collection improves operational efficiencies as an operator can typically collect carts faster than manual collection, reducing the time required for collection. Improved efficiencies may reduce GHG emissions related to waste collection.

6.1

Additional Considerations

A comprehensive communication strategy needs to be developed for the implementation process, covering all stages from program planning to roll-out and management. The P&E efforts should include various channels, such as print, digital and social media advertising, to effectively communicate any changes in the collection service. Initial communications should emphasize the reasons behind HRM's transition to the new system and highlight the associated benefits.

When opting for a cart system, P&E should state that many other jurisdictions have already embraced or are currently adopting cart-based collection systems. In the months leading up to the roll-out, promotional materials should provide details on the arrival of carts, guidelines for their usage and guidance on overcoming potential challenges such as snow, long driveways and mobility issues.

Recommended P&E materials include ongoing updates on HRM's website, social media pages, radio, and newspapers throughout planning, roll-out and establishment phases. The garbage and recycling guide distributed by mail should feature information about the transition a year before the roll-out, offering residents notice. In the case of a cart system, this communication can clarify that residents do not need to purchase new containers. Furthermore, an educational mail should be sent to households,

containing relevant information about the transition, general waste management guidelines (such as sorting, collection times and collection days) and instructions on how to reach HRM with any additional questions.

Appendix A

25-Year Cost Estimate

contract renewal year

future inflation assumption of 3.5%

2026 green cart costs - \$825,000 (Provided by HRM)

2024 green cart costs = \$570,000 or \$4/unit

Total Cost

Assumptions						Operating Costs Per Serviced Unit					Capital Costs - Status Quo Model				Capital Costs - Status Quo				Capital Costs - Option 1: Semi-Automated				Capital Costs - Option 2: Fully Automated				Capital Costs - Option 3: Hybrid Collection			
Year	FY	Number of Serviced Units	Inflation	Garbage Cart Replacement %	Recycling Cart Replacement %	Status Quo	Model Status Quo	Option 1: Semi-Automated	Option 2: Fully Automated	Option 3: Hybrid	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total
1	FY 28/29	149,446	3.5%			\$ 15,681,407	\$ 18,478,625	\$ 16,634,144	\$ 19,388,367	\$ 18,699,812	\$ 853,875	\$ -	\$ -	\$ 853,875	\$ 853,875	\$ -	\$ -	\$ 853,875	\$ 853,875	\$ 13,958,009	\$ 20,665,287	\$ 35,677,172	\$ 853,875	\$ 13,958,009	\$ 20,665,287	\$ 35,677,172	\$ 853,875	\$ 13,958,009	\$ 20,665,287	\$ 35,677,172
2	FY 29/30	150,941	3.5%	5%	3%	\$ 16,392,559	\$ 19,316,631	\$ 17,388,503	\$ 20,267,630	\$ 19,547,848	\$ 883,761	\$ -	\$ -	\$ 883,761	\$ 883,761	\$ -	\$ -	\$ 883,761	\$ 883,761	\$ 692,160	\$ 626,158	\$ 2,202,079	\$ 883,761	\$ 692,160	\$ 626,158	\$ 2,202,079	\$ 883,761	\$ 692,160	\$ 626,158	\$ 2,202,079
3	FY 30/31	152,450	3.5%	5%	4%	\$ 17,135,961	\$ 20,192,640	\$ 18,177,071	\$ 21,186,767	\$ 20,434,343	\$ 914,692	\$ -	\$ -	\$ 914,692	\$ 914,692	\$ -	\$ -	\$ 914,692	\$ 914,692	\$ 699,082	\$ 843,226	\$ 2,457,001	\$ 914,692	\$ 699,082	\$ 843,226	\$ 2,457,001	\$ 914,692	\$ 699,082	\$ 843,226	\$ 2,457,001
4	FY 31/32	153,975	3.5%	5%	5%	\$ 17,913,077	\$ 21,108,376	\$ 19,001,402	\$ 22,147,587	\$ 21,361,040	\$ 946,706	\$ -	\$ -	\$ 946,706	\$ 946,706	\$ -	\$ -	\$ 946,706	\$ 946,706	\$ 706,073	\$ 1,064,573	\$ 2,717,353	\$ 946,706	\$ 706,073	\$ 1,064,573	\$ 2,717,353	\$ 946,706	\$ 706,073	\$ 1,064,573	\$ 2,717,353
5	FY 32/33	155,514	3.5%	10%	8%	\$ 18,725,435	\$ 22,065,641	\$ 19,863,115	\$ 23,151,980	\$ 22,329,764	\$ 979,841	\$ -	\$ -	\$ 979,841	\$ 979,841	\$ -	\$ -	\$ 979,841	\$ 979,841	\$ 1,426,267	\$ 1,720,350	\$ 4,126,459	\$ 979,841	\$ 1,426,267	\$ 1,720,350	\$ 4,126,459	\$ 979,841	\$ 1,426,267	\$ 1,720,350	\$ 4,126,459
6	FY 33/34	157,070	3.5%	10%	10%	\$ 19,574,634	\$ 23,066,318	\$ 20,763,907	\$ 24,201,922	\$ 23,342,418	\$ 1,014,136	\$ -	\$ -	\$ 1,014,136	\$ 1,014,136	\$ -	\$ -	\$ 1,014,136	\$ 1,014,136	\$ 1,440,530	\$ 2,171,942	\$ 4,626,608	\$ 1,014,136	\$ 1,440,530	\$ 2,171,942	\$ 4,626,608	\$ 1,014,136	\$ 1,440,530	\$ 2,171,942	\$ 4,626,608
7	FY 34/35	158,640	3.5%	15%	15%	\$ 20,462,343	\$ 24,112,375	\$ 21,705,551	\$ 25,299,479	\$ 24,400,997	\$ 1,049,630	\$ -	\$ -	\$ 1,049,630	\$ 1,049,630	\$ -	\$ -	\$ 1,049,630	\$ 1,049,630	\$ 2,182,403	\$ 3,290,493	\$ 6,522,526	\$ 1,049,630	\$ 2,182,403	\$ 3,290,493	\$ 6,522,526	\$ 1,049,630	\$ 2,182,403	\$ 3,290,493	\$ 6,522,526
8	FY 35/36	160,227	3.5%	15%	15%	\$ 21,390,311	\$ 25,205,872	\$ 22,689,897	\$ 26,446,810	\$ 25,507,582	\$ 1,086,367	\$ -	\$ -	\$ 1,086,367	\$ 1,086,367	\$ -	\$ -	\$ 1,086,367	\$ 1,086,367	\$ 2,204,227	\$ 3,323,398	\$ 6,613,992	\$ 1,086,367	\$ 2,204,227	\$ 3,323,398	\$ 6,613,992	\$ 1,086,367	\$ 2,204,227	\$ 3,323,398	\$ 6,613,992
9	FY 36/37	161,829	3.5%	15%	15%	\$ 22,360,361	\$ 26,348,958	\$ 23,718,884	\$ 27,646,173	\$ 26,664,351	\$ 1,124,390	\$ -	\$ -	\$ 1,124,390	\$ 1,124,390	\$ -	\$ -	\$ 1,124,390	\$ 1,124,390	\$ 2,226,269	\$ 3,356,632	\$ 6,707,291	\$ 1,124,390	\$ 2,226,269	\$ 3,356,632	\$ 6,707,291	\$ 1,124,390	\$ 2,226,269	\$ 3,356,632	\$ 6,707,291
10	FY 37/38	163,447	3.5%	20%	25%	\$ 23,374,404	\$ 27,543,883	\$ 24,794,536	\$ 28,899,927	\$ 27,873,579	\$ 1,163,744	\$ -	\$ -	\$ 1,163,744	\$ 1,163,744	\$ -	\$ -	\$ 1,163,744	\$ 1,163,744	\$ 2,998,042	\$ 5,650,330	\$ 9,812,116	\$ 1,163,744	\$ 2,998,042	\$ 5,650,330	\$ 9,812,116	\$ 1,163,744	\$ 2,998,042	\$ 5,650,330	\$ 9,812,116
11	FY 38/29	165,082	3.5%	3%	3%	\$ 24,434,433	\$ 28,792,998	\$ 25,918,968	\$ 30,210,539	\$ 29,137,646	\$ 1,204,475	\$ -	\$ -	\$ 1,204,475	\$ 1,204,475	\$ -	\$ -	\$ 1,204,475	\$ 1,204,475	\$ 454,203	\$ 684,820	\$ 2,343,498	\$ 1,204,475	\$ 454,203	\$ 684,820	\$ 2,343,498	\$ 1,204,475	\$ 454,203	\$ 684,820	\$ 2,343,498
12	FY 39/40	166,733	3.5%	4%	3%	\$ 25,542,534	\$ 30,098,761	\$ 27,094,393	\$ 31,580,587	\$ 30,459,038	\$ 1,246,632	\$ -	\$ -	\$ 1,246,632	\$ 1,246,632	\$ -	\$ -	\$ 1,246,632	\$ 1,246,632	\$ 611,661	\$ 691,668	\$ 2,549,960	\$ 1,246,632	\$ 611,661	\$ 691,668	\$ 2,549,960	\$ 1,246,632	\$ 611,661	\$ 691,668	\$ 2,549,960
13	FY 40/41	168,400	3.5%	5%	4%	\$ 26,700,888	\$ 31,463,740	\$ 28,323,124	\$ 33,012,767	\$ 31,840,356	\$ 1,290,264	\$ -	\$ -	\$ 1,290,264	\$ 1,290,264	\$ -	\$ -	\$ 1,290,264	\$ 1,290,264	\$ 772,221	\$ 931,447	\$ 2,993,932	\$ 1,290,264	\$ 772,221	\$ 931,447	\$ 2,993,932	\$ 1,290,264	\$ 772,221	\$ 931,447	\$ 2,993,932
14	FY 41/42	170,084	3.5%	5%	5%	\$ 27,911,774	\$ 32,890,620	\$ 29,607,577	\$ 34,509,895	\$ 33,284,316	\$ 1,335,423	\$ -	\$ -	\$ 1,335,423	\$ 1,335,423	\$ -	\$ -	\$ 1,335,423	\$ 1,335,423	\$ 779,944	\$ 1,175,951	\$ 3,291,318	\$ 1,335,423	\$ 779,944	\$ 1,175,951	\$ 3,291,318	\$ 1,335,423	\$ 779,944	\$ 1,175,951	\$ 3,291,318
15	FY 42/43	171,785	3.5%	10%	8%	\$ 29,177,572	\$ 34,382,210	\$ 30,950,281	\$ 36,074,919	\$ 34,793,760	\$ 1,382,163	\$ -	\$ -	\$ 1,382,163	\$ 1,382,163	\$ -	\$ -	\$ 1,382,163	\$ 1,382,163	\$ 1,575,486	\$ 1,900,337	\$ 4,857,986	\$ 1,382,163	\$ 1,575,486	\$ 1,900,337	\$ 4,857,986	\$ 1,382,163	\$ 1,575,486	\$ 1,900,337	\$ 4,857,986
16	FY 43/44	173,503	3.5%	10%	10%	\$ 30,500,775	\$ 35,941,443	\$ 32,353,876	\$ 37,710,917	\$ 36,371,657	\$ 1,430,538	\$ -	\$ -	\$ 1,430,538	\$ 1,430,538	\$ -	\$ -	\$ 1,430,538	\$ 1,430,538	\$ 1,591,241	\$ 2,399,176	\$ 5,420,955	\$ 1,430,538	\$ 1,591,241	\$ 2,399,176	\$ 5,420,955	\$ 1,430,538	\$ 1,591,241	\$ 2,399,176	\$ 5,420,955
17	FY 44/45	175,238	3.5%	15%	15%	\$ 31,883,986	\$ 37,571,387	\$ 33,821,125	\$ 39,421,107	\$ 38,021,111	\$ 1,480,607	\$ -	\$ -	\$ 1,480,607	\$ 1,480,607	\$ -	\$ -	\$ 1,480,607	\$ 1,480,607	\$ 2,410,730	\$ 3,634,751	\$ 7,526,089	\$ 1,480,607	\$ 2,410,730	\$ 3,634,751	\$ 7,526,089	\$ 1,480,607	\$ 2,410,730	\$ 3,634,751	\$ 7,526,089
18	FY 45/46	176,990	3.5%	15%	15%	\$ 33,329,924	\$ 39,275,250	\$ 35,354,913	\$ 41,208,854	\$ 39,745,369	\$ 1,532,429	\$ -	\$ -	\$ 1,532,429	\$ 1,532,429	\$ -	\$ -	\$ 1,532,429	\$ 1,532,429	\$ 2,434,837	\$ 3,671,099	\$ 7,638,365	\$ 1,532,429	\$ 2,434,837	\$ 3,671,099	\$ 7,638,365	\$ 1,532,429	\$ 2,434,837	\$ 3,671,099	\$ 7,638,365
19	FY 46/47	178,760	3.5%	15%	15%	\$ 34,841,436	\$ 41,056,382	\$ 36,958,258	\$ 43,077,676	\$ 41,547,821	\$ 1,586,064	\$ -	\$ -	\$ 1,586,064	\$ 1,586,064	\$ -	\$ -	\$ 1,586,064	\$ 1,586,064	\$ 2,459,186	\$ 3,707,810	\$ 7,753,059	\$ 1,586,064	\$ 2,459,186	\$ 3,707,810	\$ 7,753,059	\$ 1,586,064	\$ 2,459,186	\$ 3,707,810	\$ 7,753,059
20	FY 47/48	180,547	3.5%	20%	25%	\$ 36,421,495	\$ 42,918,289	\$ 38,634,315	\$ 45,031,248	\$ 43,432,015	\$ 1,641,576	\$ -	\$ -	\$ 1,641,576	\$ 1,641,576	\$ -	\$ -	\$ 1,641,576	\$ 1,641,576	\$ 3,311,704	\$ 6,241,480	\$ 11,194,759	\$ 1,641,576	\$ 3,311,704	\$ 6,241,480	\$ 11,194,759	\$ 1,641,576	\$ 3,311,704	\$ 6,241,480	\$ 11,194,759
21	FY 48/49	182,353	3.5%	5%	3%	\$ 38,073,210	\$ 44,864,634	\$ 40,386,381	\$ 47,073,415	\$ 45,401,657	\$ 1,699,031	\$ -	\$ -	\$ 1,699,031	\$ 1,699,031	\$ -	\$ -	\$ 1,699,031	\$ 1,699,031	\$ 836,205	\$ 756,467	\$ 3,291,703	\$ 1,699,031	\$ 836,205	\$ 756,467	\$ 3,291,703	\$ 1,699,031	\$ 836,205	\$ 756,467	\$ 3,291,703
22	FY 49/50	184,176	3.5%	5%	4%	\$ 39,799,830	\$ 46,899,245	\$ 42,217,903	\$ 49,208,195	\$ 47,460,622	\$ 1,758,497	\$ -	\$ -	\$ 1,758,497	\$ 1,758,497	\$ -	\$ -	\$ 1,758,497	\$ 1,758,497	\$ 844,567	\$ 1,018,709	\$ 3,621,774	\$ 1,758,497	\$ 844,567	\$ 1,018,709	\$ 3,621,774	\$ 1,758,497	\$ 844,567	\$ 1,018,709	\$ 3,621,774
23	FY 50/51	186,018	3.5%	5%	5%	\$ 41,604,753	\$ 49,026,126	\$ 44,132,485	\$ 51,439,786	\$ 49,612,961	\$ 1,820,044	\$ -	\$ -	\$ 1,820,044	\$ 1,820,044	\$ -	\$ -	\$ 1,820,044	\$ 1,820,044	\$ 853,013	\$ 1,286,121	\$ 3,959,178	\$ 1,820,044	\$ 853,013	\$ 1,286,121	\$ 3,959,178	\$ 1,820,044	\$ 853,013	\$ 1,286,121	\$ 3,959,178
24	FY 51/52	187,878	3.5%	10%	8%	\$ 43,491,528	\$ 51,249,461	\$ 46,133,893	\$ 53,772,581	\$ 51,862,909	\$ 1,883,746	\$ -	\$ -	\$ 1,883,746	\$ 1,883,746	\$ -	\$ -	\$ 1,883,746	\$ 1,883,746	\$ 1,723,086	\$ 2,078,371	\$ 5,685,203	\$ 1,883,746	\$ 1,723,086	\$ 2,078,371	\$ 5,685,203	\$ 1,883,746	\$ 1,723,086	\$ 2,078,371	\$ 5,685,203
25	FY 52/53	189,757	3.5%	10%	10%	\$ 45,463,869	\$ 53,573,624	\$ 48,226,066	\$ 56,211,167	\$ 54,214,892	\$ 1,949,677	\$ -	\$ -	\$ 1,949,677	\$ 1,949,677	\$ -	\$ -	\$ 1,949,677	\$ 1,949,677	\$ 1,740,317	\$ 2,623,943	\$ 6,313,937	\$ 1,949,677	\$ 1,740,317	\$ 2,623,943	\$ 6,313,937	\$ 1,949,677	\$ 1,740,317	\$ 2,623,943	\$ 6,313,937

Cost Per Serviced Unit

Assumptions						Operating Costs Per Serviced Unit					Capital Costs - Status Quo Model				Capital Costs - Status Quo				Capital Costs - Option 1: Semi-Automated				Capital Costs - Option 2: Fully Automated				Capital Costs - Option 3: Hybrid Collection			
Year	FY	Number of Serviced Units	Inflation	Garbage Cart Replacement %	Recycling Cart Replacement %	Status Quo	Model Status Quo	Option 1: Semi-Automated	Option 2: Fully Automated	Option 3: Hybrid	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total	Green Cart	Garbage Cart	Recycling Cart	Total
1	FY 28/29	149,446	3.5%			\$ 105	\$ 124	\$ 111	\$ 130	\$ 125	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ 93	\$ 138	\$ 237	\$ 6	\$ 93	\$ 138	\$ 237	\$ 6	\$ 93	\$ 138	\$ 237
2	FY 29/30	150,941	3.5%	5%	3%	\$ 109	\$ 128	\$ 115	\$ 134	\$ 130	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ 5	\$ 4	\$ 15	\$ 6	\$ 5	\$ 4	\$ 15	\$ 6	\$ 5	\$ 4	\$ 15
3	FY 30/31	152,450	3.5%	5%	4%	\$ 112	\$ 132	\$ 119	\$ 139	\$ 134	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ 5	\$ 6	\$ 16	\$ 6	\$ 5	\$ 6	\$ 16	\$ 6	\$ 5	\$ 6	\$ 16
4	FY 31/32	153,975	3.5%	5%	5%	\$ 116	\$ 137	\$ 123	\$ 144	\$ 139	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ 5	\$ 7	\$ 18	\$ 6	\$ 5	\$ 7	\$ 18	\$ 6	\$ 5	\$ 7	\$ 18
5	FY 32/33	155,514	3.5%	10%	8%	\$ 120	\$ 142	\$ 128	\$ 149	\$ 144	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ 9	\$ 11	\$ 27	\$ 6	\$ 9	\$ 11	\$ 27	\$ 6	\$ 9	\$ 11	\$ 27
6	FY 33/34	157,070	3.5%	10%	10%	\$ 125	\$ 147	\$ 132	\$ 154	\$ 149	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ -	\$ -	\$ 6	\$ 6	\$ 9	\$ 14	\$ 29	\$ 6	\$ 9	\$ 14	\$ 29	\$ 6	\$ 9	\$ 14	\$ 29
7	FY 34/35	158,640	3.5%	15%	15%	\$ 129	\$ 152	\$ 137	\$ 159	\$ 154	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ 14	\$ 21	\$ 41	\$ 7	\$ 14	\$ 21	\$ 41	\$ 7	\$ 14	\$ 21	\$ 41
8	FY 35/36	160,227	3.5%	15%	15%	\$ 134	\$ 157	\$ 142	\$ 165	\$ 159	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ 14	\$ 21	\$ 41	\$ 7	\$ 14	\$ 21	\$ 41	\$ 7	\$ 14	\$ 21	\$ 41
9	FY 36/37	161,829	3.5%	15%	15%	\$ 138	\$ 163	\$ 147	\$ 171	\$ 165	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ 14	\$ 21	\$ 41	\$ 7	\$ 14	\$ 21	\$ 41	\$ 7	\$ 14	\$ 21	\$ 41
10	FY 37/38	163,447	3.5%	20%	25%	\$ 143	\$ 169	\$ 152	\$ 177	\$ 171	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ 18	\$ 35	\$ 60	\$ 7	\$ 18	\$ 35	\$ 60	\$ 7	\$ 18	\$ 35	\$ 60
11	FY 38/29	165,082	3.5%	3%	3%	\$ 148	\$ 174	\$ 157	\$ 183	\$ 177	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ 3	\$ 4	\$ 14	\$ 7	\$ 3	\$ 4	\$ 14	\$ 7	\$ 3	\$ 4	\$ 14
12	FY 39/40	166,733	3.5%	4%	3%	\$ 153	\$ 181	\$ 163	\$ 189	\$ 183	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ -	\$ -	\$ 7	\$ 7	\$ 4	\$ 4	\$ 15	\$ 7	\$ 4	\$ 4	\$ 15	\$ 7	\$ 4	\$ 4	\$ 15
13	FY 40/41	168,400	3.5%	5%	4%	\$ 159	\$ 187	\$ 168	\$ 196	\$ 189	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ 5	\$ 6	\$ 18	\$ 8	\$ 5	\$ 6	\$ 18	\$ 8	\$ 5	\$ 6	\$ 18
14	FY 41/42	170,084	3.5%	5%	5%	\$ 164	\$ 193	\$ 174	\$ 203	\$ 196	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ 5	\$ 7	\$ 19	\$ 8	\$ 5	\$ 7	\$ 19	\$ 8	\$ 5	\$ 7	\$ 19
15	FY 42/43	171,785	3.5%	10%	8%	\$ 170	\$ 200	\$ 180	\$ 210	\$ 203	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ 9	\$ 11	\$ 28	\$ 8	\$ 9	\$ 11	\$ 28	\$ 8	\$ 9	\$ 11	\$ 28
16	FY 43/44	173,503	3.5%	10%	10%	\$ 176	\$ 207	\$ 186	\$ 217	\$ 210	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ 9	\$ 14	\$ 31	\$ 8	\$ 9	\$ 14	\$ 31	\$ 8	\$ 9	\$ 14	\$ 31
17	FY 44/45	175,238	3.5%	15%	15%	\$ 182	\$ 214	\$ 193	\$ 225	\$ 217	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ -	\$ -	\$ 8	\$ 8	\$ 14	\$ 21	\$ 43	\$ 8	\$ 14	\$ 21	\$ 43	\$ 8	\$ 14	\$ 21	\$ 43
18	FY 45/46	176,990	3.5%	15%	15%	\$ 188	\$ 222	\$ 200	\$ 233	\$ 225	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ 14	\$ 21	\$ 43	\$ 9	\$ 14	\$ 21	\$ 43	\$ 9	\$ 14	\$ 21	\$ 43
19	FY 46/47	178,760	3.5%	15%	15%	\$ 195	\$ 230	\$ 207	\$ 241	\$ 232	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ 14	\$ 21	\$ 43	\$ 9	\$ 14	\$ 21	\$ 43	\$ 9	\$ 14	\$ 21	\$ 43
20	FY 47/48	180,547	3.5%	20%	25%	\$ 202	\$ 238	\$ 214	\$ 249	\$ 241	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ 18	\$ 35	\$ 62	\$ 9	\$ 18	\$ 35	\$ 62	\$ 9	\$ 18	\$ 35	\$ 62
21	FY 48/49	182,353	3.5%	5%	3%	\$ 209	\$ 246	\$ 221	\$ 258	\$ 249	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ -	\$ -	\$ 9	\$ 9	\$ 5	\$ 4	\$ 18	\$ 9	\$ 5	\$ 4	\$ 18	\$ 9	\$ 5	\$ 4	\$ 18
22	FY 49/50	184,176	3.5%	5%	4%	\$ 216	\$ 255	\$ 229	\$ 267	\$ 258	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ 5	\$ 6	\$ 20	\$ 10	\$ 5	\$ 6	\$ 20	\$ 10	\$ 5	\$ 6	\$ 20
23	FY 50/51	186,018	3.5%	5%	5%	\$ 224	\$ 264	\$ 237	\$ 277	\$ 267	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ 5	\$ 7	\$ 21	\$ 10	\$ 5	\$ 7	\$ 21	\$ 10	\$ 5	\$ 7	\$ 21
24	FY 51/52	187,878	3.5%	10%	8%	\$ 231	\$ 273	\$ 246	\$ 286	\$ 276	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ 9	\$ 11	\$ 30	\$ 10	\$ 9	\$ 11	\$ 30	\$ 10	\$ 9	\$ 11	\$ 30
25	FY 52/53	189,757	3.5%	10%	10%	\$ 240	\$ 282	\$ 254	\$ 296	\$ 286	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ -	\$ -	\$ 10	\$ 10	\$ 9	\$ 14	\$ 33	\$ 10	\$ 9	\$ 14	\$ 33	\$ 10	\$ 9	\$ 14	\$ 33

Appendix B

Detailed Financial Analysis

Cart Costs

The assumptions for cart costs are provided below. **Table B 1** provides the expected costs per cart in 2028. **Table B 2** outlines the distribution of carts expected for this assignment and **Table B 3** provides a breakdown of costs.

Table B 1: Expected 2028 Cart Costs

Cart Size	Cost per Cart
120 L	\$42.13
240 L	\$75.39
360 L (split cart)	\$121.96

Table B 2: 2028 Assumptions for Cart Distribution

Cart Size	Garbage	Recycling	Organics	Assumptions
120 L	2%	0%	0%	-
240 L	98%	0%	0%	Assume garbage carts initially issued are 240 L and 120 L for accessibility
360 L	0%	100%	0%	Assume recycling carts initially issued are 360 L
Total %	100%	100%	0%	-

Table B 3: 2028 Cart Cost Breakdown

	Unit Cost	All Waste Streams		Assumptions
		# of carts	\$ of carts	
Carts - 120 L	\$42.13	5,978	\$251,858	
Carts - 240 L	\$75.39	149,446	\$11,267,186	
Carts - 360 L	\$121.96	149,446	\$18,226,322	
Kitchen Catcher	\$3.88	0	\$0	Assumed not needed for this assignment
Costs for Shipping	\$10.00	304,871	\$3,048,707	Shipping costs are estimated. Actual costs will vary based on number of truckloads required to ship all units and supplier. Costs for shipping is for carts for two streams.
Costs for Assembly and Delivery	\$6.00	304,871	\$1,829,224	
Total (rounded to nearest \$5,000)			\$34,625,000	

Capital and Operational Costs

Operational costs per option are provided in **Table B 4** to **B 7**. An additional breakdown of garbage/organics and recycling costs are provided in **Table B 8**. Tables **B 9** to **Table B 12** provide the number of collection vehicles used in each analysis.

Table B 4: Estimated Costs for Modelled Status Quo

	All Waste Streams	
	No. of Units	Total Cost
Capital Costs		
Estimated Cart Costs		
Total Cart Costs	0	\$0
Organics Costs	1	\$853,875
Internal Advertising	0	\$0
Capital Costs		\$853,875
Capital Costs (rounded)	-	\$855,000
Estimated Operation Costs		
Area 1		\$3,682,845
Area 2		\$2,925,755
Area 3		\$1,762,332
Area 4		\$2,407,205
Area 5		\$2,838,432
Area 6		\$2,083,378
Area 7		\$1,649,441
Area 8		\$2,243,085
Estimated Program Costs	-	\$19,592,472
Ongoing Costs for year 1		\$20,446,347
Ongoing Costs for year 1 (rounded)	-	\$20,445,000
TOTAL (Initial Capital + Annual costs for year 1)	-	\$21,300,000

Table B 5: Estimated Costs for Option 1: Semi-Automated Collection

	All Waste Streams	
	No. of Units	Total Cost
Capital Costs		
Estimated Cart Costs		
Total Cart Costs	0	\$34,625,000
Organics Costs		\$853,875
Internal Advertising	1	\$200,000
Capital Costs		\$35,678,875
Capital Costs (rounded)	-	\$35,680,000
Estimated Operation Costs		
Area 1		\$4,240,868
Area 2		\$3,432,196
Area 3		\$2,343,437
Area 4		\$2,428,083
Area 5		\$3,432,196
Area 6		\$1,982,398
Area 7		\$1,757,420
Area 8		\$2,210,644
Estimated Program Costs	-	\$21,827,242
Ongoing Costs for year 1		\$57,506,117
Ongoing Costs for year 1 (rounded)	-	\$57,505,000
TOTAL (Initial Capital + Annual costs for year 1)	-	\$93,185,000

Table B 6: 2028 Estimated Costs for Option 2: Fully Automated Collection

	All Waste Streams	
	No. of Units	Total Cost
Capital Costs		
Estimated Cart Costs		
Total Cart Costs	0	\$34,625,000
Organics Costs		\$853,875
Internal Advertising	1	\$200,000
Capital Costs		\$35,678,875
Capital Costs (rounded)	-	\$35,680,000
Estimated Operation Costs		
Area 1		\$3,502,129
Area 2		\$2,577,528
Area 3		\$2,061,105
Area 4		\$2,505,541
Area 5		\$3,034,510
Area 6		\$2,225,489
Area 7		\$1,725,341
Area 8		\$1,812,874
Estimated Program Costs	-	\$19,444,517
Ongoing Costs for year 1		\$55,123,392
Ongoing Costs for year 1 (rounded)	-	\$55,125,000
TOTAL (Initial Capital + Annual costs for year 1)	-	\$90,805,000

Table B 7: 2028 Estimated Costs for Option 3: Hybrid Collection

All Waste Streams		
	No. of Units	Total Cost
Capital Costs		
Estimated Cart Costs		
Total Cart Costs	0	\$34,625,000
Organics Costs		\$853,875
Internal Advertising	1	\$200,000
Capital Costs		\$35,678,875
Capital Costs (rounded)	-	\$35,680,000
Estimated Operation Costs		
Area 1		\$3,503,385
Area 2		\$2,549,868
Area 3		\$1,998,679
Area 4		\$2,398,062
Area 5		\$3,128,645
Area 6		\$2,180,611
Area 7		\$1,640,328
Area 8		\$1,773,633
Estimated Program Costs	-	\$19,173,210
Ongoing Costs for year 1		\$54,852,085
Ongoing Costs for year 1 (rounded)	-	\$54,850,000
TOTAL (Initial Capital + Annual costs for year 1)	-	\$90,530,000

Table B 8: Breakdown of Operational Costs Per Waste Stream

Waste Stream	Modelled Status Quo	Option 1	Option 2	Option 3
Garbage/ Organics	\$12,546,411	\$12,931,479	\$10,921,932	\$10,765,912
Recycling	\$7,046,062	\$8,895,763	\$8,522,585	\$8,407,298
Total	\$19,592,472	\$21,827,242	\$19,444,517	\$19,173,210

Table B 9: Operational Cost Assumptions Modelled Status Quo

Area	Number of Collection Vehicles (Garbage/Organics)	Number of Collection Vehicles (Recycling)	Number of Spare Vehicles*	FTE Per Vehicle
Area 1	7	6	3	1.5
Area 2	5	5	3	1.5
Area 3	2	4	2	1.5
Area 4	4	4	3	1.5
Area 5	5	5	2	1.5

Area	Number of Collection Vehicles (Garbage/Organics)	Number of Collection Vehicles (Recycling)	Number of Spare Vehicles*	FTE Per Vehicle
Area 6	3	4	3	1.5
Area 7	3	3	2	1.5
Area 8	4	4	4	1.5

*spare vehicles used for bulky waste and spares

Table B 10: Operational Cost Assumptions Option 1: Semi Automated

Area	Number of Collection Vehicles (Garbage/Organics)	Number of Collection Vehicles (Recycling)	Number of Spare Vehicles*	FTE Per Vehicle
Area 1	8	7	5	1
Area 2	6	6	4	1
Area 3	4	4	3	1
Area 4	4	4	3	1
Area 5	6	6	4	1
Area 6	3	4	2	1
Area 7	3	3	2	1
Area 8	4	4	2	1

*spare vehicles used for bulky waste and spares

Table B 11: Operational Cost Assumptions Option 2: Automated

Area	Number of Collection Vehicles (Garbage/Organics)	Number of Collection Vehicles (Recycling)	Number of Spare Vehicles	FTE Per Vehicle
Area 1	5	4	4	1
Area 2	3	3	2	1
Area 3	2	2	2	1
Area 4	3	3	3	1
Area 5	4	3	2	1
Area 6	3	3	3	1
Area 7	3	2	2	1
Area 8	4	3	3	1

*spare vehicles used for bulky waste and spares

Table B 12: Operational Cost Assumptions Option 3: Hybrid

Area	Number of Collection Vehicles (Garbage/Organics)	Number of Collection Vehicles (Recycling)	Number of Spare Vehicles*	FTE Per Vehicle
Area 1	5	5	4	1
Area 2	3	3	3	1
Area 3	2	2	2	1
Area 4	3	3	3	1
Area 5	5	4	2	1
Area 6	3	3	4	1
Area 7	3	2	2	1
Area 8	4	3	4	1

*spare vehicles used for bulky waste and spares

Appendix C

Net Present Value Calculations

$$NPV = \frac{Cash\ Flow_1}{(1+r)^1} + \frac{Cash\ Flow_2}{(1+r)^2} + \frac{Cash\ Flow_n}{(1+r)^n} - Initial\ Investment$$

DISCOUNT RATE5.00%

NPV: Net Present Value

DCFV: Discounted Cash Flow Valuation

Lifecycle Costing	Negative Cash Flows				Positive Cash Flows			
	Operating Cost (Today's \$)				Revenue (Today's \$)			
Lifecycle Replacements (Building and Site Elements)								
	Modelled Status Quo	Option 1: Fully Automated Collection	Option 2: Semi-Automated Collection	Option 3: Hybrid Collection	Modelled Status Quo	Option 1: Fully Automated Collection	Option 2: Semi-Automated Collection	Option3: Hybrid Collection
Year								
2024	\$17,073,708	\$19,021,181	\$16,944,773	\$16,708,345	\$0	\$0	\$0	\$0
2025	\$17,244,445	\$19,211,393	\$17,114,221	\$16,875,429	\$0	\$0	\$0	\$0
2026	\$17,416,889	\$19,403,507	\$17,285,363	\$17,044,183	\$0	\$0	\$0	\$0
2027	\$17,591,058	\$19,597,542	\$17,458,216	\$17,214,625	\$0	\$0	\$0	\$0
2028	\$17,766,969	\$19,793,517	\$17,632,799	\$17,386,771	\$0	\$0	\$0	\$0
2029	\$17,944,638	\$19,991,452	\$17,809,126	\$17,560,639	\$0	\$0	\$0	\$0
2030	\$18,124,085	\$20,191,367	\$17,987,218	\$17,736,245	\$0	\$0	\$0	\$0
2031	\$18,305,326	\$20,393,280	\$18,167,090	\$17,913,608	\$0	\$0	\$0	\$0
2032	\$18,488,379	\$20,597,213	\$18,348,761	\$18,092,744	\$0	\$0	\$0	\$0
2033	\$18,673,263	\$20,803,185	\$18,532,248	\$18,273,671	\$0	\$0	\$0	\$0
2034	\$18,859,995	\$21,011,217	\$18,717,571	\$18,456,408	\$0	\$0	\$0	\$0
2035	\$19,048,595	\$21,221,329	\$18,904,747	\$18,640,972	\$0	\$0	\$0	\$0
2036	\$19,239,081	\$21,433,543	\$19,093,794	\$18,827,382	\$0	\$0	\$0	\$0
2037	\$19,431,472	\$21,647,878	\$19,284,732	\$19,015,655	\$0	\$0	\$0	\$0
2038	\$19,625,787	\$21,864,357	\$19,477,579	\$19,205,812	\$0	\$0	\$0	\$0
2039	\$19,822,045	\$22,083,000	\$19,672,355	\$19,397,870	\$0	\$0	\$0	\$0
2040	\$20,020,265	\$22,303,830	\$19,869,079	\$19,591,849	\$0	\$0	\$0	\$0
2041	\$20,220,468	\$22,526,869	\$20,067,770	\$19,787,767	\$0	\$0	\$0	\$0
2042	\$20,422,672	\$22,752,137	\$20,268,447	\$19,985,645	\$0	\$0	\$0	\$0
2043	\$20,626,899	\$22,979,659	\$20,471,132	\$20,185,501	\$0	\$0	\$0	\$0
2044	\$20,833,168	\$23,209,455	\$20,675,843	\$20,387,356	\$0	\$0	\$0	\$0
2045	\$21,041,500	\$23,441,550	\$20,882,601	\$20,591,230	\$0	\$0	\$0	\$0
2046	\$21,251,915	\$23,675,965	\$21,091,427	\$20,797,142	\$0	\$0	\$0	\$0
2047	\$21,464,434	\$23,912,725	\$21,302,342	\$21,005,114	\$0	\$0	\$0	\$0
2048	\$21,679,078	\$24,151,852	\$21,515,365	\$21,215,165	\$0	\$0	\$0	\$0
2049	\$21,895,869	\$24,393,371	\$21,730,519	\$21,427,317	\$0	\$0	\$0	\$0
2050	\$22,114,828	\$24,637,305	\$21,947,824	\$21,641,590	\$0	\$0	\$0	\$0
2051	\$22,335,976	\$24,883,678	\$22,167,302	\$21,858,006	\$0	\$0	\$0	\$0

*Revenues can not be estimated at this time due to the uncertainty involved with the EPR program and contract structure in the years to come.

Results of NPV Calculation	
Options	NPV
Modelled Status Quo	-\$ 283,544,118
Option 1: Fully Automated Collection	-\$ 347,530,907
Option 2: Semi-Automated Collection	-\$ 313,117,192
Option 3: Hybrid Collection	-\$ 309,198,718

Results of NPV Calculation (ROUNDED)	
Options	NPV
Modelled Status Quo	-\$ 283,544,100
Option 1: Fully Automated Collection	-\$ 347,530,900
Option 2: Semi-Automated Collection	-\$ 313,117,200
Option 3: Hybrid Collection	-\$ 309,198,700

Options											
Modelled Status Quo			Option 1: Fully Automated Collection			Option 2: Semi-Automated Collection			Option 3: Hybrid Collection		
Initial Investment:	\$ 570,000.00	DCFV	Initial Investment:	\$ 32,280,000.00	DCFV	Initial Investment:	\$ 32,280,000.00	DCFV	Initial Investment:	\$ 32,280,000.00	DCFV
Cash Flow Year 1	-\$17,073,708	\$ 17,073,707.75	Cash Flow Year 1	-\$19,021,181	\$ 19,021,180.77	Cash Flow Year 1	-\$16,944,773	\$ 16,944,772.79	Cash Flow Year 1	-\$16,708,345	\$ 16,708,345.23
Cash Flow Year 2	-\$17,244,445	\$ 17,244,444.83	Cash Flow Year 2	-\$19,211,393	\$ 19,211,392.57	Cash Flow Year 2	-\$17,114,221	\$ 17,114,220.52	Cash Flow Year 2	-\$16,875,429	\$ 16,875,428.69
Cash Flow Year 3	-\$17,416,889	\$ 17,416,889.28	Cash Flow Year 3	-\$19,403,507	\$ 19,403,506.50	Cash Flow Year 3	-\$17,285,363	\$ 17,285,362.72	Cash Flow Year 3	-\$17,044,183	\$ 17,044,182.97
Cash Flow Year 4	-\$17,591,058	\$ 14,472,207.09	Cash Flow Year 4	-\$19,597,542	\$ 16,122,945.95	Cash Flow Year 4	-\$17,458,216	\$ 14,362,917.80	Cash Flow Year 4	-\$17,214,625	\$ 14,162,514.43
Cash Flow Year 5	-\$17,766,969	\$ 13,920,884.92	Cash Flow Year 5	-\$19,793,517	\$ 15,508,738.48	Cash Flow Year 5	-\$17,632,799	\$ 13,815,759.02	Cash Flow Year 5	-\$17,386,771	\$ 13,622,990.07
Cash Flow Year 6	-\$17,944,638	\$ 13,390,565.49	Cash Flow Year 6	-\$19,991,452	\$ 14,917,929.40	Cash Flow Year 6	-\$17,809,126	\$ 13,289,444.39	Cash Flow Year 6	-\$17,560,639	\$ 13,104,019.02
Cash Flow Year 7	-\$18,124,085	\$ 12,880,448.71	Cash Flow Year 7	-\$20,191,367	\$ 14,349,627.32	Cash Flow Year 7	-\$17,987,218	\$ 12,783,179.84	Cash Flow Year 7	-\$17,736,245	\$ 12,604,818.29
Cash Flow Year 8	-\$18,305,326	\$ 12,389,764.95	Cash Flow Year 8	-\$20,393,280	\$ 13,802,974.85	Cash Flow Year 8	-\$18,167,090	\$ 12,296,201.56	Cash Flow Year 8	-\$17,913,608	\$ 12,124,634.74
Cash Flow Year 9	-\$18,488,379	\$ 11,917,773.91	Cash Flow Year 9	-\$20,597,213	\$ 13,277,147.24	Cash Flow Year 9	-\$18,348,761	\$ 11,827,774.84	Cash Flow Year 9	-\$18,092,744	\$ 11,662,743.89
Cash Flow Year 10	-\$18,673,263	\$ 11,463,763.47	Cash Flow Year 10	-\$20,803,185	\$ 12,771,351.16	Cash Flow Year 10	-\$18,532,248	\$ 11,377,192.94	Cash Flow Year 10	-\$18,273,671	\$ 11,218,448.89
Cash Flow Year 11	-\$18,859,995	\$ 11,027,048.67	Cash Flow Year 11	-\$21,011,217	\$ 12,284,823.49	Cash Flow Year 11	-\$18,717,571	\$ 10,943,776.07	Cash Flow Year 11	-\$18,456,408	\$ 10,791,079.41
Cash Flow Year 12	-\$19,048,595	\$ 10,606,970.63	Cash Flow Year 12	-\$21,221,329	\$ 11,816,830.22	Cash Flow Year 12	-\$18,904,747	\$ 10,526,870.31	Cash Flow Year 12	-\$18,640,972	\$ 10,379,990.67
Cash Flow Year 13	-\$19,239,081	\$ 10,202,895.56	Cash Flow Year 13	-\$21,433,543	\$ 11,366,665.26	Cash Flow Year 13	-\$19,093,794	\$ 10,125,846.68	Cash Flow Year 13	-\$18,827,382	\$ 9,984,562.45
Cash Flow Year 14	-\$19,431,472	\$ 9,814,213.82	Cash Flow Year 14	-\$21,647,878	\$ 10,933,649.44	Cash Flow Year 14	-\$19,284,732	\$ 9,740,100.14	Cash Flow Year 14	-\$19,015,655	\$ 9,604,198.17
Cash Flow Year 15	-\$19,625,787	\$ 9,440,339.01	Cash Flow Year 15	-\$21,864,357	\$ 10,517,129.46	Cash Flow Year 15	-\$19,477,579	\$ 9,369,048.71	Cash Flow Year 15	-\$19,205,812	\$ 9,238,323.95
Cash Flow Year 16	-\$19,822,045	\$ 9,080,707.05	Cash Flow Year 16	-\$22,083,000	\$ 10,116,476.91	Cash Flow Year 16	-\$19,672,355	\$ 9,012,132.56	Cash Flow Year 16	-\$19,397,870	\$ 8,886,387.80
Cash Flow Year 17	-\$20,020,265	\$ 8,734,775.35	Cash Flow Year 17	-\$22,303,830	\$ 9,731,087.31	Cash Flow Year 17	-\$19,869,079	\$ 8,668,813.23	Cash Flow Year 17	-\$19,591,849	\$ 8,547,858.74
Cash Flow Year 18	-\$20,220,468	\$ 8,402,022.00	Cash Flow Year 18	-\$22,526,869	\$ 9,360,379.22	Cash Flow Year 18	-\$20,067,770	\$ 8,338,572.73	Cash Flow Year 18	-\$19,787,767	\$ 8,222,226.03
Cash Flow Year 19	-\$20,422,672	\$ 8,081,944.97	Cash Flow Year 19	-\$22,752,137	\$ 9,003,793.35	Cash Flow Year 19	-\$20,268,447	\$ 8,020,912.81	Cash Flow Year 19	-\$19,985,645	\$ 7,908,998.37
Cash Flow Year 20	-\$20,626,899	\$ 7,774,061.36	Cash Flow Year 20	-\$22,979,659	\$ 8,660,791.70	Cash Flow Year 20	-\$20,471,132	\$ 7,715,354.23	Cash Flow Year 20	-\$20,185,501	\$ 7,607,703.19
Cash Flow Year 21	-\$20,833,168	\$ 7,477,906.64	Cash Flow Year 21	-\$23,209,455	\$ 8,330,856.77	Cash Flow Year 21	-\$20,675,843	\$ 7,421,435.97	Cash Flow Year 21	-\$20,387,356	\$ 7,317,885.93
Cash Flow Year 22	-\$21,041,500	\$ 7,193,034.00	Cash Flow Year 22	-\$23,441,550	\$ 8,013,490.80	Cash Flow Year 22	-\$20,882,601	\$ 7,138,714.60	Cash Flow Year 22	-\$20,591,230	\$ 7,039,109.32
Cash Flow Year 23	-\$21,251,915	\$ 6,919,013.66	Cash Flow Year 23	-\$23,675,965	\$ 7,708,214.96	Cash Flow Year 23	-\$21,091,427	\$ 6,866,763.57	Cash Flow Year 23	-\$20,797,142	\$ 6,770,952.78
Cash Flow Year 24	-\$21,464,434	\$ 6,655,432.19	Cash Flow Year 24	-\$23,912,725	\$ 7,414,568.68	Cash Flow Year 24	-\$21,302,342	\$ 6,605,172.58	Cash Flow Year 24	-\$21,005,114	\$ 6,513,011.72
Cash Flow Year 25	-\$21,679,078	\$ 6,401,891.91	Cash Flow Year 25	-\$24,151,852	\$ 7,132,108.92	Cash Flow Year 25	-\$21,515,365	\$ 6,353,546.95	Cash Flow Year 25	-\$21,215,165	\$ 6,264,896.99
Cash Flow Year 26	-\$21,895,869	\$ 6,158,010.32	Cash Flow Year 26	-\$24,393,371	\$ 6,860,409.53	Cash Flow Year 26	-\$21,730,519	\$ 6,111,507.07	Cash Flow Year 26	-\$21,427,317	\$ 6,026,234.24
Cash Flow Year 27	-\$22,114,828	\$ 5,923,419.45	Cash Flow Year 27	-\$24,637,305	\$ 6,599,060.60	Cash Flow Year 27	-\$21,947,824	\$ 5,878,687.75	Cash Flow Year 27	-\$21,641,590	\$ 5,796,663.42
Cash Flow Year 28	-\$22,335,976	\$ 5,697,765.37	Cash Flow Year 28	-\$24,883,678	\$ 6,347,667.81	Cash Flow Year 28	-\$22,167,302	\$ 5,654,737.74	Cash Flow Year 28	-\$21,858,006	\$ 5,575,838.14

NPV	-\$ 283,544,118.17
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NPV	-\$ 347,530,906.92
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NPV	-\$ 313,117,191.68
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NPV	-\$ 309,198,717.76
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