

Automated Cart Recycling: A Study of Municipal Collection and Operations in Ontario

CIF Project 888

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1 Introduction

Automated collection of waste has been developing in North America for the last 30 years. The evolution of solid waste collection, with the focus on vehicles, has been driven by an overwhelming desire to collect more waste for less money, as well as lessening the physical demands on waste management workers.



In Ontario, residential waste management and recycling services are mandated by the provincial government under Ontario Regulation 101/94: Recycling and Composting of Municipal Waste. This Regulation stipulates the need for municipalities, with at least 5,000 population in Southern Ontario and 15,000 in Northern Ontario, to establish a recycling program and leaf and yard waste diversion program.

Each municipality must source separate designated recyclable materials but is permitted to develop its own collection approach, which could include: curbside collection or depot drop-off. Municipalities can use a range of approaches and policies to drive diversion and cost efficiencies, including pay-as-you-throw, clear bags, co-collection, or any combination of these elements as long as the program is in compliance with the requirements of the Environmental Protection Act.

Ontario municipalities regulate waste management and recycling activities mainly through by-laws. These by-laws impact residential waste collection and can for example:

- Set limits for the amount of garbage that can be generated by residents;
- Require the recycling of materials (beyond mandatory legislation);
- Determine fees for waste collection service (e.g. bag tags); and
- Set landfill bans (restrict what materials can be landfilled).

Further, municipalities can determine the approach to:

- Set-out requirements for recycling/Blue Box materials (one-stream, dual/two-stream, or more streams);
- Frequency of collection (weekly, bi-weekly, alternate weeks, or depot); and
- Special needs and/or exemptions for unique demographics.

Currently 16 municipalities throughout Canada and 27 in the United States have adopted automated cart (auto-cart) collection¹. While automated cart collection programs are becoming common place in the United States, fewer than 10 municipalities in Ontario have switched from manual curbside collection to auto-cart curbside collection. This study aims answer questions directed at Municipal staff in Ontario about the merits of this approach.

The composition of Ontario Blue Box recyclables has changed over the past decade due to the packaging shifts (i.e. glass to plastic) increases in plastic packaging, and lightweight packaging (see Section 5.1). Further, the growing recycling market has allowed municipalities to increase the number of recyclable items allowed in the Blue Box program. As a result of these market shifts and program changes, multiple blue boxes are often required to meet the storage needs of typical Ontario households. Many municipalities have provided larger blue boxes (from 16 gallon to 22 gallon) in order to meet storage capacity, mainly for containers. Carts may

¹ Waste Collection Contract. July 06, 2015. Richmond Hill staff report to Committee Of The Whole Meeting

provide an alternative means of increasing storage capacity and encouraging participation in recycling programs.

Auto-cart collection programs have become synonymous with single stream recycling collection and as a result proponents of single stream collection often confuse the benefits of auto-cart collection with those of single stream collection. This report endeavours to de-tangle the two issues.

Deciding whether to transition from a manual curbside collection system to an automated (fully automated collection, no handling involved) or semi-automated (crew required to bring the cart to the equipment on the vehicle that tips the cart) cart system can be a challenging task with several factors to consider.



Automated collection in the City of Guelph

Source: <http://www.guelphmercury.com/news-story/2790723-challenges-encountered-on-first-day-of-guelph-waste-cart-pick-up/>



Semi-automated collection in the City of Toronto

<http://www.theglobeandmail.com/news/toronto/winning-bidder-for-toronto-garbage-contract-no-stranger-to-controversy/article559012/>

2 Study Overview

2.1 Purpose of Study

The purpose of the study is to explore the core topics surrounding implementation of automated carts and to discuss whether its costs are balanced out by the intended main benefits such as:

- Improved collection efficiency (and reduced cost);
- Reduced claims and costs associated with worker health and safety; and
- Increased participation and diversion.

Ontario municipalities (there are 444) provide residential waste and, in most cases, recycling services utilizing resources and policies, resulting in waste and recycling programs that are unique. This study is intended to provide an overview on issues and situations that local municipalities may wish to consider whilst evaluating the implementation of an auto-cart system. It is not intended to provide specific recommendations but rather a process for thoughtful deliberation and analysis of compatibility with local conditions.

2.2 Report Outline

Auto-cart programs have a variety of interrelated and connected issues. For the purposes of this report they have been organized into the following sections / topics:

Section 5 - Collection Design Considerations

Section 6 - Operations, including:

- Collection Efficiency and Challenges
- Processing Implications

Section 7 - Financial Implications

Section 8 - Resident Feedback

Section 9 - Program Planning and Implementation

Section 10 - Promotion and Education

Section 11 - Impact on Recycling

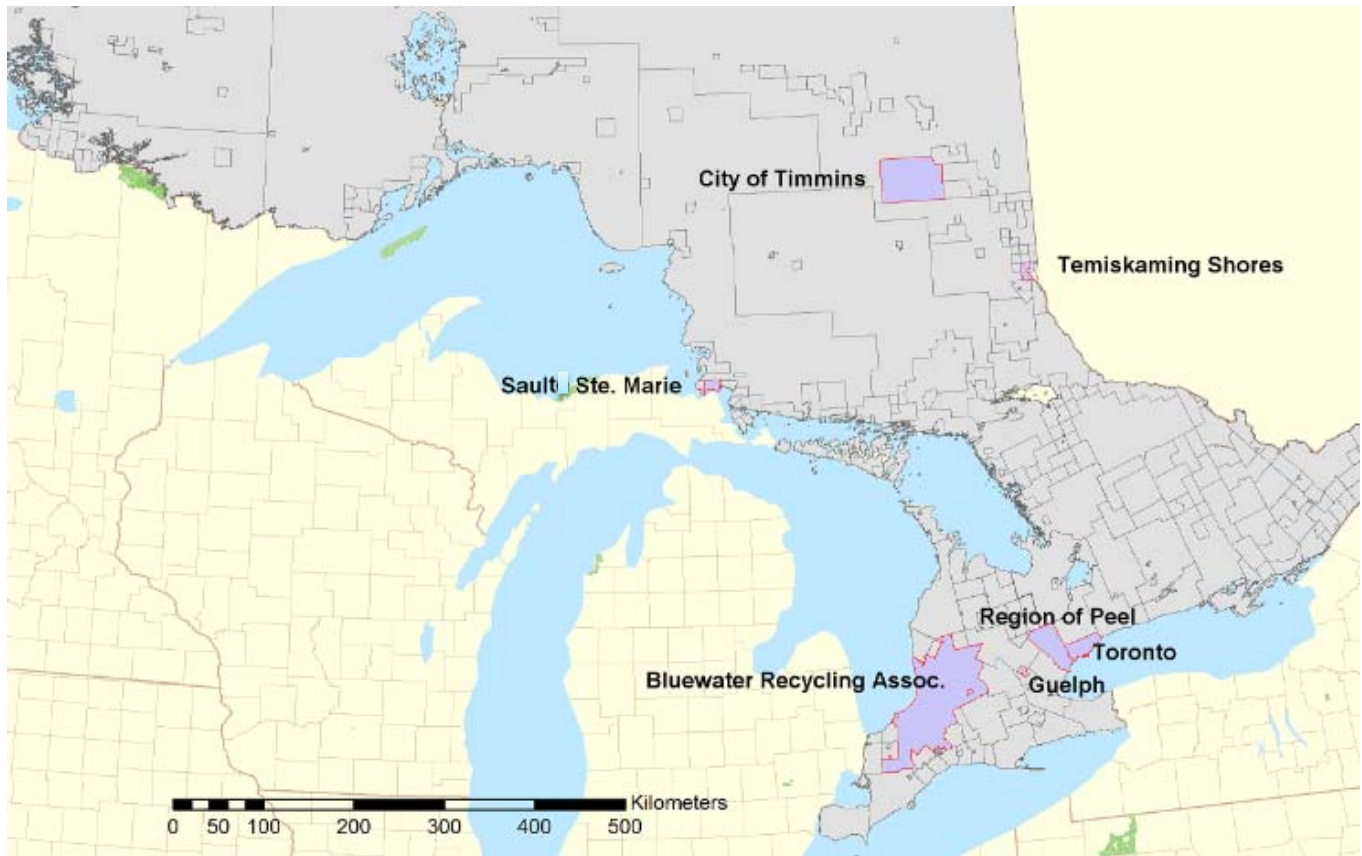
Section 12 – Summary of Key Findings, Core Considerations, and Conclusions

A Municipal Auto-Cart Evaluation List is provided in Section 13. This list is designed to help identify some of the many variables that should be calculated by each municipality during the decision making process.

3 Surveyed Municipalities

This report highlights the experiences of seven Ontario municipalities (see Figure 1) that currently have, or are planning on executing, an auto-cart program.

Figure 1: Map of Ontario Municipalities Surveyed



Six municipalities employ carts for the curbside collection of recyclable materials. The Region of Peel, a seventh municipality, conducted extensive piloting in 2012/2013 of comparative programs (bag limits, weekly vs. bi-weekly collection, automated carts) and has moved forward in January 2016 with the implementation of an auto-cart collection system.

4 Methodology

Information and data regarding automated cart programs were obtained using three distinct approaches:

1. A municipal survey of seven auto-cart municipalities in Ontario;
2. A literature review; and
3. An analysis of WDO Datacall information.

4.1 Municipal Survey

Seven municipalities were sent an extensive survey to gain insight into the merits and challenges associated with the implementation and operation of the auto-cart program. The survey elicited information about program costs, WSIB impacts, operational costs and attainment of municipal goals with respect to automated cart implementation.

The surveys captured insights into issues concerning: ease of use, accommodating groups with special needs, weather (e.g., heavy snow accumulation) and geographical conditions (e.g. high density housing, parked cars) and the viability and cost of operating an auto-cart collection system with an overall goal of quantifying and qualifying the benefits and/or drawbacks of the automated cart usage.

The municipalities surveyed represent a diverse group of varying population, geography, and demographics. Respondents to the survey also represent a balance of both direct municipal and contracted collection systems. It should be noted that only one municipality (Sault Saint Marie) was utilizing carts for recycling only. All of the other municipalities had integrated carts into the entire waste management system. Key municipality characteristics of the seven municipalities and recycling program highlights are summarized in Table 1. A summary of survey results is provided in Appendix A.

4.2 Literature Review

In addition to the municipal survey, a literature review was conducted based on reports available online and from the Continuous Improvement Fund (CIF). This included several reports submitted to CIF by Ontario municipalities as part of funding received to help transition to an auto-cart program. The literature review not only augmented the information captured through the surveys but documented perspectives from other jurisdictions. The majority of this study is based on experience reported by municipalities disclosed during the Ontario survey.

4.3 WDO Datacall Information

For the last 10 years in Ontario, the WDO has required Ontario municipalities to complete the annual Municipal Datacall in order to be eligible for funding through the Ontario Blue Box Program Plan. The Datacall tracks residential waste diversion statistics and trends across the province. Participating municipalities input program tonnage and operating costs, and tonnes collected of recycling, garbage, organics, electronics, household hazardous waste, and other recyclables such as scrap metal. For the purposes of this report, pre and post automated cart implementation program data was reviewed to determine program impacts (see Appendix B).

Table 1: Ontario Municipalities with Auto-Cart Programs

	Bluewater Recycling Association	Guelph	Temiskaming Shores	Timmins	Sault Ste. Marie	Toronto	Region of Peel
Baseline	Membership based municipal association (22 municipalities) ~ 71,000 households with 56,000 carts in service. Cart expansion based on member acceptance. 5% seasonal residents	Single tier municipality Population 127,000 29,500 single family households (hhlds) 40% Multi-Residential	Single tier municipality Population 10,400 4,400 single family hhlds 27% Multi-Residential	Single tier municipality Population 43,000 18,500 single family hhlds 10% Multi-Residential	Single tier municipality Population 75,00 26,000 single family hhlds 20% Multi-Residential	Large single tier municipality Population of 2.79 million 450,000 single family hhlds 50% Multi-Residential	Large two-tier municipality Population 1.35 million 330,000 single family hhlds 22% Multi-Residential
Setting	Small urban / rural mix Located in south-western Ontario	Medium urban Located in south-central Ontario	Small urban Located in north eastern Ontario	Medium urban Located in north eastern Ontario	Medium urban Located in north central Ontario	Very Large urban	Large urban / rural mix. Located in the Greater Toronto Area
Municipal or contract collection	Municipal Association	Municipal	Contractor	Municipal	Contractor (recycling), garbage split model, contract and municipal	Collection by districts, some municipal some contractor	Contractor
Recycling stream	Single Stream	Single Stream	Single Stream	Single Stream	Two / Dual Stream	Single Stream	Single Stream
Waste stream	Recycling and garbage	Recycling, garbage, and organics	Recycling and garbage	Recycling and garbage	Recycling only	Recycling, garbage, and organics	Recycling, garbage, and organics
Date of Conversion	Started in 2008, 80% complete in 2015	2012-2014; one third converted each year	September 2014	August 2011	Fall 2013	January 2007	Pilots conducted in 2012 and 2013 Region-wide program launch January 2016
Additional Program Changes	Varied by municipality - mostly biweekly collection with introduction of cart. Added mixed plastic, polycoat and aseptic.	Moved to a bi-weekly collection schedule with recycling and garbage alternating on bi-weekly schedule with weekly green bin.	Changed from weekly garbage to bi-weekly garbage alternating with recycling. Recycling converted from depot to curbside collection. Waste levy added to the tax bill depending on set of carts issued.	Moved to weekly recycling collection from bi-weekly collection.	Weekly garbage and recycling collection. Have co-collection vehicles (40/60 split)	Moved to a bi-weekly collection schedule with recycling and garbage alternating on bi-weekly schedule with weekly green bin. Plastic bags, diapers, and pet waste allowed in organics.	Will move to bi-weekly collection alternating recycling and garbage collection with weekly green bin starting 2016. Added mixed plastics and have "exception" days for garbage.

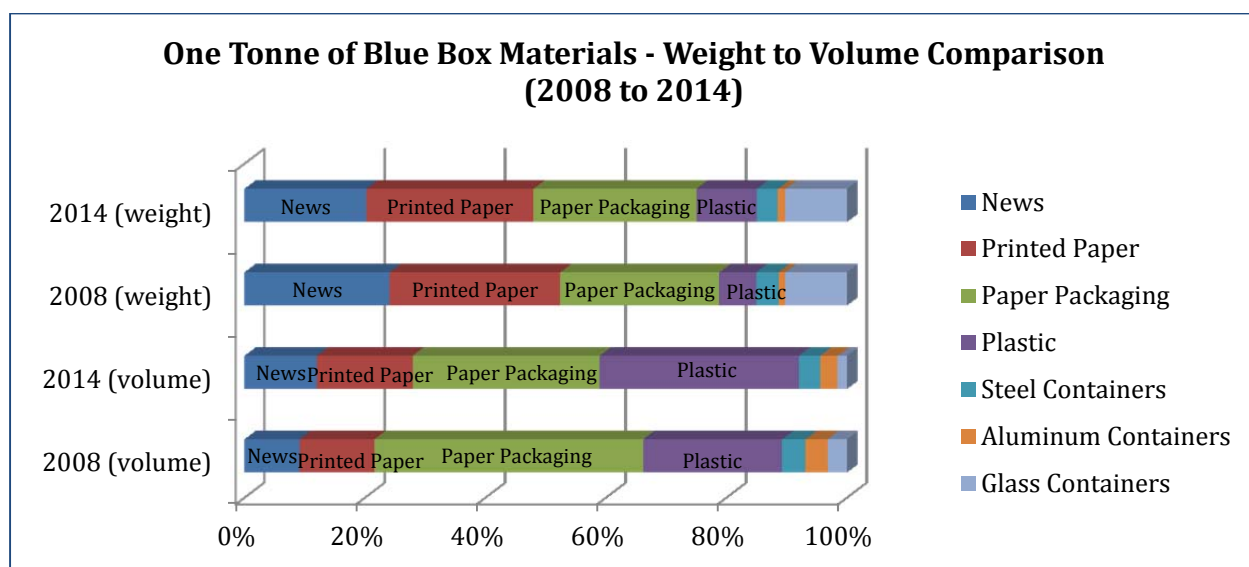
5 Collection Design Considerations

5.1 Changing Composition of the Recycling Stream

Over the past decade the composition of Ontario's Blue Box program has changed with containers such as glass and steel being replaced with lighter bulkier materials, such as plastics, resulting in a lighter but fuller blue box. Between 2003 and 2012, plastics increased by 22% by weight in the Blue Box stream.²

The density of Blue Box material is changing. Figure 2 shows the weight to volume comparison for one tonne of recyclables based on the Ontario 2008 and 2014 Blue Box program. Two major changes are occurring: less fibre/paper (News, Printed Paper, and Paper packaging) and more plastic.

Figure 2: Changing Density of Blue Box Material



A report prepared for the Continuous Improvement Fund, *Diversion versus Net Cost Analysis for The Ontario Blue Box System*, projects the change to the blue box composition by 2027. The study projects a 40% decrease in newspapers by weight with a 25% to 45% increase in cardboard, aseptic, gable tops and paper laminates. The study also projects a 20% reduction in steel cans and 40% reduction in glass with a 35% increase in PET and 20% increase in plastic laminates by weight³. Unless municipalities add new materials to the Blue Box program, the overall weight of materials is estimated to decrease by 7.38% (2008 to 2026)⁴.

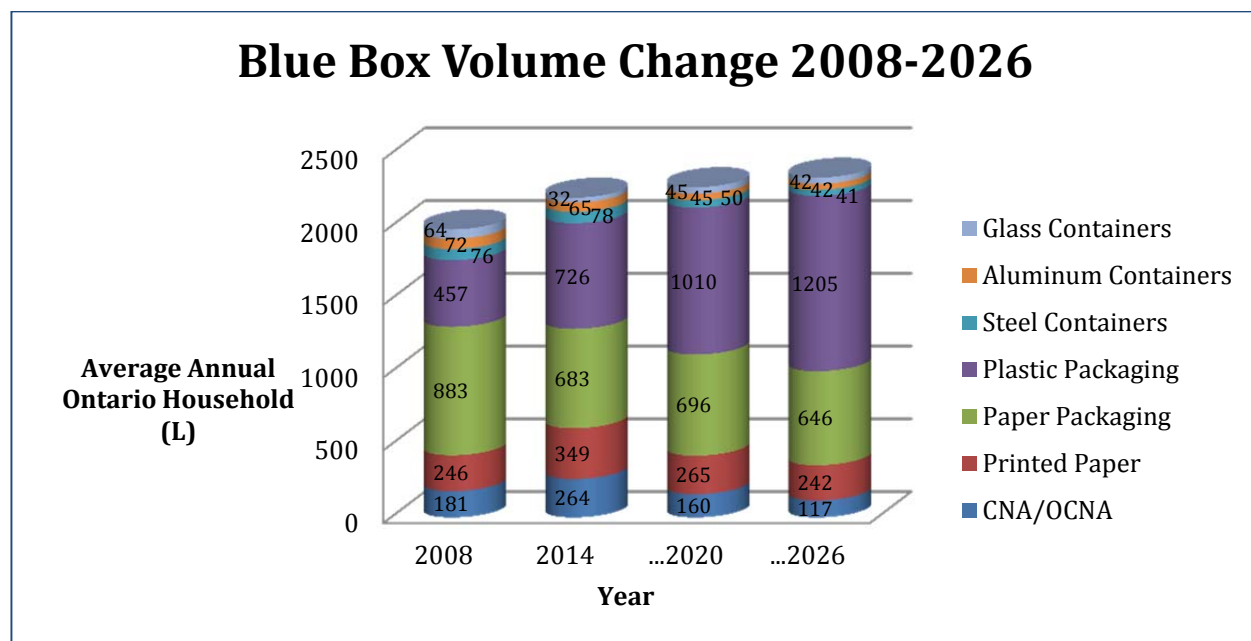
Although weight of materials is decreasing, as can be seen in Figure 3, it is anticipated that volumes of Blue Box materials will increase by 6.26%⁵. The largest growth can be seen in recyclable plastic packaging.

² Stewards need to rethink how they pay for the Blue Box. October 8, 2014. by John Mullinder for Solid Waste and Recycling Magazine

³ Diversion Vs Net Cost Analysis for The Ontario Blue Box System. CIF Project #722. August 29, 2014. Prepared by Kelleher Environmental for CIF

⁴ Based on a linear trend analysis from 2008 to 2014 with estimated growth 2015 to 2026

⁵ Based on a linear trend analysis from 2008 to 2014 with estimated growth 2015 to 2026 and including population growth

Figure 3: Volume of Blue Box Materials Change from 2008 -2026

Given these numbers and trends are based on average Blue Box program values for all Ontario households (curbside and depot – see Table 2), it is important for communities to review generated material composition information, participation and set-out rates in order to estimate volume change in Blue Box materials locally. This will help determine future household recycling capacity needs and justification for auto-cart systems. This projection does not take into consideration, for example, a rapid decline in readership of newspapers, which may further hasten the decline in fibre volumes.

Table 2: Estimated Volume Change of Blue Box Materials (2014-2026)

Blue Box Material	2014-2026 estimated volume shift
CNA/OCNA	-7.0%
Printed Paper	-5.5%
Paper Packaging	-3.4%
Plastic Packaging	18.6%
Steel Containers	-1.8%
Aluminum Containers	-1.2%
Glass Containers	0.3%

Note: CAN = Canadian Newspaper Association, OCNA = Ontario Community Newspaper Association

Also, it should be noted the shift in material volume of 23% (see Table 3) from fibres/papers in 2008 to containers in 2026, which will have an impact on collection.

Table 3: Fibres/Papers versus Containers Total Material Volume

Year	Percentage Volume of Blue Box Materials	
	Fibres / Papers	Containers
2008	66%	34%
2014	59%	41%
2020	49%	51%
2026	43%	57%

5.2 Collection Design

The manner in which recyclable materials are collected can have an impact on the success of implementing an auto-cart program. Among the municipalities surveyed for this report, all or most of the collection is based on full automation.

It should be noted that when the municipalities surveyed, moved to automated cart collection, they introduced additional program changes, which ultimately impacted the overall recycling program's performance. Some of the concurrent program changes included:

- Moving from two stream recycling to single stream recycling – City of Toronto, Bluewater Recycling Association and City of Temiskaming Shores;
- Adding new materials into recycling system – Bluewater Recycling Association, City of Toronto, City of Timmins, Region of Peel;
- Making changes to the frequency of garbage/recycling collection (all new programs had garbage and recycling at equal frequency) – City of Guelph, City of Temiskaming Shores, City of Toronto and Region of Peel.

Therefore, many of the outcomes attributed to the auto-cart program by surveyed municipalities were, in fact, the culmination of a number of simultaneous program changes. It is important to note that municipalities rarely switch to auto-cart collection without introducing other program changes at the same time. Furthermore, the decision to introduce auto-cart programs was the result of careful consideration of a number of identified community needs, noted in Appendix A.

The following sub-sections discuss the key approaches considered by the surveyed municipalities in designing an auto-cart collection program.

5.2.1 Single/One Stream versus Dual/Two Stream Recycling

One of the key questions that most municipalities will need to address when considering cart-based collection is whether to switch to a single/one stream collection system.

In 2014, almost half (48%) of Ontario households received single stream curbside recycling service. The majority of the municipalities providing single stream recycling are located in Southern Ontario⁶. Most single stream programs process their recyclables at privately owned and operated material recycling facilities (MRFs).

The majority of municipalities that have introduced auto-cart collection systems have coupled cart collection with a single stream recycling program. The carts lend themselves to a single stream system due to the additional capacity provided. Depending on the size (see Section 6.1), a recycling cart can accommodate 4 to 6 times the capacity of a typical 60 litre (~16 gallon) blue box.

Where a decision to switch to single stream collection has been made, there are potentially significant capital and/or operating cost implications to the downstream processing aspect of a recycling program. These issues are explored in Sections 6.3 and 7. Other associated issues, such as increased contamination resulting in increased residual and decreased material quality, are explored in Section 6.3.2.

Municipalities tend to benefit from a single stream program in several ways:

- It is reasonable to assume that participation rates will be higher for the single stream programs (compared with dual/two stream programs) as residents find them more convenient and easier to understand (fewer sorting requirements)⁷.
- Higher participation rates tend to result in higher capture rates of recyclable materials.
- Single stream collection costs tend to be lower per household due to reduced time to collect, higher compaction tolerance of the comingled materials, and improved utilization of truck capacity.

Sault Ste. Marie, with funding from CIF, is piloting the first dual/two cart recycling system in Ontario. The 360 litre carts separate fibre and container recyclables and are collected using a dual/two compartment automated collection vehicle.



The municipality of Sault Ste. Marie chose to stay with the dual/two stream recycling system and introduced a split cart program in 2013 (see side bar). The Sault Ste. Marie split cart recycling program is unique as only a handful of known municipalities in California (e.g., Cities of Berkeley and Davis) employ the same split cart technique. While the split cart recycling program in Berkeley, California has been operating successfully for five years, the Sault Ste. Marie split cart recycling program has been in place for two years and faces many more weather related challenges. Early results indicate that Sault Ste. Marie's split cart program is meeting staff expectations.

The CIF is currently evaluating the efficacy of split cart performance in the adjacent municipality of Prince Township. Prince Township, which operates a dual/two stream recycling program and sends its recyclables to the

dual/two stream MRF in Sault Ste. Marie for processing. The Township has decided to harmonize its collection system with Sault Ste. Marie's dual cart system. The project is expected to report in December 2016 (see CIF Project #863).

⁶ Source: Communications with Lori Andrews, WDO Datacall Manager based on 2014 WDO Datacall information.

⁷ Recycling System Options – Stantec Report (2009) – Temiskaming Shores – CIF report #196

The trade-offs between single stream and dual/two stream recycling should be considered in the context of community characteristics. These trade offs include:

- Collection efficiency,
- Contamination and residue, and
- Processing costs.

Each of the above is explored throughout this report.

5.2.2 Bi-weekly Collection

With the capacity made available through the use of carts to store recyclables, municipalities may opt to reduce collection frequency to every other week or ‘bi-weekly’ collection, thereby, reducing collection costs. Bi-weekly collections are better suited for single stream systems, as the recycling carts offer larger storage capacity.

An analysis of local set out rates and volumes per household is necessary to properly evaluate the effectiveness of a bi-weekly auto-cart recycling option.

While, lower collection frequency can decrease costs by up to 20-40%⁸, it tends to result in only small decreases in recycling tonnage. For example, the Region of Peel pilot, which introduced bi-weekly collection, resulted in 3-5% fewer recyclables set out when comparing weekly collection⁹. The decrease in recycling tonnages can potentially be offset by other program changes (e.g. limiting garbage set out).

Automated collection allows for other potential efficiency gains without the constraints placed on staff by physically lifting and tipping containers, such as operating four day, ten hours per day work weeks.

The cost savings from bi-weekly collection are due mainly to the greater efficiency in collection. Every other week collection results in houses putting out more materials and/or more containers and/or fuller containers for every set out. Bi-weekly collection can be used for single or dual/two stream recycling programs.

Changes in the frequency of collection also require that municipalities provide sufficient promotion and education (P&E) to residents to ensure that they know which weeks they are to recycle in their neighbourhood. Frustration by the resident in the new collection schedule may result in reduced participation in the recycling program and reduced capture rates of materials.

The cities of Guelph, Toronto, Temiskaming Shores, the Region of Peel and Bluewater Recycling Association (some members) transitioned to bi-weekly recycling when launching their automated cart program. The Region of Peel suggested that moving to cart based, bi-weekly recycling collection would reduce the collection fleet by 15-20% (estimated 12 trucks). Additionally, this would have greenhouse gas savings of 250 tonnes of CO₂¹⁰.

⁸ Curbside recycling, the next generation: a model for local government recycling and waste reduction
<http://www.calrecycle.ca.gov/publications/Documents/LocalAsst%5C31002014.doc>

⁹ Region of Peel (March 2013) - BI-WEEKLY GARBAGE COLLECTION PILOT PROJECT- FINAL REPORT
<http://www.peelregion.ca/council/agendas/pdf/rc-20130411/report-pw-b1.pdf>

¹⁰ Region of Peel - Bi-Weekly Garbage Collection Pilot Project – Final Report (March 2013)
<http://www.peelregion.ca/council/agendas/pdf/rc-20130411/report-pw-b1.pdf>

5.2.3 Co-Collection

Co-collection of recyclables with other streams (e.g. garbage and organics) offers an option to further decrease the cost of collecting recyclables. Co-collection involves the use of split collection vehicles that enable the municipality to collect more than one material stream at a time; for example garbage and organics on week one and single stream recyclables and organics on week two.

Many municipalities in Ontario have switched to co-collection combined with single stream recycling to improve operating efficiencies and to reduce the environmental burden associated with vehicle usage (only one truck pass per household weekly)¹¹. It should be noted however that the location of the receiving facilities for the respective waste streams need to be strategically located (preferably at or near the same site) to avoid unproductive transportation (i.e. transfer station/MRF and landfill and/or organics facility).

Co-collection is most effective if the facilities (e.g. MRF, composting facility and transfer station/landfill) are located in close proximity to one another.

In the case of the City of Guelph, the shift to bi-weekly collection of recycling (bi-weekly garbage and weekly organics) utilizing the same fleet for recycling 60/40 split with organics resulted in an 18% reduction in the size of its recycling fleet¹². Guelph suggested that due to increase recycling volumes, truck split should be 70/30 for co-collection garbage/recycling with organics. Further, labour costs were reduced by 35% with shared co-collection drivers for garbage/recycling collection trucks.

Co-collection strategies are estimated to reduce collection costs by 20-30%¹³.

While a two stream recycling program can be co-collected with garbage by alternating the fibre and container streams every other week, this approach cannot easily accommodate a fourth stream, such as organics, and must be carefully weighed against the potential for resident confusion as to which stream should be set out on collection day. With the implementation of a source separated organics program (i.e., green bin program), a municipality with a dual/two stream recycling program may need to introduce an additional collection vehicle to accommodate the fourth stream (i.e., garbage, fibre/paper, containers, green bin). At this point, it may be more feasible for the municipality to switch to a single stream recycling program and introduce bi-weekly garbage and recycling collection coupled with weekly organic collection using the same collection vehicle (green bin and garbage one week and green bin and single stream recycling the next week).

The auto-cart program complements co-collection by easily accommodating single stream recycling and the potential need for increased storage capacity.

¹¹ City of Toronto – Efficiency of Automated Collection and Performance of Compressed Natural Gas Vehicles (2014) - CIF Report #548.11

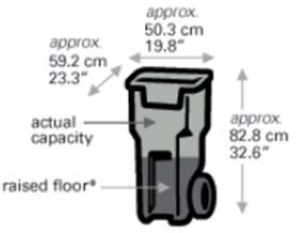

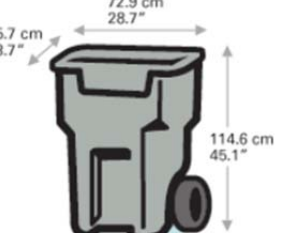
¹² Guelph Automated Waste Cart Collection System Curbside Collection Performance and Monitoring Report (March 2014) – CIF Report 284. Fleet was 11 recycling trucks (3 spares shared with garbage) reduced to 8 trucks (7 with 60/40 split and 1 dedicated recycling single stream due to high volumes) and 2 spares shared with garbage

¹³ Curbside recycling, the next generation: a model for local government recycling and waste reduction
<http://www.calrecycle.ca.gov/publications/Documents/LocalAsst%5C31002014.doc>

5.2.4 Variable Cart Programs

A cart-based recycling system creates the opportunity to move to a variable cart garbage subscription or pay-as-you-throw (PAYT) system, in which residents pay by an increasing rate structure, depending on the size of the garbage cart (rates increase as the size of cart increases – see Figure 4).

Figure 4: Toronto’s PAYT Program - Increasing Garbage Fees with Increasing Cart Sizes

75 Litre Cart	240 Litre Cart	360 litre Cart
<p>Small = 1 bag</p>  <p>\$10.63 fee/year</p>	<p>Large = 3 bags</p>  <p>\$247.39 fee/year</p>	<p>Extra-large = 4½ bags</p>  <p>\$343.60 fee/year</p>

Source: www1.toronto.ca – City of Toronto Bin Sizes and Fees

Variable cart subscription programs place a direct onus on residents to pay for the amount of garbage produced. This approach has the potential to drive waste diversion by encouraging the resident to reduce their garbage costs by participating in recycling, source separated organics collection (green bin program), and other waste diversion programs.

Bluewater Recycling Association found that capture rates for recycling were higher (by ~20%) when comparing communities with limited garbage set-outs (1 bag vs. 7 bag limit)¹⁴.

Most municipalities ensure that the overall pricing structure is set to cover the cost of providing the various waste management and diversion collection service. The City of Toronto incorporates the cost of the diversion programs (e.g. recycling and source separated organics diversion, etc.) into the cost of the garbage cart to encourage greater participation in the diversion programs, which are viewed as “free of charge”.

Some municipalities, however, apply fees for each component of the service provided (e.g. City of Vancouver has variable subscription fees for garbage, recycling, and organics collections). Currently, only the City of Toronto and some municipalities serviced by Bluewater Recycling Association have implemented a variable cart program in Ontario. Municipalities exploring variable cart subscription systems need to understand the trade-offs, mainly concerns of higher contamination problems in the recycling stream¹⁵. It should be noted that PAYT systems are not exclusive to cart based programs but are typically limited to waste collection only.

¹⁴ Bluewater Recycling Association – Recycling Collection Operations Review - Stantec Consultant Report (September 2009) - CIF Report #176 – Page 11 of 49 when comparing St. Marys and Alvinston

¹⁵ Variable Rate Pricing: Best Practice to increase recycling. March 26, 2015. Presentation by Waste Management Inc. at the Carolina Recycling Association

In the case of the City of Toronto, in 2008, the city switched to a semi-automated cart collection system and launched its Pay-as-you-Throw variable cart garbage program. Residents were asked to choose between one of four sizes of garbage collection carts - 75 litres, 120 litres, 240 litres and to 360 litres. Each size of garbage cart is associated with a variable annual fee that this added to the city's water and wastewater utility bill. At the same time, residents were allowed to choose between three recycling cart sizes - 120 litres, 240 litres and 360 litres. The recycling carts increased the volume of recyclables that could be stored over a two week period in order to accommodate the new bi-weekly collection schedule. All residents were issued a 45 litre green bin.

One of the key challenges with this approach is that residents will naturally subscribe to the smallest size of garbage cart that can accommodate their household needs and will rely on alternative sources to deal with excessive garbage situations. Frequently this results in residents placing waste in their recycling carts when necessary and can lead to significant increases in reported residue rates as was experienced by Toronto. Contamination rates in Toronto's recycling program typically reach 20% annually.

6 Operations

6.1 Cart Selection

With a growing number of recyclable materials being added to Blue Box programs coupled with the changing composition of recycling (see Section 5.1), typical 16 gallon or smaller blue boxes may no longer meet residential storage needs (as shown in the photo below).

Many municipalities have adjusted to these changes by:

- Providing more blue boxes, and/or,
- Providing larger 22 gallon blue boxes, and/or,
- Allowing the use of blue bags for excess materials.



Source: Adding Capacity & Increasing Diversion. Presentation by Elizabeth Ramsay, City of Brantford at CIF's Ontario Recycling Workshop. June, 2014. Niagara

There are, however, implications to doing so. Providing more blue boxes to residents creates potential storage and handling issues in the household, and increases curbside collection time and associated collection costs. Provision of too few blue boxes may result in recycling material being redirected to the garbage stream. Municipalities that suggest residents use blue/clear bags place the financial burden on residents to purchase bags and experience increases in processing costs and residue at the materials recycling facility (MRF).

After analyzing household seasonal material generation volumes, a key consideration for an auto-cart program is the size of recycling carts to provide residents.

There are two common approaches: Provide one size for all residents, or allow residents to choose from a variety of sizes.

Each approach has its merits and drawbacks, which are addressed in Table 4.

Table 4: Merits and Drawbacks to Choosing Cart Sizes

	Examples of Municipalities	Advantages	Disadvantages
One size fits all approach	<ul style="list-style-type: none"> • City of Temiskaming Shores (1 size – 360 litres) • City of Sault Ste. Marie (1 size – 360 litres split cart) 	<ul style="list-style-type: none"> • Less guess at the number of carts to order • Less administration and cost for setting up an ordering system • Better pricing ordering only one size • Reduction in overall scheduling and deployment costs 	<ul style="list-style-type: none"> • Tend to order a larger size cart which may cause storage issues • May experience resistance from residents who cannot easily move the larger cart (e.g. seniors)

	Examples of Municipalities	Advantages	Disadvantages
Select from variety of sizes	<ul style="list-style-type: none"> City of Guelph (4 sizes available – 80, 120, 240 and 360 litre) Bluewater Recycling Association (2 sizes available – 240 and 360 litre) City of Toronto (3 sizes available – 120, 240 and 360 litre) Region of Peel (3 sizes available – 120, 240 and 360 litre) City of Timmins (2 sizes available – 240 and 360 litre) 	<ul style="list-style-type: none"> Allows residents to pick the most appropriate size for their needs Easier to accommodate downtown locations with storage limitations Helps to establish municipality buy-in by allowing residents to select the size of the cart 	<ul style="list-style-type: none"> Need to establish an ordering and exchange system Increased administrative burden and costs Need additional stock and storage for different sized bins Increase in overall, ordering, scheduling and deployment costs

Note: 120 litres is equivalent to 32 gallons, 240 litres is equivalent to 64 gallons, 360 litres is equivalent to 96 gallons

Urban municipalities tend to be more likely to offer different sizes of recycling carts as they will need to accommodate different property sizes and storage needs. Municipalities with greater than 40,000 households, such as the cities of Guelph and Toronto and the Region of Peel offer three sizes of recycling carts ranging in size from 120 litre, 240 litre and 360 litre, as shown in Table 5.

Table 5: Comparing Volumes of Carts versus Blue Boxes

Small Recycling Cart (120 litres)		Medium Recycling Cart (240 litres)		Large Recycling Cart (360 litres)	
					
A small cart (120 L, 32 gal) will hold approximately 2 standard Blue Boxes or 1.5 large Blue Boxes		A medium cart (240 L, 64 gal) will hold approximately 4 standard Blue Boxes or 3 large Blue Boxes		A large cart (360 L, 96 gal) will hold approximately 6 standard Blue Boxes or 4.5 large Blue Boxes	
 x 2	 x 1.5	 x 4	 x 3	 x 6	 x 4.5
Standard or regular size Blue Box is 60 litres (16 gallons)	Large size Blue Box is 80 litres (21 gallons)	Standard or regular size Blue Box is 60 litres (16 gallons)	Large size Blue Box is 80 litres (21 gallons)	Standard or regular size Blue Box is 60 litres (16 gallons)	Large size Blue Box is 80 litres (21 gallons)

Source: Region of Peel website at <https://web.apps.peelregion.ca/carts/>.

6.2 Collection Efficiency and Challenges

Surveyed municipalities reported recycling efficiency and effectiveness improvements resulting from:

- Optimizing routes and reducing collection fleet size (number of vehicles and drivers required-contingent on sufficient stops to fully utilize equipment);
- Making quicker stops - automated collection services up to 180 stops per hour with one person, compared to approximately 80 per hour manually (125% more efficient)¹⁶;
- Collecting more recyclable materials per stop (~15-30%)¹⁷.

Often the gains in collection efficiencies result from a reduction in fleet size. Revising routing schedules helps to achieve further improvements in collection efficiency. Those surveyed municipalities reporting reductions in fleet size (e.g. City of Guelph, Region of Peel, Bluewater Recycling Association) coupled the auto-cart collection program with bi-weekly collection. Consequently, the City of Guelph reduced its fleet size by 18%, the Region of Peel estimated a 30% reduction in the contractor's fleet size and Bluewater Recycling Association reduced its fleet size by 10% as a result of decreased 'stop times'.

Evidence presented from the surveyed municipalities suggesting that automated collection vehicles benefit both urban and rural areas. Some municipalities responding to the survey noted that automated collection makes more sense in an urban setting since the collection time per stop is more important than the time between stops. Others noted that automated cart collection benefits rural areas if the municipality can reduce overall collection time. Collection time can be reduced with automated vehicles since the driver is sitting and can drive at the speed limit. Manual side loader collection vehicles, which use a single collection crew to drive, have the driver stand (without a seat belt) while driving on the right side of the vehicle. Under these conditions, the driver is legally obliged to not exceed 32 km per hour speed limit¹⁸.

Francis Veilleux of Bluewater Recycling Association claims, "It is unequivocally cheaper to have an automated system than a manual system overall. However, the savings depend on many factors (truck operating and capital costs, cart costs, program changes, travel time versus collection time, location and distance to facilities, etc.)"

Some surveyed municipalities reported greater collection efficiencies with the auto-cart collection vehicles attaining higher number of stops per hour.

- Bluewater Recycling Association experienced a 20% increase in the number of stops per hour. Most of the efficiency was gained in the urban (i.e. towns and villages) areas, which comprise 70% of collection routes. The auto-cart collection program effectively halved the per stop recycling collection time from 40 seconds per stop (manual) to 20 seconds per stop (automated), with no additional measures introduced (e.g. bi-weekly collection).
- City of Guelph increased stops per hour by 12%. The City already operated an effective program featuring bag collection for the garbage, recycling and source separated organic streams, resulting in a highly efficient collection system prior to the implementation of the cart system. Despite this, the City of Guelph was able to reduce its fleet size due to the operational efficiencies of the auto cart program.

¹⁶ Bluewater Recycling Association - Large Curbside Container Project - CIF #559.3 (July 2015)

¹⁷ Bluewater Recycling Association – Recycling Collection Operations Review - Stantec Consultant Report (September 2009) - CIF Report #176

¹⁸ Conversation with Francis Veilleux, Bluewater Recycling Association, December 3, 2015.

Ongoing monitoring of collection is essential for tracking efficiency. Implementing RFID (Radio Frequency Identification Device) systems increases cost but has many benefits for residential cart programs, as they allow for:

- Assigning a cart and its data to a specific collection location/resident;
- Providing a detailed history of ownership, location, and repair to monitor the cart asset over its entire useful life (including exchanges and removals);
- Generating data on participation rates;
- Determining community diversion tonnages;
- Targeting P&E in areas experiencing poor set out or contamination issues; and
- Measuring route efficiency.

Almost all surveyed respondents acquired RFID equipped carts, although not all activated the RFID system. On-truck RFID cart readers connect addresses and users in order to assist with curbside enforcement and education (e.g. through driver interaction and office follow-up support). See Section 7.1.1 for further discussion.

City of Timmins implemented RFID systems on carts, which resulted in savings of an estimated one hour per day on collection rerouting delays due to improved management of customer issues¹⁹.

Auto-cart systems may also facilitate the introduction of a third collection stream, such as source separated organics (green bin program). The cart-based system (coupled with bi-weekly collection) may accommodate the three different streams (garbage, recycling, source separated organics) more effectively since the carts offer additional storage capacity for single stream recyclables.

The use of 360 litre (96-gallon) carts in automated systems allows residents to save more materials before setting the cart out at the curb for collection. The concept of a larger size container facilitating additional recycling can also be addressed through the use of larger blue boxes. The use of larger lidded containers has been cited as supporting increased capture of recyclable materials. Findings resulting from a 2002 study in St. Paul, Minnesota that compared various dual/two stream and single stream collection methods, found that the determining factor in increased resident participation and increase in materials set out at the curb, was the recycling container capacity not whether it was dual/two or single stream²⁰. When comparing single stream auto-carts to dual/two stream manual collection, a 2009 study done by Bluewater Recycling Association waste audits showed that auto-carts collected 40% more materials (by weight) per household bi-weekly and had a 36% higher recycling capture rate²¹. More information regarding auto-cart impact on recycling is discussed in Section 11.

The provision of additional storage capacity may eliminate the need for householders to place their carts out for collection every week (especially if provided with an organics bin), which improves collection efficiency (i.e. fewer stops if residents are instructed to wait until carts are full). The additional storage capacity of the recycling bins will enable the materials to be stored for longer periods of time. This approach may benefit the householder and increase collection efficiency. Promotion and Education (P&E) becomes an important factor in reminding householders to only set out full carts.

¹⁹ City of Timmins July 2012 - Implementing On-Truck RFID Tracking for Collection CIF Report #351

²⁰ *Resource Recycling*, November 2002

²¹ Bluewater Recycling Association – CIF Report #176

Auto-cart systems have flourished in municipalities in southwestern United States and the Canadian prairies, which are characterized by wide streets with low-density housing and relatively flat terrain. These characteristics provide an ideal setting for a cart-based system. Unfortunately, this is not a typical setting for Ontario municipalities or municipalities located on the pacific coast, where cart based programs are becoming increasingly prominent.



Autocart collection in San Antonio, Texas
<http://www.junk-king.com/locations/sanantonio/>
 2011/04/27/san-antonio-recycling-how-and-what-to-recycle/



Autocart collection in Winnipeg, Manitoba
<http://garbage.speakupwinnipeg.com/2010/12/how-do-we-collect-garbage/>

Carts bring their own set of service challenges, which, if not addressed properly, can diminish any of the collection efficiency gains made when switching to the automated cart service. Prior to implementation of a cart system, it is important for the municipality to develop a strategy to deal with cart service challenges as discussed below.

6.2.1 Cart Placement

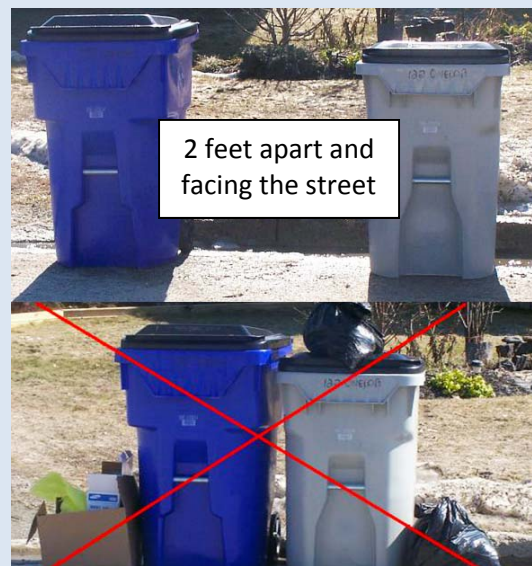
The proper placement of the carts at the curb or property line is essential for the collection system to achieve optimum efficiency. Carts that are placed close together or side-by-side cannot be collected by the automated arm and will require the driver to get out and manually move the bins or leave them behind. The extent to which this becomes a problem in the municipality depends on a large extent to the promotion and education provided to the resident. Municipalities need to be pro-active in educating residents about proper placement of carts in good weather as well as in inclement weather (as discussed in Section 6.2.4).

The City of Timmins has established the 'Rule of 2s', which aims to provide easy to remember rules for proper placement of carts and is located on the front page of the city's waste and recycling webpage (see sidebar). These rules include:

- Place the carts at least 2 feet apart,

Timmins Rule of 2's:

- ✓ Place the carts at least 2 feet apart.
- ✓ Place the 2 carts facing the street (and 2 feet back from the curb or gutter).
- ✓ Place the carts 2 feet away from any obstructions (e.g. parked cars, street lights, trees, fire hydrants).



- Place the 2 carts facing the street (and 2 feet back from the curb or gutter),
- Place the carts 2 feet away from any obstructions (e.g. parked cars, street lights, trees, fire hydrants).



City of Winnipeg uses the 'one arm' rule, asking residents to "allow one arm's length clearance on all sides of each cart to allow enough room for the collection arm on the automated truck to grab your cart"²².

Bluewater Recycling Association and Sault Ste. Marie have instructions for proper bin placement directly on the cart.

6.2.2 Large Item Materials (e.g. cardboard boxes, polystyrene packaging)

Despite the increased capacity of carts, some oversized recycling materials, such as oversized cardboard boxes and large item polystyrene packaging material, can pose collection challenges.

Many municipalities including Bluewater Recycling Association, and the Cities of Temiskaming Shores and Guelph, ask residents to flatten and place all cardboard inside the blue cart such that the cardboard can fit completely inside the cart (i.e., not crammed) in order for the lid to close. Efficient collections direct residents to take cardboard or other items that cannot fit inside the bin, to the municipal transfer station or recycling depot for diversion, free of charge.

In the case of the City of Toronto, where automated cart collection is provided outside of the city core (semi-automated cart collection is used within the city core) residents are asked to bundle and place the larger items next to the blue cart. The collection crew will empty the blue cart then place the overloads in the cart and tip it again. This approach reduces collection efficiency. To remedy this, Toronto will ask residents who experience regular overflow recycling to upsize their blue cart or get a second blue cart free of charge.

6.2.3 Density / Topography

Urban municipalities with dense downtown cores face more challenges in accommodating auto-cart programs, such as:

- Limited on-site storage (residents above commercial establishments or row houses),
- Street parking, and
- Narrow streets, one-way streets, alley and/or rear lane collection.

6.2.3.1 On-site storage

Municipalities characterized with high-density neighbourhoods will inevitably face on-site storage challenges, especially if the municipality offers three-stream (garbage, recycling and organics) cart collection service. Figure 5 shows the challenges in finding storage for the carts in downtown Toronto.

²² Source; City of Winnipeg website at <http://winnipeg.ca/waterandwaste/recycle/cartcollection.stm#faq>

Figure 5: Outdoor storage challenges**Cart storage in downtown Toronto**

https://upload.wikimedia.org/wikipedia/commons/d/df/Toronto_waste_2010.jpg

**Cart storage in downtown Toronto**

<http://www.theglobeandmail.com/globe-investor/personal-finance/mortgages/housing-market-beats-up-on-first-time-buyers/article20951842/>

Municipalities will need to be flexible in accommodating residents with limited on-site storage (e.g. minimal front yards, no garages, narrow walk ways, or no access to the rear of the property). Successful programs with high density housing have offered different sized carts and have ensured that staff listened and worked with residents to identify issues and provide solutions. Many municipalities hire temporary help and/or students to visit homes requiring extra assistance. Based on the *Diffusion of Innovation Theory*, municipalities may have to visit upward of 16% of households (“laggards”) and should budget staffing accordingly²³.

In the case of the Region of Peel the more compact the housing, the more popular the smaller sized recycling cart as shown in Table 6.

Table 6: Cart Size Selection by Type of Housing

Cart Size	Percentage of Recycling Cart by Size		
	Detached Homes	Semi Detached Homes	Townhouses
Large (360 litres or 95 gallon)	73%	33%	23%
Medium (240 litres or 64 gallons)	23%	63%	71%
Small (120 litres or 32 gallons)	4%	4%	6%

Source: Regional Council Project/Issue Update. April 16, 2015. Presented by Public Works to the Peel Regional Council

Inevitably, some homes may need to remain on a bag or blue box system. In fact, three of the seven surveyed municipalities (the Region of Peel, City of Toronto and City of Timmins) retain some manual collections in approximately 10% of their households. These households were incorporated into the overall automated system. The Region of Peel allows residents to use blue bags for recyclables and Timmins allows residents to use blue boxes, where necessary.

²³ <http://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/SB721-Models/SB721-Models4.html>

6.2.3.2 Street parking

Parked cars can be problematic for auto-cart collection vehicles, especially if street parking typically replaces driveway parking. Municipalities use different approaches to manage parked car situations. Bluewater Recycling Association and Temiskaming Shores provide collection service to the downtown core early in the morning before parking becomes an issue.

According to City of Toronto staff, approximately 30% of households have on-street parking in the downtown city core that cannot be serviced by fully automated collection vehicles and must be serviced by semi-automated collection vehicles²⁴. The City of Toronto employs a semi-automated cart collection program in the city core to enable the collection crew to manually move the bins around parked cars.

Municipalities should work with residents to find suitable locations for the bins in downtown locations where parking is a problem. Street parking can significantly reduce efficiency gains associated with an automated cart program and can be a key determinant of ongoing operating costs (see Figure 6).

Figure 6: Street Parking in Toronto Hampers Cart Collection



Source: City of Toronto Recycling Container Pilot Project Summary. March 31, 2009. Prepared by Jacques Whitford for Stewardship Ontario.

6.2.3.3 Narrow streets and Lanes

Similar to high density area, narrow streets impact the ability of automated collection vehicles to access the carts. Back lanes that are too narrow for automated collection vehicles to access can be accommodated by requiring that the carts are placed at the front of the property.

Some western municipalities, such as the cities of Lethbridge and Calgary and the Town of Taber (Alberta), have incorporated smaller automated vehicles (see sidebar) into the collection fleet to manage higher density areas.

The cities of Lethbridge and Calgary, Alberta have purchased smaller automated collection vehicles (16 yd.) that can collect from narrow lane ways (the vehicles are 7 feet wide. Storage capacity is about half of a regular packer truck.



Communications with Kevin Theodore, Waste and Recycling Specialist, City of Lethbridge, September 30, 2015.

²⁴ Curbside Waste Collection Services Review: Comparison of Curbside Waste Collection Services East and West of Yonge Street, Appendix B: Jurisdictional Review of Collection Service Comparisons. September 9, 2015. City of Toronto Staff Report.

Alternatively, a common collection area may be established where carts placed at the end of the street. These common collection areas can suffer from neglect, resulting in litter and illegal dumping.

6.2.3.4 Uneven Terrain (Hills)

Automated cart collection vehicles are not impacted by topography and can collect as effectively on hills as on flat terrain. Cart programs operating in municipalities with varying topography include the Cities of San Francisco, Vancouver and Seattle.

Wind and snow can become a factor in either tipping the cart or making access difficult for the collection vehicles on uneven terrain or a steep hill but the greatest challenge lies more with the user who may be required to transport the carts from high elevations and stairs, which is explored in Section 8.3.

6.2.4 Weather

6.2.4.1 Snow

Snow can pose challenges for movement and placement of carts. Carts can be damaged or tipped over by snowplows if placed too close to the road or on top of snow banks. Municipalities need to be strategic in dealing with carts and winter snow conditions by ensuring that residents are educated on the proper and improper placement of carts in winter conditions.

Larger wheels can be ordered with carts in areas with heavy snowfalls to permit easier movement in winter weather conditions.

Temiskaming Shores has established a separate 'Winter' link on its waste and recycling webpage to notify its residents about winter conditions cautioning that "During the winter months, it may be necessary to change the regular placement of your rollout bins after a snowfall". The municipality has developed a flier explaining the procedures for placement and collection of the carts in winter (see below).

Timmins' waste management staff worked with staff in the Roads Department to develop a better understanding of snow removal activities and cart placement challenges in order to develop effective communications about cart placement and safety measures in winter conditions.



Temiskaming Shores Winter Tips

Some of the key messaging provided by Temiskaming Shores for placement of carts in winter conditions include:

- **For residents living along roads without sidewalks or along sidewalks not maintained throughout the winter:** Place garbage and recycling bins no more than three (3) feet back from the road edge after a snowfall, to facilitate snow removal operations and to avoid damage to rollout bins.
- **For residents living along winter maintained (plowed) sidewalks:** Place bins directly behind the curb the morning of your collection day. This placement reduces safety risks associated with extending the automated sidearm across the sidewalk, and to ensure the safety of pedestrians using the sidewalk.
- Place your bins for collection at an unobstructed site. The bins should be no closer than **three (3) feet** from any obstacle (i.e. snow banks, mailboxes, hydro poles, telephone poles, parked vehicles, etc.) and not obstructing the street. **Please note:** It is the responsibility of the resident to clear a space for the placement of containers.
- **Do not place bins behind or on-top of snow banks.**

Carts have reduced the City of Guelph's time and cost in dealing with collection and snow banks, as the automated arm has the ability to collect and return the carts to the top of a snow bank. The automated trucks are fully capable of collecting most carts placed on snow banks. Even though the 2013-2014 winter had a higher than normal snowfall, weather related cart complaints in the City of Guelph were significantly lower (approximately half) than collection complaints related to residents still on bag collection²⁵.

6.2.4.2 Wind and Rain

Carts provide many benefits during inclement weather. The lid helps protect recyclable materials from getting wet and soggy during rainy weather and reduces the amount of litter generated from recyclables being dragged out of the blue boxes by animals or blown around by the wind. Carts are designed to withstand moderately windy conditions (up to 50 to 60 kilometers per hour) without the lid blowing open or the cart tipping over. Like blue boxes, some municipalities recommend setting out the cart in the morning on windy days rather than the evening before or not taking the cart to the curb unless necessary (i.e. full).

Residents serviced by Bluewater Recycling Association have applied innovative approaches to overcome problems with the wind by using old hockey sticks to stabilize the carts against gusts of wind.



According to the City of Guelph, carts meet safety rating by the American National Standards Institute for slope stability, durability during pulling, centre of balance and force to tip.

6.3 Processing Implications

Conversion to cart based collection has potential downstream processing implications, which is explored in this section.

6.3.1 Material Recycling Facility (MRF) Capacity

MRF processing capacity should also be considered as part of planning for conversion to a cart based program. As discussed, one of the primary benefits of a cart program is the ability to provide increased collection capacity for recyclables. Deployed correctly, a cart program should capture more material if curbside capacity was a limiting factor to participation in the municipality's program. Many municipalities also simultaneously take advantage of the increased available capacity offered by carts to expand the list of recyclable materials accepted in their recycling program (e.g. Bluewater Recycling Association).

These combined factors can result in a need for municipalities, with their own transfer or processing facilities, to consider the potential capital and operating implications. Those municipalities that contract out collection and/or processing and pay by the tonne will also need to consider the cost implications of the potential for increased tonnage.

6.3.2 MRF Processing and Residue – Single Stream

Deciding to retrofit an existing MRF, construct a new MRF or establish a processing contract with a single stream MRF will result in additional capital and/or operating (contract) costs.

An analysis of City of Kingston's recycling program and the merit of switching from a dual stream to a single stream program concluded that "while Single Stream programs, on average, recover more material on a per household basis, they are overall more expensive to operate than Dual Stream programs and generate less revenue resulting in overall higher net costs on a per tonne basis."

Source: Kingston Regional MRF Study Task 5: Final Report. June 10, 2015.

Where collection efficiencies may be gained by switching to a single stream recycling auto-cart program, the gains may be lost during processing of the recyclables at the MRF for two fundamental reasons:

- Processing costs for single stream operations have shown to be at least 15% more expensive than dual/two stream processing due to the higher capital and operating costs associated with separation of the comingled fibres/papers and containers and lower revenue due to lesser quality outbound bales²⁶.
- Residue levels generally increase with the provision of carts (see below), which increase MRF disposal costs.

One of the biggest challenges with a cart program is the opportunity for increased contamination rates; however, potential changes in contamination rates must be put in context with what was happening in the program prior to the auto-cart and what additional changes have been made at the launch of the auto-cart program.

Bluewater Recycling Association reported a decrease in contamination rates post cart program (from 4.5% pre-cart to 2% post-cart), which was attributed to the introduction of mixed plastic, polycoat, and aseptic materials at the same time as the auto-cart program launch. The mixed plastics and other newly introduced recyclables

²⁶ An Assessment of Single and Dual Stream Recycling, Including Current Program Performance in Large Ontario Municipalities. November 1, 2012. Prepared by HDR for the Continuous Improvement Fund.

were being counted as part of recycling rather than as part of contamination, as before. Also, Bluewater Recycling Association helps reduce contamination by monitoring carts as they get emptied into the collection vehicle using on-board cameras and linking carts to addresses for targeted education through the use of RFID tags imbedded in the carts.

Residue levels for Ontario single stream cart and non-cart recycling municipalities was reviewed as noted in Table 7 below.

Table 7: Residue Rates for Cart versus Non Cart Programs

Ontario Single Stream Municipalities	Residue Rates (2014)		
	Weighted Average	Low (WDO group)	High (WDO group)
Carts - 2 Municipalities	23.65%	2.92% (group 4)	24.87% (group 1)
Non-Cart – 11 Municipalities	12.65%	2.55% (group 7)	18.94% (group 6)

Note 1: Default MRF residue rates in the WDO Municipal Datacall for programs that do not know or measure their MRF residue rates are: 6.89% for dual/two stream systems, and 13.29% for single stream systems²⁷

Note 2: For a description of WDO Municipal Groups visit

http://www.wdo.ca/files/8313/5887/5345/Final_2011_Description_of_Municipal_Groups_for_Datacall_An.pdf

The two municipalities that employ carts and report residue rates show that performance with cart systems can be similar when compared to non-cart programs. It should be noted that the high residue rate associated with the auto-cart municipality identified in group 1 (under High residue rates) may, in part, be influenced by the presence of significant multi-residential housing stock, which is generally linked with higher than normal residue rates.

The City of Guelph reports insignificant changes in contamination and residue rates since the launch of its auto-cart program. This is likely because Guelph already had higher than average residue levels in its bag based collection system, which has continued with the conversion to carts.

The challenge associated with increases in contamination and residue rates may be a function of a cart collection program coupled with other program features. The Region of Peel and the City of Toronto have experienced up to 20% contamination/residue rates associated with their auto-cart programs. In the case of Toronto, the high contamination rates are attributed to its variable rate (pay-as-you-throw garbage) program and the opportunity for residents to more easily hide non-recyclables in the carts but may also be the impact of high multi-residential housing stock. The reasons for the high contamination rates experienced in the Region of Peel pilot are not clear but may have some relationship to the resident selection of size of the recycling cart and/or the introduction of bi-weekly garbage and recycling collection.

One key benefit of carts is that they help to keep recyclables dry during inclement weather. Keeping recyclables dry significantly improves MRF operating efficiency by reducing throughput and process loss.

BRA, however, has reported that during the winter, snow clinging to the wheels can be knocked off into the collection vehicle making the recyclables wet.

²⁷ Current State Ontario Blue Box Paper Fibres Final Report (August 2011) – CIF Report #390

One of the processing benefits associated with carts is that the losses associated with processing wet paper materials are reduced. The highly automated equipment commonly used to separate fibres from containers in single stream processing facilities (e.g. star screens) are very sensitive to varying moisture levels in the paper. Often the wet paper will not separate cleanly from the container stream and ends up in the MRF residue stream as a process loss or in the fibre stream as a lower paper grade²⁸. Carts tend to result in drier recyclables, which allows a star screen to effectively sort year-long with minimal adjustments associated with local climactic conditions²⁹.

To minimize potential processing equipment downtime, municipalities should continue to encourage residents to place recyclable materials loose in carts and minimize the use of plastic bags. Increased use of plastic bags to bundle recyclables by Bluewater Recycling Association auto-cart residents has resulted in BRA having to increase cleaning disk screens from once to four times per day³⁰. It is recommended that residents be reminded to limit the use of plastic bags for the purposes of “bag your bags” and “bag shredded paper” only.

It should also be noted that as the composition of Blue Box changes to lighter, less dense, and bulkier materials (see Section 5.1), the impact on MRF inbound and outbound storage areas and processing efficiencies should be examined, especially if an auto-cart program is being considered.

Municipalities that currently have single stream recycling and are considering switching to a cart based program should anticipate a minimum of 5% to 6% increase in contamination rates with the possibility for higher contamination levels if the list of recyclables collected is limited or if garbage collection is significantly restricted (i.e., low bag limits or PAYT systems).

Processing contracts should be reviewed for potential penalties and additional charges or load rejections if contamination exceeds the contracted amount.

Single stream cart programs that implement strong and ongoing promotion and education as well as utilize RFID tags (relate problem to cart address), cameras and driver interaction to enforce recycling program and monitor residential inputs, have demonstrated the ability to manage increases in residue/contamination rates.

²⁸ *Resource Recycling, April 2006*

²⁹ *Resource Recycling, April 2006*

³⁰ Bluewater Recycling Association – Large Container CIF Project #559.3 http://cif.wdo.ca/projects/documents/559.3-BRA_Final_Report.pdf

7 Financial Implications

7.1 Collection Capital Expenditures

Transitioning to an automated cart system imposes significant capital expenses. Some of the key capital expenditures include:

- Purchasing carts
 - At least one recycling cart per household and more if the municipality is transitioning to a full cart program for all streams (garbage, recycling and organics).
- Purchasing automated or semi-automated collection truck(s)
 - Some municipalities retrofit packer trucks to operate as semi-automated trucks (e.g. Toronto).

Municipalities can choose to purchase and own the carts and trucks or build all or part of their capital expense into the collection contract. Each approach has its merits and drawbacks as discussed in Table 8.

Table 8: Merits and Drawbacks to Purchasing Carts and Automated Collection Vehicles

	Municipalities Adopting Approach	Advantages	Disadvantages
Municipality purchases carts and vehicles	<ul style="list-style-type: none"> • Bluewater Recycling Association • City of Guelph • City of Timmins 	<ul style="list-style-type: none"> - Municipality owns everything and can arrange best fit payment schedule - Municipality is not paying additional cost to the contractor for managing the risks and administration associated with purchasing and maintaining the equipment - Opportunity to benefit from CIF funding and joint purchasing agreement for carts 	<ul style="list-style-type: none"> - Requires a huge outlay of capital and development of a replacement reserve fund - Staff time, storage space, and maintenance costs - Challenges with real estate transactions and “ownership” of carts - Changes in sizing carts (upsizing) may leave surplus to manage - Requires a unique “backup” vehicle at additional cost
Build into the Contract	<ul style="list-style-type: none"> • City of Sault Ste. Marie 	<ul style="list-style-type: none"> - Eliminates administrative responsibilities associated with purchasing and maintaining carts and collection vehicles - Capital costs are distributed over the length of the contract - Leave the challenges to the industry professionals - Automated collection vehicles tend to last 7 years which can be aligned with a 7 year contract 	<ul style="list-style-type: none"> - Municipality loses control over management of the carts but will be considered responsible by the public if a problem occurs. Need to ensure control in contract to maintain the carts - Municipality pays a premium to the contractor for assuming the risks and capital expenditures - Contracts may charge back higher interest rates for capital expenditures - Decision to implement an auto-cart program may not coincide with contract expiry/renewal - May need to align length of contract to the life expectancy of the carts e.g. contract lasts 7 years and carts last 10 years.

	Municipalities Adopting Approach	Advantages	Disadvantages
Hybrid Municipality owns Carts, Contractor owns automated collection vehicles	<ul style="list-style-type: none"> City of Temiskaming Shores Region of Peel City of Toronto (specific areas) 	<ul style="list-style-type: none"> Municipality maintains control over the carts More likely to receive Council support Reduces the upfront capital expenditures Can be more easily amortized over a 10 year period Opportunity to benefit from CIF funding and joint purchasing agreement for carts 	<ul style="list-style-type: none"> Requires the municipality to establish a replacement reserve fund Staff responsible for any risk associated with the carts

7.1.1 Cart Procurement

Among those Ontario municipalities that responded to the survey, the 360 litre (95 gallon) cart was the most prevalent size used for recycling. Most of the municipalities based their cart orders and distribution on one cart per address and provided carts to residents at no charge.

Carts that are ordered in high volumes achieve economies of scale on the per cart cost. Some smaller municipalities in southwestern Ontario have banded together to jointly purchase carts in order to reduce overall costs.

For the municipalities surveyed, the capital costs for the larger carts are in the range of \$50 to \$60 each, with some of the smaller carts (120 litre) ranging \$30-40 each. In the case of Sault Ste. Marie, each dual/two cart cost about \$75 each. The carts usually come with a 10 year warranty (one municipality reported 13 years) and typically last 10 years.

Among those municipalities that have purchased the carts, a ‘rule of thumb’ applied is that the carts are typically amortized over a ten-year period and require a replacement/reserve fund of \$7 per household per year for 10 years. See Table 9 for details.

Table 9: Cart Amortization Rate

Cart Size	Cost	10 year Amortization Rate	
120 Litre (35 gallon)	\$40	\$4	
240 Litre (65 gallon)	\$50	\$5	
360 Litre (95 gallon)	\$60	\$6	

To further reduce costs and inventory requirements, some municipalities order standardized coloured bins with unique coloured lids (i.e. recycling = grey bin with blue lid and garbage = grey bin with black lid – see side example).

The larger size container offers householders recycling capacity as a trade-off for reduced collection frequency. Four out of seven municipalities offered a 240 litre cart for recycling as an option.

Municipalities should consider community demographics in order to estimate bin size requirements; for example, smaller bins should be considered for smaller household sizes and/or high elderly population percentage. Whereas most residents will choose either the 240 litre cart or the 360 litre cart, the smallest cart (120 litre) may be required in the downtown core where homes have smaller yards and limited storage space. As discussed in Section 6.2.3.1, only a fraction of householders (fewer than 10%) can be expected to choose the 120 litre cart. Therefore, most municipalities should not consider ordering this size to reduce administration and storage costs.

In the case of Bluewater Recycling, residents can choose from only two sizes of recycling carts (240 and 360 litre) of which 25% chose the 240 litre cart and the remaining 75% chose the 360 litre cart.

Most of the surveyed municipalities (City of Guelph, Bluewater Recycling Association, and the City of Timmins) established a default recycling cart size of the 360 litre cart. In the case of the Region of Peel, staff was able to minimize the potential for cart exchanges by basing the size of the default cart on the type of housing and experience gleaned from the pilots and from other municipalities. Residents were advised of the default sizes for their house and then given three months to advise the Region if they want to change their cart size³¹.

Most surveyed municipalities have Radio Frequency Identification (RFID) tags incorporated into each cart, which enables staff to better monitor missed collections and collection problems. RFID can be used as a critical element of quality control procedures to identify and manage contamination. Bluewater Recycling Association uses the RFID to measure employee productivity and to even out routes among the drivers³². Integrated RFID system costs vary but may include: cart tag (\$0.10 - \$1.00 each), active/passive vehicle reader (\$1,500-\$10,000 each), and associated software packages (\$2,000-\$20,000)³³.

7.1.1.1 Cart Specifications

The following links may provide helpful specifications for utilization in the procurement of carts:

- ✓ Bluewater Recycling Association
http://cif.wdo.ca/projects/documents/559.3-BRA_Final_Report.pdf
- ✓ CIF Joint Purchase Opportunity
<http://cif.wdo.ca/resources/documents/2014CIFCartSupplyDeliveryTender1.pdf>

7.1.2 Cart Distribution

Municipalities often spend months designing and implementing the cart selection and distribution strategy (see Section 9) to ensure that, on the day of the launch, residents are ready to use their carts and the municipality is ready to provide auto-cart collection service.

³¹ Implementation Plan For Cart-Based Garbage And Recycling Collection. October 18, 2013. Staff report prepared for the Peel Regional Council.

³² Large Curbside Container. August 2015. Prepared by Bluewater Recycling Association. Prepared for Continuous Improvement Fund. Project # 559.3

³³ <http://itak.aitam.org/simple-cost-analysis-for-rfid-options-choice-must-fit-the-organizations-needs-and-budget/>

The most commonly reported model for distribution is a contract-based approach; generally based on a comprehensive RFP for supply that includes supplier responsibility for the logistical elements of staging, storage, assembly and delivery with the municipality assuming responsibility for cart selection process (if applicable). In one case, the City of Sault Ste. Marie left the responsibility to the private collection contractor.

Monitoring the activities of the logistics companies is strongly recommended by the surveyed municipalities. In one instance, the company retained to distribute the carts, subcontracted the work to another company with an inexperienced team. Poor communications between the subcontracted team and the municipality resulted in missed deliveries and resident frustration. Staff was required to step in and resolve problems after the contract ended and recommends requiring daily tracking and reporting of distribution progress by the contractor to municipal staff.

Typical deployment costs ranged from \$4 to \$5, per cart/household. The Region of Peel, through economies of scale, brought the cost down to \$3 per cart. The distribution cost typically included assembly, placement of instructions inside the cart, administration and distribution costs.

It is recommended that municipalities establish a protocol for the cart selection process including reporting, recording, and scheduling delivery. The protocol will also need to address cart exchanges. Residents should be given a range of options for notifying the municipality of their preferred cart selection. Most surveyed municipalities set up call centres, email and/or on-line cart selection services.

In preparing for the distribution of the bins, The City of Temiskaming Shores (which provided one size of recycling cart to residents) established the number of carts to order and deliver using the following method³⁴.

- 1) Estimate number of carts to order by developing a master list through MPAC (Municipal Property Assessment Corporation) in conjunction with the city's water and sewer records (also tax records can be used).
- 2) Prepare information required for delivery of carts:
 - Develop a list of addresses to receive bins;
 - Identify the number of bins allocated to each property; and
 - Provide road maps of city.

Most municipalities allowed residents to exchange carts for different sizes for the first three months. After the grace period, the surveyed municipalities established an exchange fee ranging between \$21 and \$35 per cart, based on their respective costs. This exchange fee helps reduce the frequency and hastiness of cart exchanges (residents think twice) and offsets the costs of the new carts and collecting the exchanged cart.

³⁴ City of Temiskaming Shores: Launching a Cart Program: What's Involved? Presented at the Spring 2014 Ontario Recycling Workshop. June 4, 2014.

Replacing Blue Boxes:

120 litre (65 gallon) cart (= 4 x 16 gallon Blue Boxes) or 360 litre (95 gallon) cart (= 6 x 16 gallon Blue Boxes) accommodate:

- New materials to be added to the collection system in the future without disruption to the collection process; and
- Changes in the recycling stream mixture as a result of consumer and/or seasonal changes.

Bluewater Recycling discovered that the portion of residents that switched carts for different sizes was fairly small, with 10% of households changing the size of the cart within the first three months of the program implementation³⁵.

Mature municipal cart programs suggested that between 1-3% of carts are replaced annually.

Cart suppliers include Rehrig Pacific, IPL, and Otto. The CIF hosts a cooperative cart-buying program. Visit <http://cif.wdo.ca/resources/containers/html>.

7.1.3 Automated Collection Vehicles

Co-collection automated cart collection vehicles are expensive and according to Bluewater Recycling Association, these vehicles cost in the range of \$325,000 to \$350,000 and as much as \$400,000 with Compressed Natural Gas (CNG) conversion based on numerous factors such as type of cab, US dollar exchange rate, the cost of new emission standards, the cost of new weight limits, addition of CNG tanks. In contrast, co-collection manual side loaders can cost \$215,000 to \$255,000 or \$300,000 with CNG conversion³⁶.



Bluewater Recycling Association Automated Collection Vehicle

Halton Region co-collection manual side loader

Surveyed municipalities suggested the incremental cost per truck for automation ranged between approximately \$60,000/truck³⁷ to \$73,000/truck³⁸. No data was available with respect to maintenance costs associated with auto-cart collection vehicles. With respect to ongoing maintenance and operating issues,

³⁵ Large Curbside Container. August 2015. Prepared by Bluewater Recycling Association. Prepared for Continuous Improvement Fund. Project # 559.3

³⁶ Conversation with Francis Veilleux of Bluewater Recycling Association on December 3, 2015

³⁷ Guelph Automated Waste Cart Collection System Curbside Collection Performance and Monitoring Report (March 2014) – CIF Report 284. Fleet was 11 recycling trucks (3 spares shared with garbage) reduced to 8 trucks (7 with 60/40 split and 1 dedicated recycling single stream due to high volumes) and 2 spares shared with garbage

³⁸ City of Toronto – Efficiency of Automated Collection and Performance of Compressed Natural Gas Vehicles (2014) - CIF Report 548.11

municipalities need to consider access/ownership of backup vehicles and supervisor vehicles with the ability to collect cart materials.



Source: <http://www.kannmfg.com/products/refuse/cocollector-cc/>

Some programs in the United States have adapted front-end collection vehicles to accommodate carts by using equipment called the Currotto Can. Although Currotto cans (see photo) offer flexibility in an existing waste management fleet, their use in urban residential collection, however, can be limited due to high overhead clearance requirements and frequency with which the front-end bin must be emptied into the vehicle body (approximately every 8-10 households).

In a Bluewater Recycling Association study (CIF report 176) three systems were analyzed for efficiency comparison in a rural setting. It was found that automated (semi or full) was more efficient at collecting larger amounts of materials faster. Automated collection averaged 100-120 stops per hour in comparison to 80 stops per hour with manual collection. This represents between a 30-50% improvements in collection efficiency (it took 30% less time to do the same number of households). Further, residents with cart systems placed ~20% more recyclables for set-out and drivers took less breaks and shorter lunches when using the automated trucks.

7.2 Collection Costs

Ontario municipalities reporting cart and non-cart based collection costs between the years 2010 to 2014 were compared, as shown in Table 10 (note: costs do not include depot/transfer costs but do include annual capital costs). All of these municipalities had single stream recycling programs.

Table 10: Comparison of Collection Costs of Cart versus Non-Cart Programs

Ontario Single Stream Municipalities 2010-2014 (5 years as applicable)	Average Collection Costs per Marketed Tonne	Low (WDO group)	High (WDO group)
Carts - 5 Municipalities	\$235.28	\$156.38 (group 3)	\$311.28 (group 6)
Non-Cart – 12 Municipalities	\$272.08	\$117.72 (group 1)	\$723.21 (group 6)

The table above shows that for the five cart-based municipalities, the average cost per marketed tonne is roughly 15% less (\$36.80/tonne) compared with twelve non-cart based municipalities. Readers are, however,

cautioned that there are many other program specific variables that can affect the overall collection costs and that a small sample group of this nature is not statistically valid. None the less, this difference in costs supports the common view that auto-cart systems can reduce collection costs.

Sault Ste. Marie shifted from a 2 stream Blue Box program to a 2 stream automated cart collection program. A comparison of collection costs, shows that the pre-cart (2010-2012) average collection cost per marketed tonne was \$141.17/tonne and the auto-cart (2012-2014) average collection cost per marketed tonne was \$154.36/tonne, resulting in a 9% increase in collection costs for the cart program.

When writing a business case for auto-cart systems, some municipalities have built deferred disposal costs or delayed landfill capital costs into the calculation in order justify the program change. In the case of the City of Toronto, increased recycling tonnage (processed locally) was highlighted when comparing costs associated with transferring and hauling garbage from Toronto to the City-owned Green Lane Landfill near London, Ontario.

The City of Guelph reports that moving to an automated cart program resulted in first year recycling program net savings of approximately \$260,000 (or \$230,000 if the bag breaking technology savings are subtracted out). These savings included savings in collection crew of \$192,000, savings in number of collection vehicles of \$81,000, savings in WSIB of \$11,000.

Source: Guelph Automated Waste Cart Collection System Curbside Collection Performance and Monitoring Final Report. March 31, 2015. Prepared by the City of Guelph for Waste Diversion Ontario (CIF Project #284)

7.3 Processing Costs

Ontario municipalities reporting cart and non-cart based processing costs between the years 2010 to 2014 were compared, as shown in Table 11 below. All of these municipalities had single stream recycling programs.

Table 11: Comparison of Processing Costs of Cart versus Non-Cart Programs

Ontario Single Stream Municipalities 2010-2014 (5 years as applicable)	Average Processing Costs per marketed tonne	Low (WDO group)	High (WDO group)
Carts - 5 Municipalities	\$142.58	\$85.17 (group 6)	\$254.88 (group 3)
Non-Cart – 9 Municipalities	\$112.12	\$60.66 (group 7)	\$296.22 (group 7)

In Ontario single stream programs in Table 11 show that the average cost per marketed tonne of processed recyclables for the five cart-based municipal programs is roughly 27% more (\$30.46/tonne) compared with nine non-cart based municipal programs.

The Continuous Improvement Fund, provided funding assistance (50% of costs) for the conversion of the Bluewater Recycling Association MRF in 2009, and assistance for the purchase of automated carts for the first municipalities converted to automated collection. BRA reported that the combined MRF upgrades and implementation of single stream processing in early 2010 (including the addition of mixed plastics) reduced MRF operating hours by 25%, increased MRF capacity by approximately 100%, resulted in a 34% reduction in collection costs while collecting 17% more material, and decreased the MRF residue rates to around 4%³⁹.

7.4 Staffing

Surveyed municipalities identified two significant staff related considerations that should be addressed when implementing an auto-cart program:

- The requirements for internal staff dedicated to the implementation of the auto-cart program; and
- Changes to the collection crew.

No information was available regarding the impact on MRF processing staff.

7.4.1 Internal staff Requirements

Each of the surveyed municipalities reported the need for additional municipal staff to implement the auto-cart program. In a few instances, existing staff were re-assigned to manage the program implementation, either in teams or as an individual, but in most cases additional staff were hired on a short-term basis to assist with the program 'roll out'.

Without exception, each surveyed municipality emphasized the need for dedicated staff to ensure a smooth transition from the manual program (or in one case, a depot program) to the auto-cart program. The number of staff and costs varied depending on size of program and ability of existing staff to manage some of the workload. Even when outside companies were used to manage the cart distribution logistics, respondents advised that oversight, monitoring and tracking by municipal staff was considered necessary. The overall message from the surveyed municipal staff was that conversion to automated carts requires a major program overhaul, which can only be accomplished through the placement of dedicated staff and many months of preparation.

For 2016 rollout of cart program the Region of Peel is seeking 21 curbside representatives for delivery support, curbside checks, and field education activities (roughly 1 staff per 15,000 households).

The key responsibilities for municipal staff overseeing auto-cart program implementation include:

- Ensuring adequate customer service staffing to address cart selection, special assistance, auto-cart program queries;
- Managing the cart procurement process;

³⁹ *Innovation in Ontario's Blue Box Program, CIF, Andy Campbell*

- Managing the contract tendering process or auto-cart collection vehicle procurement process;
- Developing and overseeing the cart selection process;
- Developing a database of households requiring carts and residential cart selection (if different size options are offered);
- Managing the logistics associated with cart storage, assembly and distribution;
- Implementing effective promotion and education and outreach; and
- Planning the new collection routes.

Most surveyed municipalities found that after the program launch, the number of staff dedicated to the cart program declines when the program shifts to maintenance mode. Bluewater Recycling Association found that it needed one full time equivalent (FTE) staff to manage the different requirements of the program, with the time and responsibilities spread over a number of permanent staff and one half time staff hired, “One person is dedicated to the management of the wheelie bins. That aspect of her job is only part time. One individual does the physical exchanges and repairs three days every two weeks, the rest of his time is spent in the MRF or managing e-waste. All and all we have one full time equivalent staff for managing 80,000 bins.”

7.4.2 Collection Crew

One of the benefits of an automated cart collection is that it allows for a more diverse workforce since collection is no longer hindered by physical strength and endurance of the collection crew as is required for manual collection. Automated cart collection enables municipalities to overcome complications that are faced by overweight containers that may put employees at risk from a health and safety perspective. In addition, an auto-cart program typically results in fewer vehicles and drivers, depending on the routing and optimized utilization of the collection vehicles.

The City of Toronto’s semi-automated vehicles require two staff in order to collect two materials. Toronto estimates that a semi-automated vehicle is able to collect from approximately 700 households per route, while a fully automated vehicle is able to collect from approximately 1,300 households per route (85% more). However, the routes collected by fully automated vehicles require a second vehicle to pick up the secondary material (green bin organics) material. Thus for every two routes, a reduction of 2 staff can be achieved⁴⁰.

The municipalities of Bluewater Recycling Association and the cities of Guelph and Sault Ste. Marie reported reductions in collection crew resulting from reduced collection times. The City of Guelph reduced its collection crew by three employees when it switched to an auto-cart, bi-weekly collection schedule. Both Sault Ste. Marie and Bluewater Recycling Association were able to reconfigure their collection routes, resulting in shorter collection times. In the case of Sault Ste. Marie, when the collection staff end their routes earlier they are re-assigned to other tasks and in the case of Bluewater Recycling Association it reduced its collection crew by 20% by decreasing its workday from 10 hours to 8 hours.

7.4.3 Health and Safety

By far the largest justification in the waste management industry to implement automated cart collection is from a Health and Safety perspective. In 2014, the waste management industry was ranked the 5th most dangerous industry, resulting in increasingly high Health and Safety coverage costs (increased costs of 27% since 2001⁴¹) and claims, especially associated with manual collection. Manual collection of waste and

⁴⁰ City of Toronto – Efficiency of Automated Collection and Performance of Compressed Natural Gas Vehicles (2014) - CIF Report #548.11

⁴¹ Based on review of waste collection rate group 570 – 2001 vs. 2015 (www.wsib.on.ca)

recyclables has been known to result in lower back and other injuries among collection workers across the province of Ontario.

In 2011, the Ministry of Labour (MOL) issued orders requiring an Ontario municipality to change the way it collects waste and recyclables based on an ergonomic assessment. These orders are an indication that the MOL may be taking a more active enforcement approach in the way it addresses ergonomic collection concerns. Even though a municipality may hire outside contractors for its collection services, the municipality still has a responsibility under the Occupational Health and Safety Act (OHSA), Section 25, to provide a safe work environment. The use of fully automated or semi-automated cart collection will reduce injuries and likely lower Workplace Safety and Insurance Board premiums over time⁴².

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%), as well as
- Reduced WSIB claims (90%)⁴³.

Auto-cart collection minimizes:

- Exposure to sharps such as broken glass or needles;
- Repetitive strain injuries to shoulder, knees, back;
- Physical fatigue for collection staff;
- Direct exposure and risk of injury from unfavourable weather such as rain, snow, ice and extreme hot and cold temperatures; and
- Exposure to traffic risks while working at the side and rear of the collection vehicles.

City of Guelph experienced a 62% savings in replacement labour costs with less than a year of automated services⁴⁴.

George South of Progressive Waste compared manual to automated systems (CIF ORW June 13, 2016) between Simcoe and the Region of Peel with a 300% savings in monthly safety costs (\$60,000 vs. \$15,000). Most of the surveyed municipalities reported that auto-cart collection programs significantly reduced labour injuries and WSIB (Workplace Safety and Insurance Board) claims. In the case of Bluewater Recycling Association and the City of Guelph, WSIB claims fell off by 92% and 90%, respectively, with relative WSIB claim costs being reduced by 99.5% and 95%, respectively.

⁴² Region of Peel – Implications of Implementing a bi-weekly garbage collection pilot (Oct 24, 2011)
<http://www.peelregion.ca/council/agendas/pdf/wm-20111103/4b.pdf>

⁴³ City of Vancouver, Automated Collection of Solid Waste (cited in CIF Report 284)

⁴⁴ Guelph Automated Waste Cart Collection System Curbside Collection Performance and Monitoring Report (March 2014) – CIF Report 284

8 Resident Feedback

The user experience with a cart system can influence success by affecting diversion and ultimately cost optimization. Thus, it is important to explore and address user accessibility issues with the implementation of auto-cart systems.

The majority of surveyed municipalities reported that residents were very satisfied with the auto-cart system. Those that followed up reported that the majority (~80%) approved of the program change. Surveyed respondents from Bluewater Recycling Association and the City of Guelph reported that they liked the new carts for recycling because they were easier to use, stored more material, and resulted in less litter.

Residents were asked to voice their concerns about a cart program at Region of Peel pre-pilot open houses. The most common concerns included:

- Space to store carts,
- Seniors ability to manoeuvre carts, and
- Long driveways (rural area only).

During the pilot none of these concerns were found to be a major issue.

Source: Bi-Weekly Cart-Based Collection Project Update. February 12, 2015. Presentation to Council

In 2012, Region of Peel launched a one-year pilot program to test bi-weekly collection in areas using the traditional manual collection (garbage bags and blue boxes) and in areas using an auto-cart system. At six month intervals, the participating residents were asked if they thought that bi-weekly collection was a good idea for the Region. Those residents participating in the auto-cart program supported bi-weekly collection more than those in the manual collection areas. By the end of the pilot project, 75-80% of auto-cart participants were in favour of the Region of Peel moving to a bi-weekly collection system, compared with 40-58% of manual collection participants⁴⁵. This clearly reveals the reluctance of residents to change systems without direct experience and education.

8.1 Accessibility - Seniors and Special Needs



Source: City of Guelph Automated Cart Collection: Does it Cut Program Costs? CIF Project #284. Presented at the Spring 2014 Ontario Recycling Workshop. June 4, 2015.

Seniors and people with special needs may show initial reluctance in shifting to a cart based program. The research, however, suggests that seniors adapt easily to the cart system and actually prefer it since it is easier to move a cart than move blue boxes. In the case of Bluewater Recycling, “seniors complained about the change, then we show them the bins and then they understand that it is easier to move than a blue box”⁴⁶.

The City of Guelph and Bluewater Recycling Association also found that carts enable seniors to avoid having to set out the cart during inclement weather (rain, ice or snow).

There will be instances in which the cart will not resolve mobility problems or health concerns. Municipalities need to offer special assistance service to those who cannot manoeuvre the carts. Most of the municipalities surveyed provide assisted waste collection service to residents in need but require that the residents complete an application form providing relevant information supporting the

⁴⁵ Source: Bi-Weekly Garbage Collection Pilot Project- Final Report. March 25, 2013. Staff Report to the Peel Regional Council

⁴⁶ Communication with Francis Veilleux, President of Bluewater Recycling Association

claim (for example: a physician's signature and/or disability parking permit). In most instances, the municipalities already provided the assistance service prior to the auto-cart program and only had to transition the service to the carts.

8.2 Long driveways/laneways

One of the potential drawbacks to the auto-cart program in rural areas is the need for residents to transport the cart down long laneways. Again, staff needs to work with residents to identify solutions and adequately communicate these options to residents. In some instances, staff may need to visit the home to address needs, educate, and provide on-site recommendations.

Many of the surveyed municipalities, with a rural collection component to their service, recommend establishing a covered depot at the end of the driveway where the bins are stored. Residents continue to drive the recyclables, organics and garbage to the storage location but on a more frequent basis. According to Bluewater, "others prefer to keep an eye on their bins so they have developed a number of devices to tow their bins to the road on collection day with their vehicle, tractor, or lawnmower"⁴⁷. Some use a special hitch that pulls the cart behind their vehicles as shown in Figure 7. Municipalities need to be aware of unique resident contraptions when developing replacement policy for broken carts.

Figure 7: Special Hitch Used to Move Carts



Source: Large Curbside Container. August 2015. Prepared by Bluewater Recycling Association. Prepared for Continuous Improvement Fund. Project # 559.3

8.3 Flights of Stairs

Carts are designed to withstand heavy use including being dragged down flights of stairs. Managing carts or Blue Box on stairs, each, present safety concerns. Municipalities need to take into consideration potential safety issues, especially concerning seniors and special need residents, and build flexibility into the program by enabling residents to choose different sizes of carts and by offering special collection. Municipalities will need to work with residents, understand their needs, and resolve concerns.

The City of Guelph reported that by allowing residents to select their cart sizes gave the public a sense that they were providing input into the program, which helped the City to earn acceptance and support for the program. The auto-cart program achieved 80% resident satisfaction.

Source: City of Guelph Automated Cart Collection: Does it Cut Program Costs? CIF Project #284. Presented at the Spring 2014 Ontario Recycling Workshop. June 4, 2015.

8.4 Litter and Community Aesthetics

The use of lidded carts can reduce potential litter by preventing loss due to wind, snow plow operations, and scavenging. In many communities the uniform aesthetics of carts, for the entire waste system, are an added benefit. Two municipalities reported the following:

⁴⁷ Large Curbside Container. August 2015. Prepared by Bluewater Recycling Association. Prepared for Continuous Improvement Fund. Project # 559.3

- The City of Guelph received fewer complaints relating to animals getting into the recyclables. Complaints regarding missed recycling due to snow banks reduced by 50%.⁴⁸
- In 2015, Bluewater Recycling Association reported that litter (bags blowing down the street before and after collection – see picture below) was eliminated with the use of wheelie carts⁴⁹.



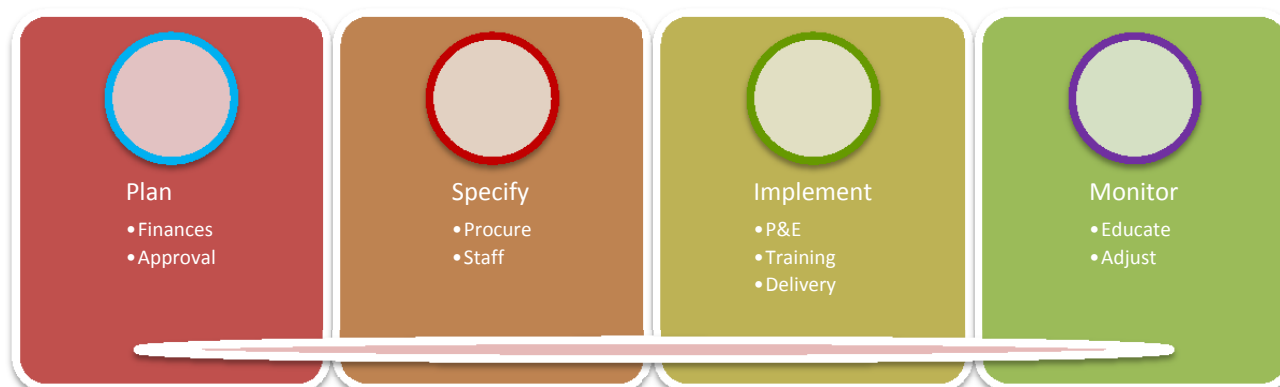
⁴⁸ Guelph Automated Waste Cart Collection System Curbside Collection Performance and Monitoring Report (March 2014) – CIF Report 284

⁴⁹ Bluewater Recycling Association August 2015 - Large Curbside Container Project - CIF Report 559.3

9 Program Planning and Implementation

One of the most important tasks associated with launching an automated cart program involves the developing a detailed implementation and task schedule - see Figure 8. After reviewing the implementation of seven automated cart programs in Ontario, it is estimated to take between 3-5 years to plan, evaluate, specify, and implement a new automated cart collection program. After program implementation it is beneficial to provide continuous monitoring to adjust the program locally and provide ongoing education to maximize residential participation.

Figure 8: Program Planning Process



The following table may assist in the stages and time required to complete the main tasks associated with automated cart collection.

Table 12: 3 Year Automated Cart Collection Program Implementation Timeline

Stage	Activities	Timeline	Running Timeline
1. Pre-Planning	<ul style="list-style-type: none"> ✓ Analyze Costs, Estimated Savings and Benefits <ul style="list-style-type: none"> ○ Compile an accurate database for households to include and locations not to implement program ✓ Attain Political Buy-in ✓ Adjust Staffing Plan <ul style="list-style-type: none"> ○ (Dedicate 1 FTP) 	2-6 months	6 months
2. Planning, Budgeting and Authorization	<ul style="list-style-type: none"> ✓ Develop Tasks, Responsibilities and Implementation Schedule ✓ Review Budget and Reserve Financing ✓ Devise Procurement procedure and specifications ✓ Attain Political Authorization to proceed ✓ Initiate public relations and outreach campaign 	1-6 months	1 year
3. Bylaw Enforcement	<ul style="list-style-type: none"> ✓ Conduct Legal Research ✓ Draft Bylaw(s) ✓ Present to Municipal CAO or Similar ✓ Present Bylaw package to Council for Consideration and Approval ✓ Establish Responsibilities and Procedures for Bylaw Enforcement ✓ Hiring and Training (as applicable) 	1-2 years (start after political authorization)	(included in overall timeline)

Stage	Activities	Timeline	Running Timeline
4. Procurement for Bins, Trucks, Hauler, Disposal / Processing, Information Systems, Public Relations	<ul style="list-style-type: none"> ✓ Prepare Collection RFP (3 months) including/not incl. Trucks <ul style="list-style-type: none"> ○ Prepare RFP for trucks (to add option for Compressed Natural Gas it may require construction of re-fueling infrastructure which could take 18 months) ✓ Prepare RFP for Bins – include assembly, communication material to be on cart, and delivery ✓ Issue applicable RFPs (1 month) ✓ Evaluation RFPs (1 month) ✓ Develop Comprehensive Communication Plan for: <ul style="list-style-type: none"> ○ Resident cart selection process; ○ Resident cart delivery process; ○ Resident collection schedule. 	5-7 months	1 year 7 months
5. Operations	<ul style="list-style-type: none"> ✓ Implement Information Systems for Customer Service (carts and complaints) ✓ Develop Routing and Billing systems ✓ Training of Drivers, Supervisors, Customer Service Reps, Bylaw Enforcement Officers, Other Waste Stakeholder positions ✓ Set-Up Facilities – Bin Storage/Maintenance, Waste Sites/Depots for bulk items ✓ Draft/Finalize Routes (analyzing day of week changes, send notifications, seek driver feedback) 	3-6 months	2 years 1 month
6. Manufacturing / Delivery, Implementation of Information Systems, Routing	<ul style="list-style-type: none"> ✓ Bins (3-6 months) – assemble/distribute to residents 1 month prior to collection ✓ Trucks (4-12 months) <ul style="list-style-type: none"> ○ May need longer for CNG ✓ Haulers (operation set-up) ✓ Software (1-3 months) ✓ Customer Service, Billing, and Software (2-6 months) ✓ Public Relations Campaign - Initial Outreach (2-3 months prior first collection) <ul style="list-style-type: none"> ○ New Service Notices Directly to Customers (1-2 weeks prior to cart delivery) ○ Media (newspaper, TV, etc.), mailings, Notices on bills ○ Website Development ✓ Work Orders and Cart Tracking ✓ Contract Management (performance tracking) 	6-12 months	3 years
		2-3 months	
		6 months prior to launch	
		1-4 months	

The scheduling depends to a large extent on the size of the municipality and whether the municipality can provide the collection service in-house or must tender an auto-cart collection contract. In the case of the Region of Peel, the implementation staff spent 36 months from start to finish in designing and launching its auto-cart program (not including the cart pilot). This included the time required to design, issue, evaluate and award a collection contract. Other municipalities, such as Bluewater Recycling took about one year to implement the auto-cart program.

10 Promotion and Education (P&E)

An auto-cart program requires the development of a multi-dimensional communication strategy to ensure resident support for the program. The communication strategy must ensure that a variety of media and communication techniques (e.g. social media) are used to reach different segments of the population. Outreach plays an important role in achieving community support by setting up information booths at events and public space locations. The strategy must also feature a well-planned approach for the municipality's customer support services for front-line questions and concerns from residents about the program.

A well-designed, effective P&E program should include the following tasks:

Stage 1 - Design	Task 1 - Identify a goal/objective Task 2 - Identify and understand the target audience Task 3 - Design the message Task 4 - Design the tools and tactics to disseminate the message
Stage 2 - Implementation	Task 5 - Logistics: Budget and schedule
Stage 3 - Monitoring and Evaluation	Task 6 - Conduct an evaluation
Stage 4 – Adjust	Task 7 – Adjust message to target challenges in key areas

Communities will determine the level of financial resources available to achieve high impact P&E and if necessary, seek alternative sources of funding or modify tactics to deliver messaging. A 2007 study of Ontario's Blue Box programs suggested that well-performing communities (with recycling recovery at or exceeding 60%) spent approximately \$0.83 to \$1.18 per household on P&E for ongoing recycling systems. This number increases to \$3-\$4 per household in the first year of large program changes such as the implementation of an auto-cart program⁵⁰.

It is recommended that municipalities should budget
\$3.50-\$4.50 per household when launching an auto-cart program.

The communication strategies used by the City of Guelph and the Region of Peel are presented below.

10.1 City of Guelph's Auto Cart Communication Strategy

In designing the communication strategy for the cart program, the City of Guelph identified its target audience as including the heads of households (residential, multi-residential and student housing), multi-residential property managers and owner, and the Industrial, Commercial and Institutional (IC&I) sector using the City's curbside waste collection services. In addition, staff anticipated potential and known concerns relating to the carts including:

- storage requirements,

⁵⁰ Source: Blue Box Program Enhancement and Best Practices Assessment Project, Final Report, July 2007

- maintenance requirements,
- the added inconvenience of moving the carts, and
- the perception that switching to bi-weekly collection for recyclables was reducing the service level to the resident.

The City developed positive messages and a variety of communication approaches to address the concerns and ensure that residents knew about the program. City staff noted, “To ensure that the approach was appropriate for each audience, the Communications Program used a variety of tactics that were proven to be effective for each group. The approach was developed considering their specific needs, the detail and scope of information that each audience would require, and the end goals to be achieved”⁵¹.

Prior to the auto-cart program launch, the City of Guelph rolled out messaging over a 6 month period using a variety of communication approaches to reach its target audience including:

- Different print and radio advertisements;
- A brochure with a tear-off cart size selection ballot (delivered door-to-door);
- A detailed Waste Cart User Guide (inserted in the green cart);
- Email, web content and messages via Facebook and Twitter.
- Invitations to participate in city-run information sessions located throughout the city,
- Display booths at Special events (e.g. multicultural festival), mall displays and other outreach events.

Feedback from the City of Guelph’s communication strategy showed the majority (74 per cent) of residents interviewed were very satisfied with the communications and information they received about the new waste cart collection system. Approximately half of respondents were most drawn to the brochure delivered to their door, followed by the Waste Cart User Guide in the cart.



Carts were deployed across the city over a three year period. A survey of residents who received carts in the first year was completed to secure feedback on the successes and challenges of the program. This information was used to modify/validate the city’s communication approach for the final two rollout years⁵².

The City of Guelph spent about \$10 per household spread out over 3 years of phased in cart implementation (\$138,000 in year 1 and about \$85,000 in years 2 and 3)⁵³.

⁵¹ 2014 SWANA Communication Excellence Award Submission City of Guelph - Waste Cart Rollout Communications Campaign 1 “We’re Rolling out the Carts”.

⁵² 2014 SWANA Communication Excellence Award Submission City of Guelph - Waste Cart Rollout Communications Campaign 1 We’re Rolling out the Carts.

⁵³ 2014 SWANA Communication Excellence Award Submission City of Guelph - Waste Cart Rollout Communications Campaign 1 We’re Rolling out the Carts.

10.2 Region of Peel's Auto Cart Communication Strategy

Region of Peel employed four different stages in its auto cart communication strategy, which was spread out of 30 months (see Table 13)⁵⁴.

Table 13: Region of Peel's Stages of Communication

Phase One	Soft Push (Jan 2014 to Dec 2014)	<ul style="list-style-type: none"> The first 12 months dedicated to educating residents about the future program changes, timing and transition to bi-weekly cart based collection (including the benefits).
Phase Two	Cart Size Education (Jan 2015 to Aug 2015)	<ul style="list-style-type: none"> Eight months to provide information so that residents make informed decisions about the cart default sizes assigned to them and whether they would prefer a different size and how to order the change. Residents were also reminded of the benefits of the cart based system and biweekly.
Phase Three	Cart Delivery (Sept to Dec 2015)	<ul style="list-style-type: none"> Three months prior program launch, residents are informed about the timing and process for the cart delivery Residents are reminded about the changes occurring on January 1, 2016, including, the change in collection day and change in collection frequency Residents are reminded how to exchange carts, if needed
Phase Four	Program Launch (Jan 2016 to June 2016)	<ul style="list-style-type: none"> Six months following program launch, communication ensure that residents understand the new collection program and changes in collection days

During the third phase, the Region of Peel employed the following communication approach three months (Sept to Dec 2015) prior to program launch:

- Media relations and advertisements in local and ethnic media;
- Outdoor advertising (e.g. mobile signs);
- Print material including in-cart delivery packages and unaddressed ad-mail;
- Extensive municipality outreach and partnership opportunities; and
- Continue to use existing and new digital platforms to reach out to different audience segments and support ordering of carts e.g. web, social media, on-line videos.



The Region of Peel's pre-program promotion and education launch cost about \$3/hhld (Includes: staff time, online and print advertisements in an amount of approximately \$500,000)⁵⁵.

⁵⁴ Implementation Plan For Cart-Based Garbage And Recycling Collection. November 14, 2013. Staff report prepared for the Peel Regional Council.

⁵⁵ Implementation Plan For Cart-Based Garbage And Recycling Collection. November 14, 2013. Staff report prepared for the Peel Regional Council.

In general, the larger the size of the municipality, the more the economies of scale factor into the education and promotion costs. It is important to continue with the promotion and education after program launch to regularly inform residents how to use the cart program effectively. Residents will benefit from gentle reminders and nudges to continue participating in the recycling program and place the appropriate recyclables in the recycling cart.

11 Impact on Recycling

It is virtually impossible to make a definitive statement about the impact of auto-carts on recycling rates since, in many cases, the auto-cart program within the seven Ontario municipalities surveyed, has been implemented as part of other, sometimes very significant, program changes such as:

- Switching to a single stream recycling program;
- Increasing the number of recycling materials in the program;
- Shifting to bi-weekly garbage and recycling collection;
- Implementing subscription-based, variable cart (pay-as-you-throw) financing system.

As a result, in many cases the performance of the auto-cart program must be considered within the overall performance of the reconfigured recycling and waste collection program.

It is generally thought that auto-cart collection increases recycling tonnages by increasing resident participation rates and potentially improving capture rates. Further, Region of Peel pilot studies suggest that residents tend to set out carts for collection when they are full, which improves collection efficiency. Bluewater Recycling Association reported a 17% increase in capture rates with implementation of an automated cart system⁵⁶.

In a pilot area, Region of Peel shifted to bi-weekly collection of garbage and recycling (weekly organics) and waste audits showed increases in recycling by 3-6%, organics 6-10%, reduced garbage by 12-15%⁵⁷.

Some programs, already achieving high recycling capture, may not achieve significant changes in recycling rates with the introduction of auto-cart systems. The City of Guelph provided a convenient recycling program with unlimited storage capacity in which recyclables were stored in transparent blue bags (paid for by the resident) with no limit on the amount of recycling bags that could be set out at the curb. Consequently, the change to auto-cart collection resulted in minimal increase in diversion of 2.4%.

Other surveyed municipalities experienced significant increases in recycling rates as a result of the launch of the auto cart program in conjunction with other measures. The City of Timmins observed a 38% increase in the recycling amounts and the City of Temiskaming Shores has estimated at 72% increase in recycling collected. It should be recognized that a large portion of the increase resulted from the other changes to the program, for example Timmins moved from bi-weekly to weekly recycling and Temiskaming Shores transitioned from a depot system to curbside collection. Bluewater Recycling Association was able to expand the list of recyclables and offer increased storage capacity with the carts and Sault Ste. Marie offered a more convenient system with the dual/two cart.

Many surveyed municipalities self-reported increases in recycling/diversion rates (e.g. Bluewater Recycling Association, Region of Peel, and the Cities of Temiskaming Shores, Timmins and Sault Ste. Marie) see Table 14.

⁵⁶ Bluewater Recycling Association – Single Stream MRF /Automated Collection Project - CIF #135 (2010)

⁵⁷ Region of Peel - UPDATE ON BI-WEEKLY GARBAGE COLLECTION PILOT (August 2012)

<http://www.peelregion.ca/council/agendas/pdf/2012/wmc-2012-09-06/4b.pdf>

Table 14: Increases in Recycling Rates Following Auto Cart Program Implementation

	Temiskaming	Timmins	SSM	Guelph	Peel (Pilot)
Increases comparing pre and post cart program	Estimated 72% increase recycling tonnage	Self-reported increase of 38% in recycling tonnage. Marketed tonnage (WDO Datacall) showed an increase of 19%	Self-reported increase of 20% in recycling tonnage	Increased marketed recyclables 3.2%	Expect increase of 4 - 6% in recyclables diverted
Notes	<ul style="list-style-type: none"> Shifted from Depot to Curbside collection (may account for +~60% increased recycling)⁵⁸ Initial numbers indicate that overall waste diversion has increased from 14.7% baseline to projected 35% 	<ul style="list-style-type: none"> Went from bi-weekly to weekly collection and implemented User Fees (weekly may account for +~6% change and same collection frequency as garbage may account for +~10% and User Fees may account for +~18%) Recycling was 2,324 tonnes in 2010, 2,927 tonnes in 2011 and 3,216 tonnes in 2013 (WDO reported) 	<ul style="list-style-type: none"> WDO Datacall Report showed marketed recycling increased by 3% 	<ul style="list-style-type: none"> Shifted recyclables diverted in overall waste stream by 2% 	<ul style="list-style-type: none"> Based on extensive pilot studies 2012-2013

In Appendix B, Table 15, Table 16, and Table 17, provide information from the annual Waste Diversion Ontario Datacall, regarding seven municipalities with automated cart collection programs in Ontario to show impact pre and post automated cart collection program implementation.

Three municipalities that had the same number of streams prior to cart collection (Sault Ste. Marie, Timmins, and Guelph) all increased marketed recycling tonnage and recyclables diverted. Overall waste diversion rates were either stable (0% change) or improved.

⁵⁸ Based on 2013 Ontario Marketed Tonnes per household with average depot rate of 93kg/year compared to curbside rate of 151kg/year

12 Summary and Conclusions

12.1 Summary of Findings – Automated Cart Recycling

Benefits Associated with Auto-Carts	Challenges Associated with Auto-Carts
<p>Collection Efficiency</p> <p>Single stream recycling cart programs showed average collection costs of 15% less than manual single stream collection.</p> <ul style="list-style-type: none"> 1 – 95 gallon cart is equal to 6 – 16 gallon Blue Boxes) allows for possible changing of the recycling collection to bi-weekly reducing collection costs by 30-50% Research suggests that automated collection is up to 125% more efficient with respect to stops per hour <p>Co-collection with either garbage and/or organics also reduces fleet and collection staff requirements.</p>	<p>Capital Expenditures</p> <ul style="list-style-type: none"> Purchase of carts ranges between \$40-60 per household (depending on size of cart, plus ~\$3-\$5 per household deployment cost) <p>Additional facilities and infrastructure are required to store and maintain inventory (roughly 1-3% are replaced annually at \$65-100 per cart – most municipalities have implemented \$21-\$35 charge for replacing bins).</p> <p>Changes to recycling program require enhanced promotion and education, which can range from \$3.50-\$5 per household.</p>
<p>Lower Labour Cost</p> <ul style="list-style-type: none"> Collection staff reduction in physical activity and disagreeable conditions resulting in lower labour injuries and thus WSIB costs of between 60-90% <p>Automated cart collection also allows for a more diverse workforce (e.g. physical ability, gender, age) and some municipalities have enhanced available services as a result of labour force changes and reduced collection times.</p>	<p>Collection Truck Costs</p> <ul style="list-style-type: none"> Incremental cost of side-loading automated truck versus an over-top recycling truck is ~30% more per truck Coupled with bi-weekly collection fleet can be reduced by 10-30% <p>Increased maintenance concerns for technology and hydraulic components on automated collection vehicles were unverified.</p>
<p>Improved Participation and Strong Resident Support</p> <ul style="list-style-type: none"> In six out of seven programs, marketed recycling rates improved between 1-3% (see Appendix B) <p>Residents appreciate the ease of use, increased home storage capacity, and convenience which results in increased capture of recyclables.</p> <ul style="list-style-type: none"> Surveys in four municipalities suggest that 80% of residents (post program implementation) support the auto-cart program (see Section 8) 	<p>Higher Residue Rates and Processing Costs</p> <ul style="list-style-type: none"> Estimated minimum increase in residue rates (from existing single stream) with auto-cart program is ~between 5-6% Processing costs showed to be ~27% more for auto-cart programs when compared to single stream programs <p>Collection monitoring is more difficult due to reduced visual and direct handling of materials. However, with directed P&E and strong curbside monitoring programs (on-vehicle cameras and direct resident feedback) two municipalities have maintained or reduced single stream residue rates with auto-cart program implementation.</p>

Benefits Associated with Auto-Carts	Challenges Associated with Auto-Carts
<p>Reduced Complaints</p> <ul style="list-style-type: none"> Carts are more resistant to animals, snowploughs, and wind. This reduces blowing litter and strewn materials, and provides a single uniform set-out container over an entire community. The cart lids help reduce odours and keep water out of materials, reducing leakage from trucks and water weight at recycling facilities <p>No quantifiable data was available to determine cost savings associated with reduced “complaints”.</p>	<p>Changes in Recycling Materials</p> <ul style="list-style-type: none"> Due to light weighting and packaging changes volume of Blue Box materials (without compaction or adding materials) are estimated to increase 6% <p>Overall weight of Blue Box material expected to decrease by 7% (2008 to 2026).</p>

12.2 Core Considerations

When considering the viability of an auto-cart program, municipalities may wish to evaluate their program characteristics with the core considerations of an auto-cart system:

- Composition of the municipality’s recycling stream, participation rates and ability for existing recycling program to accommodate storage capacity needs (now and in the future recycling program should materials be added and/or removed);
- Ability to collect/process single stream recycling materials;
- Jurisdiction over all waste streams (for co-collection opportunities) and location of disposal/transfer/processing facilities;
- Availability of reserve monies for large capital expenditures;
- Current contract(s) and/or fleet replacement timing (need a 3-5 year planning/implementation window); and
- Capacity to implement an engaging multi-faceted communications strategy.

Once a decision is made to switch to a cart based collection system, it is very difficult to reverse the decision, especially once the capital expenditures have been committed. For this reason, it is critical to explore the key considerations that can impact the success or failure of an automated cart based system.

A list of variables to consider is provided at the end of the report (Section 13) to assist the evaluation process.

12.3 Conclusions

The decision to implement an automated cart program requires that a municipality take the time to examine a cart program in the context of system change requirements, financial implications, community demographics, municipal characteristics, and user needs.

The potential benefits of implementing automated recycling cart collection appear to be largely dependent on the effectiveness and efficiency of the existing municipal waste management system. In the absence of an existing recycling program, or in circumstances where the existing system may include multi-sort approaches, inefficient collection performance and/or old infrastructure that requires replacement, transition to single stream automated cart may offer some benefits. In other circumstances, where a relatively efficient dual/two

stream collection approach is currently in effect, and where existing dual/two stream processing infrastructure is adequate and cost effective, there may be little benefit associated with such a change.

The majority of municipalities that have introduced auto-cart collection systems have coupled cart collection with a single stream recycling program to avoid the cost of providing separate carts for paper/fibres and containers while benefiting from the added capacity and efficiency of auto-cart collection. Carts have the ability to overcome the changing composition of the recycling stream, in which lighter, more bulky recyclable materials are becoming increasingly prevalent, by offering greater storage capacity. This added capacity also provides the municipality with the potential opportunity to capture more recyclables by expanding the list of recyclables collected in circumstances where the cart provides capacity in excess of the householder's current needs. The large capacity further enables municipalities to potentially reduce collection costs by reducing collection frequency from weekly to biweekly collection. Carts also allow municipalities to consider transitioning to variable cart subscription program (pay-as-you-throw garbage).

Automated cart programs impose significant capital expenses, especially associated with the high capital costs to purchase the carts and the automated collection vehicles. These costs must be carefully tracked by the municipality irrespective of whether it chooses to purchase and own the carts and trucks or build all or part of their capital expense into the collection contract. The extent to which the capital expenditures are compensated for with lower operating costs, depends on a number of factors including the urban or rural setting of the municipality and the collection efficiency of the current program. Municipalities that implemented auto-carts experienced cost savings associated with reduced stop times, reduced collection frequencies (bi-weekly), decreased WSIB claims, and less collection staff and fleet. Large urban municipalities seemed to achieve the greatest savings with respect to collection costs for auto-cart programming.

One of the biggest concerns with a cart program is the potential for increased contamination since the cart provides additional capacity in which to discard large non-recyclable items. Simultaneous expansion of a municipality's recycling program to include new materials can aid in reducing the amount of unsolicited material received that might previously have been considered contamination. Although carts may increase resident recycling capture rates (if currently low), the increased costs associated with processing single stream recycling and possible increases in residue has been found to offset the income related to the improvement in the capture rate of marketable recyclables.

Municipal characteristics and user needs should be considered when examining an auto-cart program. Urban municipalities face challenges associated with limited outdoor storage space for the carts, parked cars, stairs and congestion, which impact the ability of an auto-cart program to operate effectively and efficiently. Seniors and people with special needs may need additional help maneuvering the carts. Municipalities require flexible program design and operational policies to accommodate these challenging situations.

All settings face challenges associated with inclement weather, especially snow and ice, which pose trials for movement and placement of carts by the householder and collection by the collection crew. Rain and wind poses fewer upsets due to the larger capacity enabling seniors and others to skip a collection during poor weather conditions.

Implementation timelines of a cart system range from three to five years and require additional staff and increases in administrative costs. Among things to be considered in the implementation strategy and schedule, include the need to develop a multi-dimensional communication strategy in advance of the roll-out and during launch, the development of a staff implementation team, customer support, cart selection and distribution schedules and monitoring strategy.

Ultimately, the decision to convert to an automated cart system is the product of an assessment of the potential benefits carts can offer a community and these are program/municipality specific. The information gathered for this report suggests that carts provide additional curbside capacity, which enables municipalities to reduce collection frequency and thereby achieve cost savings. Most responding municipalities were able to show their decision-makers a net cost benefit that offset the expense of the carts and the implementation.

13 Municipal Auto-cart Evaluation List

The following list is designed to assist staff tasked with researching a municipal program change to an auto-cart collection system. It is meant as a guide to help identify some of the many variables that must be calculated by each municipality during the decision making process.

Users of this list are cautioned that in addition to the list set out below, other variables and local considerations may apply and this list should be considered as a starting point for local program research.

Cart Program Considerations:

Community Characteristics:

What are the community characteristics and how would they potentially impact a cart based system?

- Total number of single family and multi-residential households that would be serviced by the cart system
- Seasonal population that can and cannot be serviced by the cart system and alternative service requirements
- Density of households that would be serviced by a cart system and ability of auto cart or semi-auto cart to service households
- Local demographics and growth rate (age of population, etc.)

Current Waste Management System:

What changes might be needed to the current waste management system to accommodate a cart based system?

- Single stream or Dual/two stream recycling program
- Co-collection program
- Separate SSO program
- Recycling participation rate
- Extended list of recyclables collected (large/bundled OCC, film, polystyrene, etc.) and composition
- Weekly, bi-weekly or alternating week collection
- Pay as you throw program
- Bag limits
- Fleet size and collection vehicle life remaining
- Municipal or contracted collection and processing - potential implications

Local Conditions:

What local conditions need to be taken into consideration that might impact a cart based system?

- Weather related conditions – e.g. deep snow in winter, ice, high winds
- Truck accessibility issues (low wires/bridges/mature trees/street parking)
- Urban issues – e.g. narrow streets and/or laneways that currently receive collection
- Long routes (rural municipality, dead end roads, lake districts, mini depots)

Staffing Considerations:

How ready is the community to take on a cart based system?

- Local desire to expand recycling program
- Ability to deal with potential litter concerns/complaints
- Political priority/expectations for local diversion/participation/residue/sales revenue rates/funding
- Availability of staff and budget for a 3-5 year implementation period

- Availability of staff for program launch and maintenance
- Budget and quality of program monitoring and measuring
- IT staff, quality and costing of website, phone, apps, software, etc.

Program Design Considerations:

What would a cart program look like in the community?

- Automated and/or semi-automated collection
- Choice of cart sizes or not
- Multi-residential inclusion/exclusion
- Industrial, Institutional, and Commercial inclusions/exclusions
- Accommodating households with special needs
- Recycling stream processing requirements
- Number of streams accommodated by carts
 - Carts for recycling only (1/hh)
 - Carts for recycling & garbage (2/hh)
 - Carts for recycling, garbage & SSO (3/hh)



Cost Variables and Implications:


What are the cost implications of moving to a cart program?

- Cart supply, warranty, delivery
- Cart ordering and distribution
- Cart replacement costs (1-3%/yr)
- Available capital or loan costs for start-up, cart inventory, distribution & amortization
- Higher initial truck costs (new or refurbished) versus fleet efficiency savings
- Truck maintenance costs
- RFID tagging, scanning & software tracking systems
- Added staffing costs over pre-during-post programming
- Extra administrative costs (P&E, inventory management, delivery/exchange/warranty)
- Manual collections and staff for physically challenged, special cases etc.
- Enforcement of collection/rejection/contamination policy, administration, and staffing
- WSIB costs
- Processing/marketing/residue costs
- Adequate annual P&E budget

Appendix A – Highlights from Municipal Survey

The following table outlines the areas of inquiry and blended answers and highlights resulting from the survey.

Survey Question	Summary
Baseline and Background	
Collection by municipal or contract forces	Respondents represent a balance of both direct municipal and contracted collection systems, including mixed models where both approaches are used.
Single stream or Dual/two stream	All except one program are single stream recycling programs, the exception being a 2-stream program. (recommended 1 stream. providing 2 carts doubles cost or more. asking residents to use 1 cart alternate weeks confuses them)
Automated, semi-automated or manual collection	All programs contacted operate all or most of their collection based on full automation. Semi-automation and to a greater extent manual collection is used selectively in some. In these cases, the municipality in question felt that manual collection was more appropriate for the collection needs in certain areas. Additional detail about specific collection challenges follows in this summary. At least one respondent continues to support a 100% cart-based collection delivery, even though they face challenges similar if not equal to any other of the respondent programs.
Carts use – waste, recycling, organics	All responding programs used carts for recycling and all but one employ automated carts for waste. GTA-based programs had organics collection, however most respondents did not offer green-cart programs.
Policy and program environment	Several respondents noted that they employed policy instruments such as user pay and bag or container limits, and the carts themselves are generally linked to the policies. For instance, user pay may be based on the garbage cart subscription level, which is volume-based, or the garbage cart size is also by extension the waste container limit.
Collection frequency	Reporting programs, with the exception of one, reported waste and recycling frequencies as being equal, with the available capacity in carts enabling in some cases the introduction of alternating bi-weekly waste and recycling collections, in effect the equal reduction of garbage and recycling collection for an overall collection cost savings
When conversion to carts made	 back <p>Surveyed programs include those with cart implementations in 2007 and 2008, however most have occurred within the last three years or so, and several implementations occurred over the space of two or three years. Different approaches are in part due to the size and scale difference of some programs, which is also reflected in the apparent complexity in the housing types, but are also indicative simply of the internal decisions of staff and their comfort with implementation timelines. There appears also to be a connection with whether service is in house or contracted: contracted programs tend to a shortened implementation since they want to hit a contract date; in-house programs appear to be able to spread out transition. Information was also obtained from a program that will be implemented in 2016 but for which extensive piloting and reporting has been conducted over the past five years.</p>
Cart size(s)	 back <p>95 gallon for recycling was the most prevalent size, and was considered to offer greatest benefit with respect to flexibility of use given the capacity. Some programs, however, allowed people to choose between a 95 and 65 gallon recycling cart but, where no choice was made by the resident, the municipality delivered the 95 gallon cart. In general the 95 gallon option, promoted by one program as being the equivalent of 6 Blue Boxes in terms of volume, was seen as the best option to promote recycling through available capacity and also to use that capacity and trade it off against collection frequency, therefore being able to consider reduced collection frequency while still providing amply household recycling capacity.</p> <p>65 gallon carts are generally offered for garbage, however some programs allowed users to select a larger cart.</p>

	<p>35 gallon carts were not often offered but at least two programs reported this size with one noting that this size was not preferred for recyclables. One program actually offers an even smaller size, namely 18 gallons, as part of their volume-based subscription options for garbage collection. The smaller carts are offered exclusively for garbage and in the case of the subscription-based program this offering was made to allow people to control their subscription costs, and to provide an incentive (the smaller the cart the less the cost) to reduce their waste. It appears to be impractical and somewhat self-defeating since some residents in these programs have underestimated their waste generation and undersubscribed, leaving waste outside the cart for collection.</p>
Number of Carts (recycling) 	<p>Universally programs based their cart orders and distribution on a one cart per address per waste stream collected basis, but some reported that there are rare exceptions when a second cart is required. Reasons for this vary but it may be related to service levels and types of establishments served by the individual municipalities, which differs from one to the next. For the most part the one-cart per address is a standard rule and seen as manageable and fair.</p>
Cart supplier	<p>The main suppliers include Rehrig Pacific and IPL, with a minor mention of Otto. (Note: the CIF hosts a cooperative cart-buying program. Visit http://cif.wdo.ca/resources/containers.html for more information)</p>
Transitional	
Expectations and rationale for cart implementation	<p>Although there was an exception to the rule, almost all municipalities had internal and self-driven objectives and expectations related to the implementation of carts. Local priorities and the context in which carts were implemented varied considerably, however almost all programs surveyed cited increased diversion as an expected outcome with several municipally operated programs expecting a tangible benefit with respect to WSIB costs and claims. Some programs also targeted collection cost reduction however it should be noted that the implementation of carts is only part of the program overhaul where such savings are realized. The added capacity carts offer to users enable other program changes that offer a potential for savings, such as collection frequency changes noted before. For example, and as noted in this report, the cost of carts amortized over 10 years is built into a collection business case that supports a change in collection frequency.</p>
Other changes made at time of conversion to carts	<p>Municipalities reported a number of program changes associated in conjunction with automated cart implementation, including the addition of materials, changes in collection frequency, conversion to a subscription-based collection system for garbage, and conversion to single stream recycling. One municipality used the end of a contract cycle to not only introduce automated carts but also to consolidate the mixed collection model, in which recycling was contracted and waste collections performed by municipal forces, into a unified municipal collection model. Another program introduced carts at the same time as their curbside program, having formerly been a depot program.</p>
Distribution and Deployment costs	<p>The most commonly reported model for distribution is the contract-based approach, generally based on a comprehensive RFP for supply that includes supplier responsibility for the logistical elements of staging, storage, assembly and delivery. Initial delivery was reported to be in the \$4 to \$5 range, however most reported that where cart size exchanges are made, or where special requests, missed or return visits for delivery are required, the figure is \$25. The cost of carts varies with the size chosen and tended to be in the \$40/\$50/\$60 per unit range based on the respective 35/65/95 gallon size progression, however one medium-sized urban program reported an all-in average cost of \$40/hhld for carts and distribution. As noted previously, from the perspective of the recycling aspect, 95 gallon carts appear to be the preferred size.</p>

Cost to resident for the recycling cart	No municipality reported a direct charge to residents for carts, opting to cover the costs as part of program expenses within whatever financial model is used to support waste and diversion programs, such as taxes or user-pay systems.
Staff requirements, costs, and extras related to delivery	Municipal staff reported scenarios where existing staff were assigned to manage implementation, either in teams or as an individual, or where new hires were brought in to assist. Without exception, however, dedicated staff were recommended, with costs varying depending on size of program and ability of existing contingent to manage some of the workload. Even where contractor distribution is used, respondents advised that oversight, monitoring and tracking is considered necessary. The overall message is that conversion to automated carts is a major program overhaul requiring many months of preparation (the reported range was 10 months to 5 years, with the general trend to be in the realm of years, not months) including lead-in, P&E, phone centre training and support and post-distribution follow-up. For the most part the very short timeline of ten months was reported by a municipality that implemented carts in 2007, and it was unclear just how much additional work had been done prior to the official implementation. The 5 year program on the other hand, included extensive piloting of several bi-weekly collection approaches, and is likely not required for most. A 1.5 to 2 year lead in period is likely sufficient.
Contractor distribution	All programs used a contractor based supply approach, with most tasking the cart supplier to do the distribution. The other approach was to place this responsibility on the collection contractor. In the case of the latter the specific costs were hidden in a 10 year collection contract.
Cart per household, sufficiency of carts distributed	<p>All respondents felt that a single cart was sufficient, qualified by the understanding that carts come in different sizes. All programs based their delivery on the single cart per stream per address concept. Overall the largest size, the 95 gallon cart, was the usual offering for recycling. 95 gallon carts represent 6 Blue Boxes, and is more than enough capacity to allow a reduction in collection frequency for recycling. Programs surveyed were also able to use the 65 gallon capacity of carts for garbage with the same result, namely a reduction in garbage collection frequency. Depending on the program there was mention of rare exceptions where an additional cart was required. One program reported that since they offered a fuller range of cart sizes, there were occasional requests for a second cart for recycling or waste, sometimes associated with the fact that there was more than one family at the address or a rental situation is in play. In this case the garbage cart is based on a volume-rated subscription and for both collection efficiency and administrative purposes, the municipality encourages users to up-size the cart before it will consider providing a second.</p> <p>In general, municipalities offered the 65 gallon cart for garbage. One program offers even smaller sizes, namely 35 and 18 gallon, as part of their volume-based subscription options for garbage collection. At this level, as reported by this program only, people have attempted to save money by undersubscribing based on volume. The end result is that many generate an overflow amount for their garbage cart, place materials next to the cart, and undermine the efficiency of automated collection, making the small cart size a poor choice. This is representative of only one program and was not a general finding, but does speak to the importance of cart selection and sizes offered.</p>

Delivery logistics	As noted, the most commonly reported model for distribution is the contract-based approach, generally based on a comprehensive RFP for supply that includes responsibility for the logistical elements of staging, storage, assembly and delivery. In addition to storage, delivery, and assembly, respondents spoke of the need for ample lead in time for cart and truck manufacturing, and P&E support and public liaison. CIF report 559.3, for instance, cites bin deliveries of 3 to 6 months and truck deliveries of 4 to 12 months. The same report notes that outreach activities start 2 or 3 months prior to first collection, however other programs report outreach occurring as much as almost a year ahead of launch. Instructions for cart use, which is either on top of the cart lid or found inside one of the delivered carts, however most programs promoted heavily through their websites, social and print media, the use of the carts prior to delivery. Programs that were able to assign a dollar value to the P&E effort noted \$1 to \$2 per household.
Impacts	
<u>Collection</u>	
Cart capital cost, per unit and annualized	As noted, the cost for 95 gal bins is in the range of \$50 to \$60 each, usually with a 10 year warranty (one municipality reported 13 years). As such programs tended to amortize the expense over 10 years, suggesting an annual amortization operating impact of about \$5.
Truck cost (additional) per unit	Responses were dependent on the existing collection fleet, with some reporting automated trucks being \$50,000 less expensive while other reporting an added expense of \$60,000. Cost was also dependent on truck style, co-collection capability, and other factors. In cases where the municipality used a collection contractor, discrete costs were not available. One program noted a truck cost, based on a split co-collection type of vehicle, at just over \$300,000 per unit, while another program justified the additional truck expense based on an annual savings due to collection staffing of \$135,000. Such outcomes, however, depend fully on pre and post program approaches and other changes, such as collection frequency, enabled by cart capacity.
Labour demand - trucks	It was generally reported that route times are shortened and operated by one-man. It was also noted that labour costs were reduced as a result of other changes affiliated with autocart implementation. One program reported a decrease in fleet staff and a savings of \$135,000 annually due to switching to biweekly collection that was enabled by the use of carts. Others reported earlier route finishing times and an ability to assign other duties to fleet staff when routes were done.
Overall collection cost	Because the conversion to carts usually represent a number of significant changes to program delivery, overall per tonne costs are a reflection of several influences. Cost impacts are specific to reporting programs and represent a broad scale based on significant population differences, and there was reluctance to discuss cart specific per tonne impacts since, in many cases, other improvements and changes (such as fleet conversion to LNG) have been made on top of the other program changes. At least one program, however, has meticulously piloted and reported on program options and is now implementing a conversion to automated carts and a change to every-other-week alternating collection for garbage and recyclables, maintaining weekly organics collection. Bids have been received, assessed and awarded for collection and beginning in 2016 collection savings will be about \$9 million annually. In this case savings will be realized as a result of both recycling and waste collection frequency, and specifically a move from weekly collections for both to alternating every-other-week collection. This is an example of how the household garbage and recycling capacity offered by carts enable other, cost saving changes.

One-time costs (driver training, P&E)	Training costs were not specifically reported, however even if they were they are somewhat dependent on program size and degree to which the municipality supports training. Some were not privy to the costs since they are borne by the collection contractor. Several programs, however, reported increasing route time gains as operators mastered cycling of carts, so "on-the-job" training played a role in operational gains. With respect to P&E, programs reported spending \$1 to roughly \$2 per household as a one-time program-related cost associated with promoting the automated collection system.
Fleet size	Again, this aspect was dependent on other changes made with respect to the program when carts were launched. The program previously noted as having meticulously piloted and reported on program options and now implementing a conversion to automated carts has tendered and assessed bids for collection: overall fleet will be reduced by 30%, based also on the conversion to every-other-week alternating collection for waste and recycling. As previously noted one program reported a decrease in fleet staff and a savings of \$135,000 annually due to switching to biweekly collection that was enabled by the use of carts.
Truck maintenance	Little specific information was available with respect to maintenance, although one program noted that maintenance for the automated collection trucks was lower than the previous types used. In a number of cases the conversion to an automated system was made over several years and the programs did not have segregated costs for different types of vehicles. For others the costs are borne by their contractor and itemized detail not available, or the conversion to carts is still too recent to yield information on this aspect.
Cart replacement per unit costs	Carts are warrantied for 10 years, so replacement for manufacturing defects to date has been nil. Warranties cover manufacturing defects which were reported as minor, relating to lids or minor items, and in at least one case traceable to the batch run of carts and rectified by the supplier. Cart costs, as noted, are around \$50 per unit and contractual charges for replacement or exchange is generally \$25.
Cart replacement rates	Annual cart replacement rates were considered negligible by most and ranged from less than 1% to 3%. Some respondents noted, however, that programs should plan for a high rate of exchange in the first month of delivery since residents will change their minds about the size of carts ordered and some drop offs may have been to phantom addresses (more on this later). The cost for an exchange is \$25 per cart and some programs covered this in the base budget for the program.
Responsibility for replacement	Responsibility for replacement generally follows the collection model, namely whether services are offered by public forces or contracted forces. Several municipalities manage the replacement process while others require either the collection contractor or the cart supplier to manage this aspect. Some programs operate a return and pick-up option as well.

Warranty	Reported warranty periods were almost universally 10 years with one program reporting a 13 year warranty period. Warranties are limited to manufacturing defects and no program complained about the claims process, with one noting that there was an instance (which was resolved) where a problem with lids was traced back to a batch production issue. Claims were described as minimal, less than 1% annually, and overall there were no issues reported with respect to cart quality. Cart replacement for a variety of reasons was discussed with respondents: vandalism, considered "rare" or "insignificant" with very infrequent reports about theft; resident turnover, characterized as minimal with one program quantifying turnover at 3% annually; cart quality, which was not an issue, and; breakage during handling, which also did not appear to be an issue. There was some discussion with some programs about the need to coordinate with Roads departments on matters of damage associated with snow plowing, however sources indicated that ongoing experience of homeowners, snow plow drivers and waste collectors tends to minimize the issue. Winter issues can be mitigated with communications and P&E prior to the start of winter.
Replacement logistics	Replacement logistics tend to mirror delivery logistics with respect to whether the responsibility lies with municipal forces or contractors, although in some cases the municipality assumed this responsibility even though the original delivery had been contracted. Overall this activity is portrayed as a part-time function, with manageable volumes and space requirements. This is not purely warranty based: since some municipalities offer more than one size of cart, residents may change their mind about the cart they ordered. In cases where exchanges are required or carts reclaimed and reused, cleaning is required. Where this is costed out as part of a contracted service or charged back to a resident, a cost of \$25 is assigned. This was to cover retrieval, cleaning and assembly costs. Municipalities took varied approaches with respect to replacements and spare parts, either taking on the warehousing and assembly themselves or having the work done by the collection contractor or cart supplier. The latter appears to be the preferred approach.
<u>Collection Issues</u>	
Operator accessibility	In general, while one program operator reported exceptions for automated collection as high as up to 10% to 15% of collection stops, others reported 100% of stops were covered by the automated cart system and had found ways to adapt automated carts to their entire service with no exceptions. The higher range municipality made a decision early in the process to purchase automated/manual trucks and avoid automated collection in places such as those with street parking, however it is important to note that most municipalities applied resources (as discussed elsewhere) to developing collection schedules that mitigated the issue and also worked with specific sectors (example: row houses, condos) to train them for cart use.
One-ways	Some programs are either able to mandate that carts be rolled across the street to accommodate one ways, while others assessed that the available room on the opposite curb in certain areas was too restrictive to accommodate such a policy. In some cases carts are still used, however additional time and attention is required to maneuver safely and tip carts. In other cases manual collection is employed.
Steep hills	There was no explicit issue regarding hills. One respondent noted that the carts meet safety rating by the American National Standards Institute for slope stability, durability during pulling, centre of balance and force to tip. Another noted that routes may be altered in winter until hills are salted.
Low overhead clearance	Input varied from "not an issue" to some minor tree trimming required.

Service limitations (areas that can't be served)	Although some programs report limitations, other report operator and user adaptations to mitigate these issues, such as early collections in areas where parking is a daytime issue, and outreach programs for condos and apartments prior to launch.
Parked cars	As noted above, many of the programs surveyed have instituted mitigation including route times in early mornings to avoid "the morning rush" and parking in business areas that will obstruct collections later in the day.
Condo/apartment storage space	There are several approaches noted for apartments and condos, which are able to participate in the automated cart programs where certain conditions allow. Some programs find it expedient, and more efficient, to convert certain classes of apartments and condos to front end collection. Others will service apartments and condos only up to a set number of units, and anything larger is required to obtain their own service. The latter condition is arbitrary and did not appear to be a function of efficiency. Depending on the layout, some townhouse complexes present a challenge if carts cannot be stored behind the units and driveway or frontage is limited. In some cases the use of communal collection areas is used, where carts are stationed for use by residents.
Problem materials	One survey respondent noted issues with oversized OCC being placed outside the cart, and promotes a depot drop-off for the oversized material. They use numerous tools such as driver interaction and web-based P&E to rectify the situation. Others promote the breakdown and proper "loose" placement of materials in the cart to avoid jamming or clogging during tipping. One program indicated that people were using recycling carts for sharps, but that the issue was diminishing.
Wind, snow, rain	Some responses to this question suggested that Blue Boxes were in fact the greater issue when dealing with weather events. Wind ratings of 50 and up to 60Km/hr for carts were noted, and generally the carts were seen to be stable. There was mention that on occasion lids might blow open and some litter generated, but overall Blue Boxes, as mentioned, were thought to be a bigger problem in this regard. It was also noted that, with respect to automated collection vehicles, it was necessary to warm up the hydraulics prior to going out on the route on a cold day. One program noted that it was necessary to work with residents on proper cart placement in snow conditions such that carts were not obstructing traffic, or not resting on top of snow banks, and that there was some freezing of materials in carts and trucks. Their waste management staff also worked with their roads department to develop a better understanding re plowing and cart placement.
Participation fall-off in winter	Those responding universally said that participation does not fall off in winter with the exception of a non-cart related reason: seasonal households. Several spoke of how residents have learned to use cart capacity to their advantage, noting that in heavy snow events users realize that they don't have to get the carts to the curb. There is enough room in the cart to allow them to keep using it and still wait until the next collection day. One program noted that visually it may appear that the participation rate decreases in winter but some residents wait to place carts out only when full, regardless of whether a snow event has occurred, and noted a general trend, year round, that many residents hold off placing carts out weekly and only place when full. This adaptation has that particular municipality considering a move to biweekly collection, one week waste the next week recycling.

Diversion gains	Diversion gains vary widely, and like costs are closely tied to the nature of the changes made that are tangential to the automated cart system, including collection frequency and previous performance. One program opted for automated carts despite the fact that their pilots and focus group sessions indicated that higher diversion might be attained through other approaches, yet based on the overall assessment of implementation, operating cost and diversion opted for automated carts. Some respondents represented established, historical programs with what was thought to be reasonable pre-cart recycling capture while one respondent used carts to launch a recycling curbside collection program where only a depot program had been in existence before. With all circumstances considered reported diversion gains were anywhere from 4% to an average of 47%, however depending on circumstances at least one program, which is able to further segregate information into defined sub-areas, reported increases in a range from 18 to 78%, based on recycling only.
Households per truck/route	Where numbers were reported, route sizes ranged from 500 to 770 hhlds per route, however different truck configurations and streaming approaches will affect route productivity. The numbers mentioned above happen to represent two very different municipalities, one which is rural and another which is urban. One program reported that automated collection services up to 180 stops per hour with one person, compared to approximately 80 per hour manually. In terms of productivity, it was stated that it takes 10 seconds to service a stop using an automated cart compared to 30 seconds for manual Blue Box service. The same program operator, using the metric of kg/min of recyclables while on route, noted that automated collection captures 21.0 kg of recyclables per minute of on-route activity, versus 5.1 kg/minute during manual collection.
Adaptability	One of the key features of carts appears to be adaptability. Program operators in particular are taking advantage of the added curbside capacity in a number of ways. Some spoke of the ability to continue to accept new and lightweight packaging, which has been outstripping the capacity of Blue Boxes. Several noted a user adaptation in which householders set carts up near the collection point and treat the carts as a household depot, reducing distance to the curb. Noted previously was the ability to use capacity for storage when weather events cause cancellation of collection. Most notably, the capacity has allowed municipalities to reconfigure collection programs to every-other-week or alternating collection and to control capacity available for garbage versus recycling. In effect, capacity is being traded off against collection frequency. The carts can also be adapted with RFID tags to further track and educate users as required.
WSIB	Several programs responded with reductions in claims or claim cost in excess of 90%, with one approaching the elimination of claims.
Overall processing cost per tonne	Whether directly operated or by contract, there was no suggestion or evidence offered that automated carts had an impact on processing cost per tonne. One program suggested that other factors had a greater influence than carts while another noted that, if there was an impact, there were other program changes made at the time the carts were introduced that make the impact difficult to attribute. One program noted that their collection contractor, which also is the material processor, pushed for carts and does not report that there is a processing cost issue.

<u>Issues</u>	
Residue (process)	There was no evidence that process residues had increased, however one program noted a decrease in part because they had expanded the material list. In effect, the status of certain materials changed from unacceptable to acceptable as part of the overall program change. Another program considered the impact to be insignificant, and it should be noted that in at least one case the conversion to carts was from a bag-based program which, based on available curbside capacity, might perform in a manner similar to carts when it comes to contamination and residuals.
Contamination (inbound)	Two programs reported an increase while another actively attacked the issue and reported a decrease and for some the issue required qualification. For instance, the front-end depots were cited as having been rejected at the tipping floor while cart material had not been rejected. Another indicated that it was not possible to attribute contamination solely to carts given the volume-based garbage subscription aspect of their collection program (as noted before, undersubscription of garbage containers). The programs reporting an increase were targeting P&E efforts to improve the situation and one was hoping to perform audits to better quantify the situation.
Processing efficiency	Municipalities directly responsible for processing noted interesting impacts and adaptations. One cited that with the introduction of carts material preparation in households had changed and for some reason plastic bags were no longer being bagged, resulting in the need to increase daily cleaning of MRF screens to four times instead of one. Another noted that the bag breaker in the MRF (prior to carts it was a bag-based system) can now be replaced with a drum feeder allowing for improved consistency of the material feed rate, increasing throughput and reducing material surges.
Material compaction and MRF capacity	It was reported by one program that their MRF intake grew from 11,000 tonnes per year to 18,000 tonnes per year after converting to single stream recycling with automated collection and carts. They also noted, however, that material density shrunk by 30 percent due to the added capacity provided by the carts. Residents no longer compacted, flattened or stuffed their recyclables, resulting in a MRF processing capacity being lowered from 50,000 tonnes per year to 35,000 tonnes. This reduction is largely caused by the physical size – limitations based on the space required – to receive the materials.
Material Quality	Insignificant impacts but enforcement required at times.
Material Revenue	No impact reported. No direct relationship to downgrades and rejections resulting specifically from carts.
Enforcement	Almost all respondents noted that carts are RFID equipped, although not all have activated the RFID system, and several use on-board cameras to allow drivers to view materials. The cameras are considered effective for both curbside response (driver) and follow-up review, for the purposes of educating the resident. Programs connect carts with addresses and users in order to assist with curbside enforcement and education, such as driver interaction, and/or office follow-up support. Also reported was the use of bin tags and notices, and curbside inspections, to enforce waste by-laws.
Other	One program noted that the material was not as dry as expected. Lids protect the contents from precipitation however any precipitation that enters, stays there since there is no drain holes.

<u>Municipality</u>	
Litter	Respondents considered carts to be an improvement with respect to litter since the lids protect and contain the contents in wind events. The exception was a program that had previously been bag based and therefore did not previously have a litter issue. It was noted that occasional spills from carts can happen, but the prevailing opinion points to an improvement from the perspective of litter and curbside aesthetics.
Municipality acceptance	All respondents noted that acceptance is low when the change to carts is announced, universally attributed to resistance to change. Efforts were required to acquaint residents with the system, demonstrate how it would be used, anticipate questions, and find and attend venues, events and public spaces where outreach activities are possible. Respondents indicated that once the system was in place and users more familiar with the program, acceptance and/or program satisfaction was high to very high.
Complaints	Specific complaints included concerns about storage space, moving the carts, and odour, however as note previously concerns seemed to dissipate with time. In general, respondents report receiving complaints during the introduction and implementation lead up, through the various outreach activities to introduce the program and through the usual avenues of public input. Most dealt with this by training individuals who receive calls, educating politicians and senior staff, and publishing FAQs. All attributed complaints to resistance to change and noted that after about two weeks of receiving carts complaints had dropped off.
Long driveways	It was noted by several respondents that users have made interesting adaptations to carts. This includes using carts as an end-of-driveway depot, in other words placing carts near the set out point, but still on the residents' property, and transporting waste to the carts on an as-needed basis. This eliminates the need to roll carts up and all the way back on collection day. Others have devised trailers to tow carts to the end of the driveway.
Issues for Seniors	One program noted that many seniors found the wheeled carts to be an improvement to hauling out non-wheeled containers.
Issues related to disabilities, special populations	Most respondents had in place, prior to cart distribution, assistance programs usually subject to an application procedure, which can be used where required.

Additional Notes and Key Points

Additional information offered by respondents provides important insight to the implementation and operation of automated collection cart-based systems:

- The integrity of municipal data is critical to the supply and distribution of carts since it effects not only the ability to order the correct amount – at least one respondent experienced a shortage and had to institute a second distribution – but is necessary also to prevent both deliveries to “phantom” addresses, such as those for vacant properties and inappropriate deliveries such as a single set of carts to an entire complex. In either case there is an increased expense associated with a second visit for retrieval or for a second delivery. Municipal waste managers who are considering ordering carts will

want to work closely with their planning and taxation departments, MPAC, and possibly other sources to compare and confirm household addresses and housing types. This is especially true if carts are to be attributed and assigned to specific addresses for ongoing enforcement and follow up purposes or possibly even for billing purposes.

- Where collection contracts are involved, the opportunity for conversion to carts coincided with the expiry of the contract. In one case the effort to move up the cart implementation date by renegotiation was unsuccessful as truck retrofits in the contract mid to late term were not seen as viable. In this case, where more than one collection contract was involved, some contracts were extended in order to accommodate a consistent contract expiry date and therefore consistent cart implementation timing.
- Respondents noted that conversion to carts (with one exception, which stated that they would like to add carts for garbage) includes not just recycling. Waste collection is usually converted at the same time such that carts are universally used, collection equipment can also be standardized, and benefits such as every-other-week alternating collection for waste and for recycling can be performed by the same fleet. This adds other factors that affect costs such as landfill location, transfer scenarios and frequency. This also means that the municipality is providing residents with a garbage can, more specifically a cart, which was not previously the case in the past, at a cost of \$3 to \$5 per year for every household. One respondent noted that, from the residents' point of view, they would no longer require garbage bags or a garbage can for a savings of up to \$24 per year.
- One municipality, which is implementing the automated cart program in 2016, engaged in a diligent five year piloting and public reporting process to support the conversion to an automated collection program, and further to alter collection frequency for waste and recycling to every-other-week alternating collection. Their extensive reporting helped to inform this report, on the basis of four pilot approaches that were tested for cost efficiency, diversion potential and public acceptance (focus groups and surveys). The approaches tested at the curb were:
 - Four bag limit in an urban setting, bi-weekly garbage collection, weekly collection of recycling and organics
 - Three bag limit in an urban setting, bi-weekly garbage collection, weekly collection of recycling and organics
 - Carts in an urban setting, every-other-week garbage and recycling collection, weekly organics
 - Carts in a rural setting, every-other-week garbage and recycling collection, weekly organics

All approaches were shown to increase waste diversion with a particular aim by the municipality to increase green-cart organics capture. Carts did not necessarily outperform the other approaches with respect to diversion or capture, but performed well enough to be considered effective. The use of carts was further supported in follow-up surveys and public forums, being perceived as the easiest way for residents to adapt to bi-weekly garbage collection. On balance, although the bag limits for bi-weekly garbage collection appeared to yield higher recycling and organics capture, and the carts also appeared to increase recycling contamination, the municipality considered the total diversion gain for carts to be 4% to 6%, with a very strong GHG emission reduction benefit due to a fleet reduction of 30%, WSIB claims reductions, annual collection savings of \$5 to \$7 million and overall system savings based on recycling and organics collections, processing and waste collection and disposal reductions of approximately \$5 to \$6.7 million annually.

- With respect to program coverage and limitations, all surveyed programs differ. One respondent is committed to providing automated cart based service across the entirety of their curbside program.

Most others accept that there are exceptions that must be serviced another way and these might be places with space restrictions, row house complexes with structural limitations that make the use of carts impractical, residents above commercial establishments and commercial districts where parking may obstruct service. It is important to note, however, that many of the respondents have adapted automated cart service delivery to mitigate some of these issues, such as collecting from commercial areas early in the morning. Others employed staff teams to work with individuals and families prior and during program launch to assist them in overcoming perceived barriers.

- Not all programs added staff to help with implementation or follow up but all respondents acknowledged that additional staff resources should be considered essential before, during and after deployment. In some cases the change has resulted in a permanent staff contingent associated with cart related duties, dependent on the scale of the program. One of the larger programs is currently training a contingent of 21 curbside representatives for delivery support and early assistance, curbside quality checks, and field education activities. This municipality, however, serves over 1 million people.
- Further to adding staff, responses suggested that a robust online system is the key to early registration and cart selection by residents. For example, one of the large population respondents noted that 84% of households selected their cart sizes early in the process to enable manufacturing and delivery, and that 91% of those households did so online. The remainder were given default sizes. The online approach reduced the need to deal with cart selection over the phone and helped to control the overall staff burden associated with the project. The online approach is particularly effective since most municipalities have IT professionals who, other than for an allocation of their time, are generally able to assist in the development of a dedicated webpage and registration process.
- Cart implementation takes time, since lead-in time is required for ordering trucks and the large volume of carts to be manufactured and delivered. One medium sized program (CIF 559.3) reported cart delivery timelines of three to six months and truck deliveries ranging from four to 12 months.


Appendix B – WDO Datacall Results for Surveyed Municipalities


Table 15: Ontario Municipalities with less than 33,000 households with Cart Collection

Municipality	Temiskaming Shores	Timmins	Sault Saint Marie
WDO Grouping	6 – Rural North	6 – Rural North	3 – Medium Urban
Recycling Collected	Single Stream	Single Stream	Two Stream
Curbside Policy (bag limits, PAYT, etc.)	No more than fits into Cart (95 gallons) for Garbage and Recycling	Garbage cart smaller than Recycling. No more than fits into Carts	2 bag/container garbage limit additional bags need to be tagged
Collection Frequency Recycling (R), Garbage (G), and/or Organics (O)	Bi-Weekly R / G (Same fleet alternating weeks)	Weekly – R / G (split truck)	Weekly – R / G (Recycling in a two compartment cart)
Total Marketed Recycling (Tonnes)	Depot (2008) 493 Projected (2015) 850	(2010) 2,256 (2011) 2,674	(2012) 6,014 (2013) 6,214
Marketed Recycling Change	72%	19%	3.3%
Recyclables Diverted (% of waste stream)	Unknown Projected (2015) 27%	(2010) 18% (2011) 23%	(2012) 23% (2013) 26%
Recyclables Diverted Change	-	5%	3%
Recycling Collection Cost per Tonne	Depot (2008) \$187 (2015) Unknown	(2010) \$155 (2011) \$180	(2012) \$142 (2013) \$148
Collection Cost Change	-	16%	4%
Processing Cost per Tonne	(2014) \$290 (2015) Unknown	(2010) Unknown (2011) \$62	(2012) \$76 (2013) \$76
Processing Cost Change	-	-	0%
Residue Rate	(2014) over 20% -	- -	- -
Residue Rate Change	-	-	-
Overall Waste Diversion Rate	Depot (2007) 14.7% Estimated (2015) 35.0%	(2010) 26.8% (2011) 29.8%	(2012) 35.0% (2013) 35.0%
Diversion Rate Change	20.3%	2.9%	0%


In the examples above the following is seen:

 Marketed Recycling Materials (3.3% to 72%)

 Collection cost (4%-16%)

 Residue Rate (information not available)

 Recyclables Diverted (3%-27%)

 Processing cost (information not available)

 Waste Diversion (0 to 20.3%)

Table 16: Municipalities with greater than 40,000 households

Municipality	Guelph	Bluewater Recycling Association (BRA)
WDO Grouping	3 – Medium Urban	4 – Rural Regional
Recycling Collected	Single Stream	Single Stream
Curbside Policy (bag limits, PAYT, etc.)	No more than size of cart (65 / 95 gallon)	Various (locally decided)
Collection Frequency Recycling (R), Garbage (G), and/or Organics (O)	Bi-Weekly R / G Weekly O	Varying (locally decided)
Total Marketed Recycling (Tonnes)	(2012) 8,416	(2007) 11,923
	(2014) 8,688	(2008) 11,604
Marketed Recycling Change	3.2%	-2.7%
Recyclables Diverted (% of waste stream)	(2012) 28%	(2007) 36%
	(2013) 30%	(2008) 24%
Recyclables Diverted Change	2%	-12%
Recycling Collection Cost per Tonne	(2012) \$131	(2007)\$265
	(2013) \$164	(2008)\$296
Collection Cost Change	21%	12%
Processing Cost per Tonne	(2012) \$263	(2007) \$109
	(2013) \$268	(2008) \$111
Processing Cost Change	2%	2%
Residue Rate	(2012) 11.5%	(2008) 6.5%
	(2014) 13.2%	(2009) 5.6%
Residue Rate Change	-1.7%	-0.9%
Overall Waste Diversion Rate	(2012) 67.7%	(2007) 44.4%
	(2013) 69.2%	(2008) 29.9%
Diversion Rate Change	1.5%	-14.5%

Although Guelph has not fully implemented the cart program (two types of collection fleets – manual and automated – were being used prior to 2014 full system), and BRA is providing services to 80% of households, the following is seen:



Marketed Recycling up and down (-2.7% and 3.2%)



Collection cost (12%-21%)



Residue rate (-0.9% to -1.7%)



Recyclables Diverted up and down (2% and -12%)



Processing cost (2% - could be annual increase)



Waste Diversion Up and Down (-14.5% and 1.5%)

Table 17: Municipalities with greater than 300,000 households

Municipality	Toronto	Region of Peel
WDO Grouping	1 – Large Urban	1 – Large Urban
Recycling Collected	Single Stream	Single Stream
Curbside Policy (bag limits, PAYT, etc.)	No more than fits into Cart for R&G. Annual Fee for G (depending on cart size)	No more than fits into Cart for Garbage and Recycling (pilots started in 2012)
Collection Frequency Recycling (R), Garbage (G), and/or Organics (O)	Bi-Weekly R / G Weekly - Organics	Starting 2016 – Bi-Weekly R / G Weekly - Organics
Total Marketed Recycling (Tonnes)	(2007) 165,246 (2008) 166,678	(2012) 86,950 (2013) 92,688
Marketed Recycling Change	0.9%	6.6%
Recyclables Diverted (% of waste stream)	(2007) 19% (2008) 19%	(2012) 28% (2013) 23%
Recyclables Diverted Change	0%	-5%
Recycling Collection Cost per Tonne	(2007) \$143 (2008) \$142	(2012) \$229 (2013) \$216
Collection Cost Change	-0.7%	-5.7%
Processing Cost per Tonne	(2007) \$81 (2008) \$91	(2012) \$162 (2013) \$154
Processing Cost Change	12%	-5%
Residue Rate	(2008) 17.1% (2009) 23.3%	(2012) 14.7% (2014) 11.4%
Residue Rate Change	6.2%	-3.3%
Overall Waste Diversion Rate	(2007) 42.8% (2008) 44.0%	(2012) 48.36% (2013) 43.74%
Diversion Rate Change	1.2%	-4.72%

Toronto has a mature cart collection system and Peel has only implemented in 6% of households (the above information is for benchmarking Peel). The following is seen in the table above:



Marketed Recycling Materials (0.9% and 6.6%)



Collection cost (-0.7% to -5.7%)



Residue Rate up and down (-3.3% and 6.2%)



Recyclables Diverted zero and down (0% and -5%)



Processing cost up and down (12% and -5%)



Waste Diversion Up and Down (1.2% and -4.72%)