SUMMARY OF FINDINGS

Multi-unit Mandatory Waste Sorting Program

Edmonton

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ACKNOWLEDGEMENTS

This summary report and the supporting research would not have been possible without the contributions of the research team members Alireza Rajabpour, Denika Piggot, Kevin Madarash, Alison Abbink and Helene Itzek with assistance from Andrew Waddell, Malachi Wilkins, Adrienne Beaulac, and Kory deGroot. This report was written by Alison Abbink with review by Sarah Wilmot and Vahid Rashidi.

A special thank you goes to our friends and colleagues from the municipalities and organizations who provided valuable information during this study.

ACRONYMS, ABBREVIATIONS AND COMMON TERMS

MU	Multi-unit residential
SU	Single unit residential
ICI	Industrial commercial and institutional
MWP	Mixed waste processing
SSO	Source separated organics
AD	Anaerobic digestion
EWMC	Edmonton Waste Management Centre
Organic waste	This term commonly refers to the waste stream composed primarily of food scraps from residential households, and can sometimes include grass, leaf and yard waste. In Europe, this stream is commonly referred to as “biowaste”.

1. OVERVIEW

The City of Edmonton's 25-year Waste Strategy[1] commits the City to developing a program to collect source separated organics (SSO) from the multi-unit (MU) residential sector.Work on the program was initiated in fall 2019 with the launch of a comprehensive research project. The findings of the research are presented in this document.

The research addressed collection methods, processing alternatives to source separation, diversion methodology, resident and management supports, incentives and bylaw recommendations.

The research explored multiple source types in order to get a comprehensive, multi-faceted understanding of sector norms and strategy with a specific focus on food scraps collection, also known as source separated organics (SSO). The research looked not only at the Canadian context, but also a selection of international perspectives. The information gathered will assist the project team in identifying viable program approaches for consideration and further analysis.

1.1 Objectives

The identified objectives of the research were:

- Understand current and best practices in the MU sector internationally.
- Study success factors and challenges in the MU sector.
- Provide insight into the challenges faced by MU stakeholders.
- Determine potential solutions and successful approaches to overcoming challenges identified in the MU sector.
- Learn from other jurisdictions about what to avoid.
- Explore innovative approaches and the future of the sector.

1 https://www.edmonton.ca/programs_services/documents/PDF/WasteStrategy_CR_5829_25YearWasteManagementStrategy.PDF

1.2 Scope

The scope of this research phase was to inform the following aspects of the MU program:

- The infrastructure design of the waste system- including methods of collection, processing and implementation approaches.
- Behavioural supports and influencers including education, outreach, regulatory mechanisms and incentives.
- Mechanisms of measurement including diversion rate calculations and other measures of success.

Consideration was given to both current practice as well as future conditions.

Six key perspectives were identified and divided into three primary phases of work. This summary report represents the cumulative and consolidated findings and analysis from 163 sources that spanned North America, Europe, Australia and Asia.

Jurisdictional Scan

A scan of publicly available online data was conducted for 49 municipalities. Municipalities were chosen based on a variety of criteria including population (mainly medium to large cities), service offerings, program maturity, geographic and climatic conditions, such as being a winter city, and political context. Given the strategic directive of this project, municipalities that collected source separated organics from MU buildings were targeted.

Municipalities in the Edmonton area were also scanned to provide local context even if they did not meet other criteria. Priority was given to scanning municipalities in Canada, particularly those that were known to have source separation programs already in place. Cities elsewhere in North America were given second priority, followed by international examples.

Some municipalities were added to the scan based on suggestions from municipalities that were interviewed, and on information gathered through the literature review and behaviour change analysis line of inquiry.

Literature Review

A desk review of 73 reports were primarily found online or provided by contacts during interviews. They include documents such as research reports from municipalities, municipal and regional strategic plans, annual reports, policy briefs, industry association white papers, conference papers and pilot results among others.

Municipality Interviews

14 municipalities were directly engaged via phone interviews and email correspondence to discuss program successes, challenges and experiences in the MU sector.

All but one of the municipalities chosen for interviews were from the jurisdictional scan (Milan was added based on the recommendation of another municipality). The municipalities interviewed each fit into one of the following categories:

- The municipality is considered a 'peer' of Edmonton's current state.
- The municipality represents Edmonton's next phase of growth.
- The municipality represents a thought leader or innovation leader.

Industry Discussions

16 industry expert groups were identified and contacted for an interview. 10 of those were engaged via phone interviews and email correspondence to discuss outside perspectives and experiences in the multi-unit sector.

Behaviour Change Analysis

Desk research was conducted to determine how the municipalities included in the jurisdictional scan are influencing residents' behaviour as part of the program design. An additional 11 academic sources about behaviour change programming were also reviewed.

Processing Alternatives to Source Separation (SSO)

This included desk research, interviews with two municipalities and fieldwork at the Edmonton Waste Management Centre conducted to investigate alternative approaches to source separation of organics and evaluate their effectiveness.

1.3 Limitations

The primary goal was to address methods and approaches to support a transition towards three-stream waste collection for MU buildings in Edmonton as defined by the 25-year WasteStrategy. Therefore, some topics were not covered in depth because they were considered out of scope for the purpose of this project. Examples of some of these topics that are not covered in detail are transitioning to multi-stream recycling, broad educational campaigns that were not specific to the MU

sector, onsite composting for MU complexes, solutions for bulky waste and the implementation of a disposal ban on organic waste at landfills. Additionally, priority was given to municipalities in the peer and next level of growth categories, and therefore some leading or innovative municipalities (e.g. in Asia) were not included for detailed study.

The research did not include documentation of the current state/baseline data for the City of Edmonton. This analysis has been addressed in a separate stream of work.

2. ENABLING POLICIES

★ Key findings
- Higher orders of government, such as provincial or federal governments, have a major influence on the sector through legislation and regulation.
- Engagement at all jurisdictional levels augments success.
- Regional alignment is a very useful tool to set standards in the absence of provincial or federal level policy.

Although the research focused largely around the operational and educational aspects of a successful MU program, the importance of strong enabling policies, enshrined in waste strategies, bylaws and provincial/state legislation/regulations, arose as important influences and considerations. While the findings presented in this section apply across sectors, their relevance to the MU sector cannot be overstated.

2.1 Leveraging different levels of government and policy

2.1.1 Local government and City Council

The role of municipalities in delivering waste-related services to the MU sector varied across jurisdictions. While the provision of a municipal program is the most common service model of the jurisdictions that were studied, it is not unanimously so. While municipalities scanned in Europe and the USA do not discriminate between single unit (SU) and MU residential sectors when it comes to providing collection programs, it differs in Canada. Some Canadian municipalities treat the MU sector to be the same as the industrial, commercial and institutional (ICI) rather than a residential sector. This means that while they offer programs to SU residents, it may be left to private contracts to service MU residents.

In many jurisdictions, even if a municipality does not provide direct or complete services for a given sector, they may still be accountable for achieving goals such as diversion from landfill or waste reduction. Where there are gaps in policy, results can often be weaker than desired. At a municipal level, an engaged local government and city council are crucial to realizing success.

City administration and council need to work together not only to ensure accountability but to ensure alignment across municipal programs (e.g. space requirements for collecting multiple streams from MU buildings must be accepted by planning departments). City councillors are not only able to influence from the top down, but also connect program decisions to grass roots initiatives. Without a synergistic relationship, programs may be

more fragmented and the full potential and benefits may not be realized.

2.1.2 Regional government

Regional governments can be a powerful tool. At this level, a group of municipalities can collaboratively plan for and deliver regional scale services. This collaborative level of government is governed by a board of elected officials that represent each local authority. While policies enacted at this level do not (by definition) cover as large an area or population as provincial or federal level legislation, they have advantages.

Regional strategies and policies can be set and agreed upon by a regional government more quickly than provincial or federal legislation. Local consistency can also be obtained through a regional government as a decision related to waste reduction, waste facilities and disposal bans can be enacted for the entire region. By joining together in this way municipalities can also gain support for local waste strategy efforts. This type of government can be seen in Canadian examples such as Metro Vancouver and York Region where regional bylaws provide oversight and control for all municipalities that fall within that metropolitan area.

2.1.3 Provincial and Federal government

Where municipalities are not the sole service provider or the service provider at all, provincial and federal legislation can be effective at creating a level playing field. Policies from senior governments can also influence the ability of municipalities to collect data and report on outcomes for diversion or other strategic goals. This type of legislation also removes the need for local bylaws to create standards, and the need for adjacent local governments to harmonize their bylaws.

Whether it is provincial or federal, these higher levels of policy can set the standard all municipalities work towards and be a powerful catalyst for change. This higher level of legislation can also push municipalities across the country to work towards the same goal and benchmark with one another. The importance of this type of senior government influence was noted in a number of sources.

At a provincial or state level, legislation, such as ordinances in California or provincial legislation in Nova Scotia or Ontario, ensure targets are set and in some cases enforced, such as the obligation for all sectors to have arrangements for collection of recycling and organic waste.

At a federal level, legislation such as those enacted by the European Commission, set strict targets to be met by member states, prompting countries across Europe to change their practices. Targets include separate collection for organics, diversion levels for different recycling streams, such as glass and plastic), the phasing out of landfilling and many others.

2.2 Regional alignment

In the absence of policies from higher levels of government, adjacent municipalities can choose to align themselves to create a regional approach. Regional alignment can reduce confusion, provide consistency and augment outcomes. If expectations and goals are closely aligned, desired behaviours are reinforced. Additional benefits to regional collaboration can include a reduced need for regional landfill or incineration capacity, as well as a collectively stronger voice when lobbying to higher government levels for change.

3. COMPLEXITIES OF THE MULTI-UNIT RESIDENTIAL SECTOR

★ Key findings:
- The MU sector has special challenges that do not exist in the SU sector.
- Approaches to collection and education cannot be a one-size-fits-all solution.
- Systemic planning is important for the success of all program aspects.
- The MU sector is more resource intensive than the SU sector.
- It takes time and consistency for a program to reach maturity.

3.1 What makes MU different from SU?

The SU sector has often been the first sector addressed by municipal waste strategies around the world, and the factors that contribute to successful programs are well understood. In contrast, diversion programs for the MU sector are less well-established. The MU sector is more variable and developing a successful program will require more time and resources. The MU sector presents specific challenges that are distinct from the SU sector.

In general, MU residents tend to have a less direct relationship with their waste set out and collection than SU residents. The collection point is often further away from their residence and residents may not be billed directly for waste services (i.e. it may be part of their rent or condo fees). As a result, buildings in the MU sector require more regular check-ins, more frequent monitoring and a more targeted approach.

Common specific challenges in the MU sector include:

- Anonymity which leads to a "tragedy of the commons" effect on waste containers.
- Space constraints in buildings (both in units and in communal areas).
- Wide variety of building stock (ages, configurations and sizes).
- Poor access to sorting spaces and collection locations, which results in a lack of convenience for residents.
- Illegal and opportunistic dumping.
- "Yuck" factor when transporting waste to sorting and collection locations.
- Higher resident turnover, which requires more sustained and repetitive effort from municipal staff to maintain educational exposure.
- Lack of property manager engagement.
- Difficulty engaging directly with residents (i.e. no access to doors for door-to-door campaigns without manager approval).
- Lack of consistency between SU and MU sectors in terms of service level and/or the actions required of residents.

3.3 Key considerations for overcoming these challenges

- Systems approach: When planning a MU residential waste program, a systems approach is required. This means that aspects, such as the logistics of collection, the preferred method of processing and educational programming, need to be planned together rather than decided independently of each other.

- Time: While some immediate benefits can be realized, it takes time for a program to mature and for residents to form lasting waste habits. While this is also true for new programs in the SU sector, the most successful MU programs

from the sources examined are the ones that have an established legacy of source separation and have experienced some generational turnover.

Legacy of Source Separation

Many European municipalities such as Milan and Rotterdam have had source separation programs for more than 20 years.

This has allowed for more generational turnover and the maturing of the program compared to younger programs such as those in Toronto.

- One size does not fit all: A wider variety of collection approaches were observed in the MU sector in response to the unique needs and challenges presented by different spaces and configurations of different buildings. The approach cannot be one-size-fits-all, or even a one-size-fits-most, such as the approach often taken with the SU sector. The research uncovered a diverse range of collection approaches and program features in response to the varied building configurations and neighbourhood challenges.

There are three key components that need to be considered together when planning a new MU program:

- The design of the system (infrastructure),
- Behavioural supports (education and outreach), and
- Regulatory tools (bylaws and standards).

Each of these is discussed in turn in the following three sections.

4. DESIGNING THE SYSTEM - USER-FOCUSED DESIGN

★ Key findings:
  - Source separation is preferred over collecting and processing mixed waste.
  - Convenience and co-location of communal collection containers are the most important factors in implementing a successful source separation program.
  - Carts are often preferred to bins for source separated organics collection.
  - Giving MU residents a more direct experience with their waste, by reducing the anonymity, aids participation.

★ Best practices:
  - Sorting rooms need to remove barriers for residents.
  - Curbside collection should be used where possible; where communal containers are required, they should be placed in a high traffic location.
  - Phased implementation of new collection programs allows more resources to be dedicated to each building as it comes online.

4.1 Source separation of waste streams

The majority of sources found that separate collection (source separation) of different waste streams is not only common, but also preferred practice internationally with few exceptions. In many jurisdictions, it is mandatory or becoming mandatory to have source separation. Source separation is also fast becoming the gold standard.

While the reduced collection cost and increased convenience associated with mixed waste processing (MWP) appeal to some, MWP was not recommended as a replacement for SSO. Instead, MWP can supplement SSO programming and in doing so, contribute to diversion success. A number of municipalities have started to look at MWP as a means to extract additional organic or recyclable material from the garbage stream. Overall source separation has not been shown to reduce participation rates, and it yields higher quality products.

Cities that are leaders in MU diversion, such as Milan, Italy have a legacy of source separation with programs.

Many of the scanned municipalities collect as many as four to five streams in addition to garbage. This is the case when recycling is collected in multiple streams (e.g. glass, plastics, paper and cardboard) and/or when additional services for bulky items and/or household hazardous waste are provided. Some municipalities and many of the organizations researched recommend multi-stream recycling as the end products tended to be higher quality and more in line with market demands.

*Multi-stream recycling collection programs are common in European municipalities such as Copenhagen, Barcelona, Milan and Treviso as well as in some North American cities such as those in the Metro Vancouver area where **cardboard & paper**, **plastic**, **glass**, and **metal** are common categories.*

Image source: Contarina SPA

4.2 Convenience, co-location and access

All sources agreed that convenience and co-location of resident access to disposal containers were the most important aspects of the infrastructure design. This is because the success of the program largely depends on participation.A user-focused design that prioritizes convenience and access will lead to higher participation. No amount of education can make up for a poorly designed user experience, and sources agreed that even those who aren't motivated by factors such as environmental concerns will participate if the program is adequately convenient.

It was reported that participation depends more on having different waste streams located together than on container type. The distance travelled to the collection points was also critical. Efforts by municipalities to co-locate waste streams manifested in different configurations as it is necessary to work alongside property managers to meet individual building needs.

Examples of co-location efforts in MU buildings that were found are:

- Same floor sorting stations. Rather than obligating residents to take their waste to a centralized sorting area on the main floor, in the basement or outdoors, a means of disposal can be provided on each floor for each stream. This can include chutes or containers only. This approach has been shown to have a positive effect on resident participation, capture rates and contamination. However, it is more labour intensive for property managers, who are required to move collection containers from each floor to the centralized collection area, for servicing.
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- Garbage chutes. Modifications or or closing garbage chutes reduce the convenience of garbage disposal and puts all streams on a level playing field.
- Container placement. Containers for each stream can be placed next to each other in common areas. Where this is not possible, as many streams as possible should be grouped together, rather than placed in different locations. Where it is necessary to split up containers, clear signage regarding the location of other containers is recommended.
- Sorting room. Locate waste sorting rooms or common disposal points in higher traffic areas. This can be near laundry rooms and parkades to reduce the distance residents need to travel and enable joint trips.
- Indoor or outdoor sorting areas. Indoor sorting areas are more desirable. However, it is not always achievable and every effort must be made in outdoor areas to meet the same best practices.

4.2.1 Chutes

In many jurisdictions, garbage chutes have been (and continue to be) installed in higher density buildings. Chutes pose some challenges to co-locating waste streams and sustaining participation in diversion programs as they make disposal of mixed waste very easy and convenient.

The following options were discussed when it came to achieving co-location and convenience in buildings with chutes:

- Chute closure program. Buildings are encouraged to close chutes and relocate sorting and collection areas. Options for chute replacement include centralized containers and same floor sorting stations.
- Add containers. Locate containers for other waste streams adjacent to garbage chutes. This enables multiple streams to remain together despite having an existing chute, which maintains convenience for residents.
- Repurposing chutes.Use chutes for organic waste instead of garbage.
- Retrofit chutes. Retrofit existing chutes to have a tri-sorter option or add multiple chutes. This option is the most challenging and the least recommended among all sources.

The City of Toronto has a voluntary chute closure program and a number of buildings in the greater Toronto area have started to convert their garbage chutes into organics chutes for food scraps. Some buildings in New York are following suit and repurposing chutes or adding containers.

Image source:
https://www.cbc.ca/news/technology/what-on-earth-highrises-zero-waste-1.5711010

4.3 Waste sorting areas

After convenience and co-location of waste streams, the implementation of best practices in waste sorting areas is considered the second most important aspect of a well-designed program. Making the sorting process as simple and straightforward as possible ensures that residents will continue to participate successfully and engage with waste programming. Reducing barriers for residents to sort waste and the following key factors were noted as common and recommended actions from all sources:

- Clean and tidy. Waste should not be strewn around, nor should containers be overflowing. Cleanliness will help to prevent odors and deter pests, creating a pleasant experience for residents.

- Well-lit. This not only provides safety for residents using sorting areas after hours, but also deters opportunistic and illegal dumping for both indoor and outdoor sorting areas.

- Adequate and visible signage with consistent use of colour and images. Colours provide visual cues to residents and the containers (or at a minimum, container lids) should be colour-coded to help with habitual responses. Images reduce the need for translations and help to avoid issues with language barriers.

Image: Waste room best practices. (Source: City of Richmond waste design guidelines)

4.4 Options for collection

In contrast to the SU sector, the research showed that the MU sector requires multiple collection options. There is no one-size-fits-all approach to collecting waste from MU buildings. Each municipality studied uses several methods to collect various waste streams from the MU sector successfully. Some municipalities use as many as four distinct methods of collection within the same city to address a variety of neighbourhood set ups and building needs.

The full range of collection containers and methods found through the research include:

Manual Collection of Bags

- Various colours and sizes, primarily clear, yellow, blue and black.
- Requires manual collection.

Carts

- Wide range of sizes from mini 30L carts to large 360L carts.
- Serviced by automated or semi-automated vehicles.

Bins

- Both skid bins and caster bins.
- Both metal and plastic composition.
- Wide range of sizes from approximately one to six cubic yards with some municipalities ranging as high as eight cubic yards in certain instances.
- Compactors are sometimes used in high density residential buildings for residual waste and/or cardboard.
- Serviced by front or side-load vehicles.

Underground Collection Containers

- Waste receptacles are installed in a centralized area (usually on public property on the streetscape).
- Typically one waste receptacle is provided for each stream.
- Serviced by crane vehicles.

Underground Pneumatic Collection

- Involves waste deposit points that are installed in a centralized area (usually on public property on the streetscape).
- Typically one waste deposit point is provided for each stream.
- No vehicle is required for service. Waste travels through a vacuum system to a centralized processing facility or staging location.

Mobile Collection

- Mobile containers set up in pre-established central collection points where residents can bring their waste. The container remains on site for a set amount of time and has an attendant

assisting residents to dispose of their waste into the containers.
- Supplementary collection of smaller containers can be done by small collection vehicles that travel predetermined routes in areas with insufficient space for storage or set out on collection days.

Waste Drop Off

- Designated locations in a neighborhood or city that residents can bring their waste that is not collected at their building.

Diverse Methods

Many municipalities use more than one approach to collection.

*Barcelona, for example, uses **4** different methods to ensure up to **5** streams of waste are collected regularly.*

Appendix A and Appendix B provide a qualitative high level comparison of each method as well as images for reference.

Despite the wide range of methods, there were some noteworthy trends:

- Carts and bins are the most common method currently used, particularly in North America., Carts were noted as the preferred method across all jurisdictions.
- Carts are available in a range of colours, which can be used to denote streams and are popular due to the ease of set up, low cost and small footprint.
- Approximately 50 per cent of the Canadian municipalities included in the scan provide collection service only to those buildings with garbage and recycling streams that were serviceable by carts with no more than 5 to 7 dwelling units in most cases. For buildings in those municipalities that require larger collection containers that are not compatible with vehicles that empty carts, private collectors provide collection service. The other 50 per cent offered services to all MU buildings regardless of whether they are serviced by carts.
- Underground collection seems to be gaining popularity in Europe based on interview feedback and future-focused waste strategies found online. Positive feedback regarding their increased use was noted.
- Where above ground bins are still used in Europe, they tend to be more for common public use rather than being for a specific building.
- For the garbage stream, carts and bins were the most common method of collection.
- Carts and bins were most commonly found for co-mingled recycling and are often used together where recycling is collected through multiple streams (cardboard is collected in bins because it is bulky).
- Across all jurisdictions, carts were preferred for organics collection, or if more capacity was needed, smaller bins such as one or two cubic yards could be used. Other containers are not preferred for organics collection for several reasons:
    - Organic materials need to be collected more frequently due to odors, so larger capacity containers are not practical or necessary.

    - The density of organics makes larger containers difficult and unsafe to manage for collection staff.
    - The high moisture content in the organic waste stream also posed challenges for underground collection containers. Where underground containers are used for other streams, above ground containers for organics were placed beside to ensure co-location of streams.
- Collection frequency was most commonly set at weekly or biweekly for all streams. However, flexibility in frequency is required to accommodate locations where smaller containers are necessary due to space constraints. Some municipalities have opted to make garbage collection less frequent than other streams to act as a deterrent and to promote the participation in those diversion based streams.
- Organic waste can be collected less frequently during winter months as odor will be lessened.

4.4.1 Methods to assist with illegal dumping and contamination

In an effort to mitigate illegal dumping and contamination, municipalities have implemented a range of solutions. The following options have shown promising results:

- Smaller containers. Making efforts to choose smaller containers that still provide adequate storage for a collection cycle will help to ensure resident needs are met while reducing opportunity for dumping bulky items.

- Specific opening shapes. Container openings that are shaped to reflect the intended wastes stream (e.g. round for bottles, flat for paper) deter the placement of the wrong items. It also removes the opportunity to deposit bulky items in containers.

- Locks or controlled access. Lockable lids and gravity locks ensure that residents use side openings to deposit materials, which limits the size of materials that are deposited because the locks prevent lids from being opened to insert bulky items. Gravity locks make collection easier as they automatically unlatch when tipped during collection.

- Indoor sorting rooms. Locating sorting areas inside the building and limiting access to those areas avoids opportunistic dumping from non-residents.

- Separate collection areas in mixed use buildings. Controlled access will prevent residents and commercial tenants from utilizing the wrong waste containers.

4.5 How processing fits into the design

4.5.1 Co-design

One of the most important considerations for processing was the need to co-plan the list of acceptable materials in each stream with the processing system. As mentioned previously, systemic planning is crucial to a municipality's ability to achieve success. If processing and collections aren't harmonious, then outcomes will be limited from the start. The most prevalent examples of this from the research were ensuring that there is sufficient processing capacity and the use of plastic bags.

Available processing capacity in local or regional facilities is crucial to the ability to offer separate collection of different materials. As established earlier, waste collection programs require some time to mature, which means processing capacity needs to be available when a program is introduced and also must be sufficient to

account for growth in the future. It is impossible to offer a collection program without having established this availability in advance.

Plastic bags, both conventional and compostable, are being used by many municipalities as a simple yet powerful tool to augment resident participation in organics collection programs. Seventy-six per cent of the municipalities in this study with an organics collection program allowed plastic bags of some kind to help with participation.Themajority of those surveyed preferring certified compostable types. Bags increase convenience and mitigate the “yuck” factor when it comes to transporting organic waste to collection areas. There were some municipalities, such as Halifax and the Metro Vancouver area, that did not allow plastics of any kind and encouraged residents to use paper liners only. These requirements are related to processing capacity, as there were significant concerns about the effect the plastics would have on processing.

The challenge with accepting plastic bags is that even certified compostable products do not typically fully break down and can act as contaminants, similar to conventional plastics. Wet anaerobic digestion (AD) facilities offer an advantage in this regard as contaminants can be more easily screened out during the hydropulping (feedstock preparation) process. When co-planning takes place early on, processing facilities can be designed to screen out these materials or adjust the process to better break down remnant compostable materials. As policies and markets surrounding plastics evolve, the popularity and likelihood of compostable replacements for conventional plastics to appear in the waste stream are growing and municipalities will have to be prepared to handle this.

4.5.2 Alternatives to source separation of organics

Despite the research indicating a strong preference for source separation of organics, processing approaches were examined in order to allow an informed comparison with source separation. Alternatives were assessed for effectiveness at recovering organics from a non-source separated waste stream in the context of the current EWMC in the City of Edmonton.

Three primary alternatives to SSO were identified:

- Maximizing the use of existing waste processing infrastructure at the EWMC (considered low cost).
- Adding significant new infrastructure to existing facilities at the EWMC (considered medium cost).
- Using a waste-to energy facility (considered high cost).

The results indicated that all three options successfully divert organics from landfill:

- While the first alternative has a lower capital cost because of the opportunity to leverage current infrastructure, the relative contamination is still quite high in the outbound organics stream, limiting the potential to produce a high quality and marketable end product.
- With the addition of new technology (in the second alternative), organics could be effectively removed from a mixed waste stream. However, due to the moisture content, the materials that remain after the organics extraction process could not be directly used for refuse derived fuel (RDF) production and would either have to undergo further processing to dry or would have to be sent to landfill.
- The waste-to-energy alternative (using a mass burn technology) would result in a high diversion rate. While this does not separate organics for additional uses, it does result in recoverable energy, such as heat and electricity, that can be sold or made available for municipal use. In

addition to having the highest capital and operating costs of the three alternatives examined, this type of facility is low on the waste hierarchy and does not align well with Zero Waste philosophy. It is however still considered by many as a favourable alternative to landfilling.

4.6 Emerging technology for collections and processing

As part of the future consideration of this research, emerging technologies were looked at. Some of the noteworthy technologies currently being used in the MU sector are:

- Dynamic Routing. The desire to move towards on-demand service rather than scheduled collection on a fixed route is increasing, and some municipalities are testing this approach. Using fill sensors installed in underground collection bins, routes can be set and collected based on which bins are at least 75 per cent full, rather than following a pre-set route. This approach eliminates the need to collect from near-empty bins. While this technology hasn't been widely implemented and has some significant up front costs, it has been able to achieve an increase in routing efficiency of approximately 30 per cent.

- Radio Frequency Identification (RFID) and on board scales. RFID technology has the potential to aid with the collection of data, such as location and volume of waste collected, which can assist municipalities with monitoring. Onboard scales in turn weigh each load when a container is tipped. These technologies have been tested for effectiveness to aid with data tracking related to waste production and diversion in MU buildings in a number of the municipalities studied. It was found that these technologies still have a considerable number of challenges. RFID is not well suited to every vehicle type because the RFID readers and tags and onboard scales all require considerable financial resources to maintain. On-site inspections and audits are required to validate results. There were many challenges with the onboard scales and the RFID tags on the containers did not read consistently. Further, they should only be used for monitoring and not to calculate charges for billing purposes. These technologies are not recommended and further work to develop the technology is required before they could be reliably used in the MU sector.

- On site processing of organics: In sink units like macerators, dehydrators and the like have been studied by a few jurisdictions, however no definitive results were found and this technology is not recommended at this time.

4.7 Implementation and roll out

4.7.1 Phased Implementation

The implementation of a new collection program takes time. Across all sources, the research identified that a phased approach to implementation is preferred.

Even in municipalities that had already established other source separation programs and were simply adding another stream, a lead time of about one year is recommended to provide adequate time for educational campaigns and a soft launch. This allows residents and property managers to understand the changes and begin to transition.

The most commonly found stages of phasing in a new program are as follows:

- Pre-testing and pilot studies. This allows municipalities to test options and

measure results. These smaller tests can help to provide sample data that can be used to plan for later phases of implementation. Pilots can range from several months to full studies of up to two years. Pilots can be undertaken with buildings that volunteer, or designate an area of the city for mandatory participation.

- Voluntary opt-ins. Buildings that are keen to start or have conditions that make implementation easy can sign themselves up to begin the program with the support of municipal staff. This phase can be in place for many years and to allow for a gradual expansion of the program. While some municipalities spend less time (two to three years) in the voluntary phase, the research found that some municipalities spend as many as five to nine years building the program by encouraging buildings to sign themselves up. For example, San Francisco introduced organics collection as optional in the early 2000s. Organics separation and collection became mandatory in 2009. This rollout was phased over three years.
  Similarly, Seattle started with a voluntary organics program for approximately four years before it became mandatory in 2011.

  The benefits of a voluntary opt-in program include reduced demand on municipal support programs, opportunity to expand processing capacity gradually, and the chance to make minor revisions to program parameters and supporting educational materials based on feedback.

- Mandatory rollout. Mandatory rollout, often takes place by splitting the municipality into geographic regions, which are rolled out sequentially. This stage can take several years, with two to three years as average depending on the population density and number of buildings involved. Mandatory rollout typically consists of sending information packages to property managers and residents announcing policy changes and what to expect several months prior to the start date. This information can also include the introduction or amendment of a bylaw. A mandatory rollout would follow a pilot project or voluntary opt-ins if the municipality chose one of those options first.

  In municipalities where collection is delivered through the private sector, there could be several months before equipment is delivered (e.g. kitchen pails and collection containers). Once collection programs have started, ongoing education continues to build awareness and understanding.

- Enforcement. Municipalities commonly elected to begin enforcement using a “soft” approach. This includes providing grace periods following the start of a new program or bylaw. Municipalities can determine how strongly to enforce programs with a range of tools, such as warning letters, stickers or non-collection to ensure compliance with the new program.

Additional information regarding educational tools and practices to support both implementation and ongoing program needs can be found later in this report.

5. WASTE BEHAVIOUR SUPPORTS AND INTERVENTIONS

★ Key findings:
- Convenience and access are more important than educational tools.
- Education needs to be ongoing and face-to-face interactions have the most impact. Education should target property managers and residents, and needs to speak to "why" as well as "how".
- The buy-in of property managers is key to success in a MU building.

★ Best practice:
- Education needs to be targeted to property managers and residents.
- On-site and in-person interaction are important in addition to "self-serve" information.
- Building relationships and maintaining communication with property managers should be prioritized.
- Dedicated teams are needed for troubleshooting, as well as for education and establishing relationships.
- Providing in-unit aids such as totes or kitchen pails increases resident participation.
- Communication tools, such as images, are more effective, than translated documents and should be used more frequently.

5.1 The role of education programs

When we examined the role of education in MU waste programs, the results were unanimous: convenience and container access play a larger role in program success than education. Even the most ingenious educational campaigns cannot replace an intuitive and convenient system. However, this does not mean that education is not important. The research showed that when the infrastructure and the educational campaigns are designed to complement each other, success is far greater than when each component is done in isolation. Educational campaigns should not be used as a band aid solution to a poorly planned program.

Understanding how to use the system and having accountability for the success of the program are important for having residents and property managers work effectively with the waste system. Furthermore, sources agreed that education must not only say "what" to do, but also explain "why" and "how". Relating individual actions to an important impact or outcome, such as financial savings or community benefits is an important part of building the accountability, motivation and ensuring success.

Educational campaigns are required to precede new program changes, as well as support the sector on an ongoing basis.

5.2 Waste education in schools

Although this finding was not specific to the MU sector, many sources pointed to a need for waste sorting to be taught in schools. Many municipalities have started to invest more into integrating waste knowledge into school curriculums. School children are seen as the future and it is critical that they develop new habits in family units as part of a generational turnover.

5.3 Resident supports

To support residents in the MU sector, the research found:

- It is important to have alignment between single and MU residential sectors. Having two separate systems can create barriers as residents can frequently transition between dwelling types due to changes in circumstances.
- Education must be targeted, simple and ongoing. This is especially important in light of the higher turnover experienced by the MU sector and the variety of sociocultural backgrounds of residents.
- Education tends to be more successful when it touches on why the desired behaviour is beneficial to the community in a specific and relatable way.
- Campaigns need to address MU specific challenges and expectations.
- While the gold standard is face-to-face and on-site interactions, campaigns must have a variety of media types and options for accessing information. This can range from online for the more tech savvy residents to brochures for those who are harder to reach.
- The provision of in-unit equipment, such as kitchen pails and totes, was both popular and recommended. These types of in-unit supports are seen as more important than information on communal containers because decisions are made in the household prior to transporting waste to sorting and collection locations.

  To complement this, using plastic bags as liners for both kitchen pails, as well as in collection containers, such as carts, can have a tremendous amount of potential when it comes to bolstering participation and motivating residents to use the program by aiding with transportation and reducing the "yuck" factor.

  It is also noteworthy that municipalities that experience winter freezing conditions concluded that paper liners and bags also aided in the operational aspect of collections by preventing materials from freezing to containers and allowing them to fall from containers when tipped.

  The benefits of plastic liner bags in the organics stream were not unanimously supported. Some sources think that allowing compostable bags provides an opportunity for residents to mistakenly use conventional plastic, posing challenges to processing facilities. A municipality's ability to use plastic bags as liners seems to hinge on processing set up and tolerance for contamination as even compostable plastics do not fully break down and require additional treatment.

Top image: in-unit kitchen pail with certified compostable bags - Milan, Italy. (Source: AMSA SPA).
Bottom: Reusable recycle bags provided as in-unit support - Ottawa, Canada (Source: City of Ottawa).

5.3.1 Ambassador programs

Ambassador programs are a tactic that sees residents volunteer to act as liaisons in their

building. They receive training from the municipality and are part of education and outreach efforts like putting up signage and door knocking. This tactic was more commonly found among North American sources as a way to integrate waste culture into a building. While anecdotal evidence seems to indicate a potential for a positive impact on participation of residents in a given building, the research is inconclusive. The research did not find any concrete data to quantify the impact of this type of program on a building's success. Further data collection would be required to determine the effectiveness of running an ambassador program.

5.4 Support for property managers

During the research, many of the conversations that were had with both municipalities and industry experts were centred around the fact that without buy-in and engagement from property management, MU programs often fail to realize their full potential and success is limited. By working with property management, challenges that are faced by MU buildings can be solved quickly and more effectively. The creation and maintenance of ongoing relationships between municipal staff and property managers ensures that education and engagement with residents is successful, best practices are implemented, participation rates remain high and contamination low.

Some key findings to support this ae:

- Early engagement. Relationships and dialogue must be cultivated early and supported through engagement in the planning phases and continued throughout implementation phases. This can be done through the creation and maintenance of stakeholder working groups that include property management companies. Early engagement with property managers provides opportunities to field ongoing program concerns, gather feedback for updates and changes to programs, and work collaboratively to uncover better solutions.

- Dedicated support teams. Dedicated teams are important to provide ongoing assistance. Support teams work with building managers to resupply educational materials, assist with determining capacity needs and advise on container placement. These teams can work closely with the building management to ensure that best practices are in place at a given property. Further to this point, the research showed that in-person interactions between municipal staff and property management were the best method of communication and education.

- Self serve materials. In addition to a dedicated team, self-serve supports, such as online tools, free educational materials and handbooks ensure that information is available at any time.

- Clarifying roles. In many cases, property managers need to designate someone to move containers from storage locations, inform tenants of expectations and maintain sorting locations. It is important to distinguish the role of the municipalities early on in the program to avoid challenges or enforcement steps.

It is important to note that these findings are not generally supported by rigorous studies to evaluate their effectiveness. Aside from some pilot studies, it is difficult to pinpoint the impact of specific interventions on success measures, such as diversion rate. As a result of this lack of data, it has been difficult to establish best practices.

6. REGULATORY MECHANISMS

- ★ Key findings:
  - Programs need to be mandatory and consistent between MU buildings, as well as between sectors such as SU, MU and ICI.
  - Municipalities are using financial incentives and deterrents to further motivate residents and property management companies.
- ★ Best Practice:
  - Have a bylaw mandating source separation.
  - Have comprehensive design standards mandating co-location of collection containers tied to a planning bylaw, such as zoning.
  - Use financial mechanisms, such as variable pricing and incentives, to encourage positive waste sorting behaviours.

6.1 A clear and detailed bylaw

Bylaws are a very practical tool that allow a municipality to enforce consistent compliance with program requirements. An effective bylaw can establish a standard within a sector, and also provide greater motivation for those who are not driven by the "greater good" of the program. The research found the following regulatory components are particularly noteworthy:

- Make it mandatory. A bylaw that makes source separation programs mandatory was both the most common approach and also the most preferred, even where municipalities did not directly service the sector. Even without direct and active enforcement, making programs mandatory has a direct impact on participation rates by reinforcing norms and gaining the interest of those who are generally willing to abide by the rules. When a program is mandatory it also standardizes the requirements and set up from building-to-building and ensures that there are no buildings that can opt out. Further to this point, in municipalities where the programs were mandatory, there were no criteria provided for buildings to opt out and only three instances were found where exemptions were permitted under very specific conditions. In two of those instances, other policies requiring mandatory diversion meant that even if a building was permitted to opt out of municipal service, they would still be required to provide diversion programs. In the third instance a financial deterrent is in place and new buildings that are not compliant with the municipal developer standards must get private collection service without receiving a break on the taxes that fund municipal service (i.e. they end up paying twice).

Conversely, in municipalities where source separation of organics was voluntary, less than 50 per cent of buildings opted into the program, reinforcing the importance of mandatory programs.

In many jurisdictions, co-mingled recycling (and in some cases multi-stream recycling) has already been mandatory for a number of years and municipalities are now looking to make source separation of organics mandatory by updating bylaws and building codes, and lobbying higher levels of government to pass legislation obliging separation.

Reports reviewed during the research revealed that 90 per cent of high recovery MU programs are mandatory.

> *"The most direct example of inducing increases in recycling participation using formal law is through mandatory provision of multi-tenant programs. Mandatory recycling can send a strong message to citizens that recycling is important. Even with little threat of enforcement, a recycling law can help to reconstruct social norms."*
>
> Multi-Tenant Recycling Literature Review
> State of Oregon 2018

- Consistency. It is important for the expectations between sectors to be the same. Residents often move between the single and MU residential sectors and therefore program expectations should remain consistent.

  The need for consistency also applies between the residential and ICI sectors. The research indicated that where municipalities had achieved the most success, expectations were consistently enforced in all daily spheres of life such as at work, home and school. This cross-sector consistency reinforces concepts communicated through educational programs and facilitates the formation of habitual behaviour change needed to achieve success.

- Enforcement. Once a bylaw is in place enforcement is up to the discretion of the municipality. Common mechanisms include refusing collection, penalties and fines.

Image source: San Francisco Department of Environment

6.2 Developer standards

Developer standards are an important tool that municipalities are leveraging to help ensure that new buildings are designed and constructed to include waste diversion best practices. Appendix C shows some examples of comprehensive standard documents.

The research found that that these standards need to:

- Be integrated in the approval process for new buildings. Waste sorting space plans should be included in the site plan and permitting process for a new building alongside other considerations for servicing and access, such as fire departments.

- Be enforceable. This is a major challenge for municipalities in Canada because

these documents remain educational tools or guidelines and are not considered mandatory unless they are tied to bylaws such as zoning. These standards should be used to ensure that a building is serviceable and encompasses best practices. The lack of appropriate infrastructure creates challenges for future residents of the building ,as well as logistical challenges and costs for property managers and service providers. In the USA, these standards are more commonly enforced by ordinances, and in some cases, are enforced through the building code itself.

The research also found that developer standards need to include the following provisions:

- Access requirements. This ensures that collection vehicles are able to gain access to the collection location at each building. Vehicle dimensions, turning radius, and overhead clearances must be considered when designing collection locations, including details such as door size to facilitate moving containers for collection.

- Provide separate collection spaces in mixed-use buildings. It is very important to ensure that there are separate centralized waste collection spaces for residential and commercial customers in mixed-use buildings. This is especially important in municipalities where different sectors may be serviced by different service providers. Residents must not have access to commercial collection areas and vice versa.
  Even in municipalities that do not provide service to MU buildings, such as the City of Vancouver, separate residential and commercial sorting and collection areas are still required to be in place. If these collection areas are not separate, it can be very difficult to offer variable rates, incentives or other volume-based financial incentives as it is difficult to differentiate the origin of the waste in a shared area. An example of developer standards for separate sorting areas in mixed use sites can be found in Appendix C for reference.

- Allocate waste stream volume needs. A formula is used to calculate the required volume for each waste stream based on factors such as the number of units and residents per unit (most commonly set at two residents per unit).
  Should units be larger than double occupancy, the formula can be adjusted to accommodate the additional perceived capacity requirement. Once the required volume is determined for each site, the appropriate number and size of containers is assigned to each site.

- Mandatory co-location of waste streams and implementation of sorting area best practices. Buildings must have adequate space in a convenient location on the property to allow for separation and temporary storage of waste streams. Options to achieve co-location can be diverse. However, care should be taken to avoid methods that are not flexible enough to allow for program evolution. Internal sorting areas are preferable to external sorting areas and standards should include a sorting room with adequate space to house all of the containers based on allocation formulas. Sorting areas both inside or outside must follow sorting area best practices so as to contribute to a positive visual and experiential amenity.

- Define roles and responsibilities of key stakeholders. This includes setting out requirements, such as snow removal or positioning of containers for collection. It is important to be clear what service is provided by the hauler, and what needs to be done by the property manager or delegate.

6.3 Volume limits and Incentives

Although the research found no municipalities with hard volume limits, such as refusing to collect excess, many are working to control volumes through a variety of mechanisms. Common approaches to limiting volume and promoting reduction are as follows:

- Educate and calculate. The most common approach is to educate and assist building managers and owners with accurately estimating the volume needs for each waste stream. Where excess waste is detected on an ongoing basis, municipal teams can meet with building management to adjust service subscriptions, such as upsizing a container or increasing collection frequency before charging for excess amounts. Rates can be set so that increased regular service can be less expensive than excess waste, which helps to streamline operational planning and route setting compared to an ad hoc excess waste collection.

- Unlimited recycling and organics. Offering diversion streams, such as organics and recycling streams, at no additional cost, or allowing for the collection of unlimited volumes of those streams for no extra cost, can encourage resident participation in those programs and potentially reduce the volume found in the garbage stream.

- Variable pricing/rates. This approach is both common and considered best practice as a tool to promote waste reduction. Pay-as-you-throw (PAYT) is a type of variable pricing used by many municipalities to reduce residual waste. Collection of organics and recycling streams can be included in a base cost and collection of garbage can be based on a variable, volume-based rate. Alternatively, PAYT can be used to incentivize overall reduction by charging for all streams based on volume. While the structure can vary, the goals are the same: reduction of waste through the use of economic principles.

  The most common setup is a subscription-based rate where a building pays for services based on the volume of garbage set out. Anything above the subscription amount can be charged as extra and the rates can be set in a way that is a deterrent to setting out additional garbage. In North America, variable pricing often means customers get diversion “included” in the price and the rate fluctuates with the garbage volume only.

- Incentives. While rate structure and fees can act as a deterrent, incentives should also be established. These incentives can include a “diversion discount” for buildings that meet criteria such as high diversion rate, an on-site composting program or overall reduction of waste by volume collected per cycle. Incentives can provide positive reinforcement and can be a powerful counterpoint to more punitive measures. While many sources agreed that incentives should be established, few active examples were found.

The challenge with all of these methods is that they target property managers (those responsible for the overall system), rather than

residents (those responsible for waste generation and sorting). Property managers can be encouraged to support diversion through economic incentives (the more your building recycles/composts the less you pay). However, the connection to the residents is not as strong or direct as they are often not the account holder. For the full effect of these incentives and deterrents, work must be done to cascade the results of the efforts made at a building to those residents. Municipalities examined as part of this research reinforced that the relationship the city has with the property manager will help to support them to build the culture in their respective buildings. All of them expressed a desire to determine a way to make the economic incentive more direct for residents.

7. MEASURING SUCCESS

★ Key findings:
- There is no current standard methodology for calculating a diversion rate.
- Diversion rate alone may not be an adequate measure of success.
- There is no one method of calculating success.

7.1 The question of method

Diversion from landfill is one of the most common methods of measuring success in North America. However, among all sources examined, there was no standard method for calculating diversion rates for the MU sector. Because waste from the MU sector is not always collected separately from other sectors' waste, it is difficult to establish an MU-specific diversion rate. For those who were able to separate out the MU portion of their data, the high performers in North America were reaching between 20 and 40 per cent diversion from landfill. There were a number of municipalities that estimated that their diversion rates were higher, but they did not have the ability to break out the MU sector specifically from their data and these estimates remain inconclusive.

Additionally, several sources noted that diversion rate alone may not be an adequate metric when measuring success in the MU sector. Diversion is a quantitative measure that does not reflect qualitative aspects of a program success, such as the marketability or usefulness of end products. It also does not show the change in total waste produced by residents, and therefore does not speak to waste reduction efforts. More waste would be sent to landfill if waste generation rises and the diversion rate remains the same.

7.2 Potential measures

A number of alternative or complementary measures to diversion rate were identified in the research. A combination of these measures could be used to generate a more comprehensive indication of success:

- Container fullness
- Contamination
- Waste generation/reduction
- Capture rates
- Participation rate
- Container lift data
- GHG emissions
- Financial efficiency (cost per volume or weight)

7.3 Tools for measurement

All sources agree that while there are a number of very useful tools that may be employed to measure success, none of them can be counted as perfect. When it comes to measurement, a number of potential tools were noted:

- Regular audits and waste composition studies.

- Surveys, such as satisfaction, public perception and barriers.
- Online data harvesting, such as tracking numbers of views, likes and shares on social media platforms to determine the reach and impact of educational campaigns or other online tools including applications.
- Technology, such as onboard scales, RFID and fill sensors. It must be noted however that these technologies, while being employed by other municipalities come with challenges and their use has not been perfected.

If a regular account is taken of building statistics, the impact of new incentives or behaviour interventions can then be measured against baseline data.

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https://resourcelondon.org/resources/research-and-innovation/making-recycling-work-for-people-in-flats/
https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/Documents/city-of-london-waste-strategy.pdf
https://www.london.gov.uk/sites/default/files/waste_management_in_high_density_development_spd_final.pdf

Australia
City of Melbourne
https://www.melbourne.vic.gov.au/residents/waste-recycling/apartment-buildings/Pages/waste-recycling-apartments.aspx
https://www.melbourne.vic.gov.au/SiteCollectionDocuments/waste-resource-recovery-strategy.pdf
https://www.sustainability.vic.gov.au/Government/Waste-and-resource-recovery/Waste-management-in-multi-unit-developments
https://www.melbourne.vic.gov.au/residents/waste-recycling/Pages/bins-collections.aspx

City of Perth
https://perth.azureedge.net/-/media/Project/COP/COP/COP/Documents-and-Forms/Live-and-Work/Documents/Residents/2019-Waste-and-Recycling-Guide.PDF?modified=20190220054351&la=en&hash=A60B5FDD52BB754316322943096B6773D1A63884

https://www.perth.wa.gov.au/en/live-and-work/residents/rubbish-waste-and-recycling

South Korea
City of Seoul
http://english.seoul.go.kr/policy-information/environment-energy/climate-environment/3-waste-treatment-projects/
http://english.yongsan.go.kr/pms/contents/contents.do?contseqn=885&sitecdv=S0001501&menucdv=03090000&decorator=user15En
http://susa.or.kr/en/content/solid-waste-management?ckattempt=2

Municipal Interviews

Canada
British Columbia: City of Vancouver
Alberta: City of Calgary
Saskatchewan: City of Saskatoon
Ontario: City of Toronto, City of Ottawa
Nova Scotia: City of Halifax

United States
California: City of San Francisco, City of San José
Washington: City of Seattle

Italy
City of Milan, City of Treviso

Netherlands
City of Rotterdam

United Kingdom
City of London

Australia
City of Melbourne

Industry Interviews

Solid Waste Association of North America (SWANA)
Recycle BC
Recycling Council of British Columbia (RCBC)
Recycling Council of Alberta (RCA)
Alberta CARE
Recycling Council of Ontario (RCO)
Municipal Waste Association (MWA)
Waste Connections of Canada
Waste Management
Walker Industries

The following sources were selected but we were unable to conduct an interview:
International Solid Waste Association (ISWA)
Continuous Improvement Fund (CIF)
Green for Life (GFL)
SUEZ
Greenwaste Recovery
Recology

Alternative Processing Options

Internal City of Edmonton data collection, EWMC
Interview - Anaergia Inc. (https://www.anaergia.com)
Interview - Durham Region - Durham York Energy Center (DYEC)
Interview - Metro Vancouver - Burnaby Waste to Energy Facility (BWtEF)

The following sources were selected but we were unable to conduct an interview:
Covanta (https://www.covanta.com)

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APPENDICES

Appendix A - Overview of Collection Methods.

Appendix B - Supplementary Photographic Examples.

Appendix C - Examples from Developer Standards.

APPENDIX A - OVERVIEW OF COLLECTION METHODS

The following table presents some qualitative information related to each method of collection identified in the research. This information addresses subjective criteria such as user experience; operational impacts, including health and safety and the effect a particular method of collection has on operational efficiency; set up and implementation considerations; the prevalence or popularity of each method; the appropriateness both to different building types as well as applicability to each waste stream; and the flexibility of the method to be altered to accommodate future program changes.

Costs have not been included here as prices can vary by region and vendor availability and would require further analysis.

	Ease of Use	**Ease of Service** *Efficiency, safety, etc.*	**Ease of Installation** *Set up and implementation*	**Prevalence and Application** *Appropriate for different buildings, different streams*	**Flexibility to Program Changes**
Manual Bag Collection	<u>Residents:</u> • Easy to use and transport. • Easy to store at home. <u>Property Management:</u> • Can tear, causing mess, odours, and attracting pests. • Inexpensive.	• Requires manual collection, increasing workplace hazards for collectors. • No concerns with waste freezing to containers under winter conditions. • Flexible collection frequency options.	• Typically no permanent infrastructure installation is required. • Storage location can be flexible as bags do not require permanent infrastructure to facilitate collections. • Temporary and small footprint.	• Transparent bags for garbage is a common application where bags are used. • Typically not used for the collection of organics. • Least commonly used method of collection among sample municipalities researched. • Less suitable for high density buildings due to the quantity of bags required to meet needs. • Less suitable for use in mixed use buildings due to quantity needed to	• Can be obtained in multiple colours to align with different collection streams. • Plastics have an impact on processing facilities and may not be suitable for all program streams.

				meet needs, and difficulty separating waste collection for each tenant.	
Carts and Mini Containers	<u>Residents:</u> • Easy to use and maneuver. • Mini containers (30L) are easy to carry to the collection area. • May be easier to access than Front Load Bins (FLB). <u>Property Management:</u> • Odour can be a concern if not serviced frequently enough. • Potential of additional work/cost to relocate from storage location to collection area each collection cycle (if management performs this role).	• Flexible collection frequency options. • May require higher service frequency than larger containers depending on the number of carts on a site (assuming similar usage). • Depending on the jurisdiction, use of bags may be allowed for the organics stream to help prevent material freezing to the container. • Containers require maintenance and cleaning. • Enhanced collector safety over manual bag collection.	• Typically no permanent infrastructure installation is required. • Can be located inside building sorting rooms or outdoors. • Storage and set out location can be flexible. • Small footprint per container (3 to 6 square feet per container).	• Carts can be used in most building settings effectively, especially where property space constraints will not permit the placement of an FLB. • Can be used for most waste streams, including organics. • Most commonly used for organic streams as plastic does not deteriorate as quickly as steel containers in the presence of wet waste. • Most commonly used for organic streams due to the more compact nature of food scrap materials and the typically higher frequency of collection to mitigate odours and pests. • Where there is a large quantity of bulky recycling such as cardboard, carts will fill faster, making them less	• Can be obtained in multiple colours to align with different collection streams. • Can be easily relocated to accommodate any changes to site or program needs. • Can be exchanged quickly for different sizes should building needs or additional program requirements be introduced.

				ideal when compared to FLB. • Less suitable for high density buildings due to the quantity of carts required to meet needs. May be appropriate to use in conjunction with FLB. • Ideal application in low to mid rise buildings. • Suitable for use in mixed use buildings, however less suitable in high density mixed use buildings due to quantity required to meet needs. • Suitable for indoor or outdoor settings. • Very common where source separation includes more than three streams. • Large range of sizes can be combined to suit building needs (30L to 360L). Most common sizes are 240L and 360L. • Has an approximate average lifespan of 12 years.	
Front Load Bins (FLB)	<u>Residents:</u> • Easy to use. <u>Property Management:</u>	• Flexible collection frequency options. • Containers require maintenance and	• Infrastructure may be required depending on site layout and	• Most commonly used for garbage and commingled recycling (especially	• Can be obtained in multiple colours to align with different collection streams.

	• Odour can be a concern if not serviced frequently enough. • Allows for the disposal of illegal bulky material if the openings are large. • Potential of additional work/cost to relocate from storage location to collection area each collection cycle (if management performs this role). May require more than one person to move a bin.	cleaning. • Potential for infrastructure damage by FLB vehicles. • Potential safety concern if the FLB need to be moved by the collectors. • Depending on the jurisdiction, use of bags may be allowed for the organics stream to reduce freezing of material to the container. • Generally requires less frequent servicing than carts due to their larger size (assuming similar usage).	jurisdiction. • Choosing a location may be more difficult than carts in existing sites. • Larger footprint than carts per container (20 to 30 square feet per container).	cardboard). • Can be used for organics. However, it is less common due to the more frequent average collection of that stream to mitigate issues such as odour or pests. For larger buildings that require larger volumes the most common size is a 2 cubic yard FLB. • Can be used indoors or outdoors, but most commonly found in outdoor collection areas. • More commonly used for buildings with medium density. • Suitable for mixed use buildings. • Volume ranges from 1-8 cubic yards. Most common volume is 3-6cubic yards. • Has an approximate average lifespan of 12 years.	• Less easily relocated compared to carts to accommodate any changes to site or program needs. • Can be exchanged quickly for different sizes should building needs or additional program requirements be introduced.
Roll-off Compactors	<u>Residents:</u> • Easy to use. • Noisy. <u>Property Management:</u> • Additional training required to operate the compactor. • Can cause noise,	• The container needs to be loaded on a vehicle and taken off site for emptying. • Considerably less frequent servicing required due to large capacity	• Site must be designed and built to ensure adequate infrastructure is in place for these containers. • Difficult to retrofit and add in existing buildings.	• Cannot be used for organic waste due to the moisture content. • Most suitable for recycling and garbage streams. • More commonly used for buildings	• Costly and difficult to modify. Can be replaced with a different size if needed. • Can be obtained in multiple colours to align with different collection streams.

	odour and vibration concerns.	(assuming similar usage). • Containers require maintenance. • Enhanced collector safety over manual bag collection.	• Large footprint (approx. 100 to 200 square feet per container). • In sites with existing roll-off compactors, it is difficult to add additional ones if it's not planned. Or space to add other types of containers may be limited if not taken into account during the design phase.	with high density. • Suitable for mixed use buildings. • Volume ranges from 10 to 30 cubic yards.	• Cannot be relocated to accommodate any changes to site or program needs.
Underground Containers - Crane Unloaded	<u>Residents:</u> • Easy to use. <u>Property Management:</u> • Less opportunity for salvaging waste (i.e. "dumpster diving"). • Odour can be a concern if not serviced frequently enough. • Openings are typically small and prohibit the disposal of illegal bulky material. • Perceived improved aesthetic compared to FLB. • Does not require manual maneuvering for collection.	• Requires a collection vehicle with a crane to service the container. • Generally similar servicing frequency requirements as FLB (assuming similar usage). • Containers require maintenance and cleaning. • Enhanced collector safety over manual bag collection.	• Custom infrastructure required. • Requires more overhead clearance for servicing than carts and FLB. • Less flexibility in site location due to access and underground utilities and the permanent nature of the infrastructure. • Generally requires the same or slightly larger footprint as FLB.	• More common in ICI settings in North America. • Not commonly used by municipalities for regular residential collection service. • Cannot be used for organic collection. • Volume typically up to 6 cubic yards. • Has an approximate average lifespan of 12 years.	• Costly and difficult to modify. • Above ground portion can be obtained in multiple colours to align with different collection streams. • Cannot be relocated to accommodate any changes to site or program needs.
Underground Containers - Front Load Truck Unloaded	<u>Residents:</u> • Easy to use. <u>Property Management:</u>	• Can be serviced by front load vehicles similar to FLB. • Generally similar	• Custom infrastructure required. • Requires more	• More common in ICI settings in North America. • Not commonly	• Costly and difficult to modify. • Above ground portion can be

	• Odour can be a concern if not serviced frequently enough. • Openings are typically small and prohibit the disposal of illegal bulky material. • Perceived improved aesthetic compared to FLB. • Does not require manual maneuvering for collection.	servicing frequency requirements as FLB (assuming similar usage). • Containers require maintenance and cleaning. • Enhanced collector safety over manual bag collection.	overhead clearance for servicing than carts and FLB. • Less flexibility in site location due to access and underground utilities and the permanent nature of the infrastructure. • Generally requires the same footprint as FLB.	used by municipalities for regular residential collection service. • Cannot be used for organic collection. • Volume typically up to 6 cubic yards. • Has an approximate average lifespan of 10 years.	obtained in multiple colours to align with different collection streams. • Cannot be relocated to accommodate any changes to site or program needs.
Underground Containers - Euro-Style	<u>Residents:</u> • Easy to use. <u>Property Management:</u> • Less opportunity for salvaging waste. • Odour can be a concern if not serviced frequently enough. • Openings are typically small and prohibit the disposal of illegal bulky material. • Perceived improved aesthetic compared to FLB. • Does not require manual maneuvering for collection.	• Some styles include a compactor which could reduce frequency of service (assuming similar usage). • Requires a collection vehicle with a crane to service the container. • Containers require maintenance and cleaning. • Enhanced collector safety over manual bag collection.	• Custom infrastructure required. • Requires more overhead clearance for servicing than carts and FLB. • Generally requires the same footprint as FLB. • Not recommended for use for organic waste. • Less flexibility in site location due to access and underground utilities and the permanent nature of the infrastructure. • Potential for more streamlined streetscape than above ground options. • Can be placed on either public or private property.	• Not recommended for organic collection. • Commonly used in higher density areas. • Access can be controlled or open for combined use to service multiple sectors in mixed use settings. • Not currently available in North America.	• Costly and difficult to modify. • Above ground portion can be obtained in multiple colours to align with different collection streams. • Cannot be relocated to accommodate any changes to site or program needs.

			Research showed that they are more commonly found on public property due to smaller above ground footprint than above ground bins or other styles of underground collection. • Not recommended for use for organic waste.		
Pneumatic Collection	<u>Residents:</u> • Easy to use. <u>Property Management:</u> • Less opportunity for salvaging waste. • Odour can be a concern if not serviced frequently enough. • Openings are typically small and prohibit the disposal of illegal bulky material. • Perceived improved aesthetic compared to FLB. • No requirement for waste storage on the property.	• Does not require collection vehicles. • Requires maintenance. • Enhanced collector safety over manual bag collection.	• Extensive infrastructure needed. • Site must be designed and built to ensure adequate infrastructure is in place. • Low above ground footprint compared to other options.	• Not as commonly available as other methods. • More ideal for large scale developments or mixed commercial. Less practical to install for individual buildings. • Access can be controlled or open for combined use to service multiple sectors in mixed use settings.	• Costly and difficult to modify. • Above ground portion can be obtained in multiple colours to align with different collection streams. • Cannot be relocated or expanded to accommodate any changes to site or program needs.
Mobile Collection	<u>Residents:</u> • Challenging to use if route schedules are inconvenient or irregular. • All residents need to dispose of their waste at the same time (as the vehicle	• Flexible frequency options. • No requirement for containers and space for them.	• No infrastructure required.	• Found in very specific locations such as space-constrained historic centres. • Least common of options. • Can be used for most waste	• Routes and schedules can be altered to accommodate changes. • Waste streams collected can be flexible. • Can change easily

	arrives at the designated location). <u>Property Management:</u> • Reduced or no requirement for waste storage on the property.			streams, including organics.	to accommodate changes to program streams or requirements as it does not rely on containers or physical space infrastructure.
Waste Drop Off (exclusive)	<u>Residents:</u> • Challenging to use depending on distance to site and operating hours. • Can typically dispose of household waste and household hazardous waste in one location. <u>Property Management:</u> • May find the lack of on site service challenging if residents have challenges accessing the drop off sites. • May lead to illegal dumping.	• Typically requires on site staff to operate. • Operating hours can be changed to match the need. • Need for collection vehicles is different and likely reduced.	• Requires planning to choose a site and ensure adequate space for residents and customers to access.	• Non exclusive waste drop off is common in all jurisdictions as it can serve multiple sectors (not just residents with communal collection). • Most commonly used as supplementary service alongside regular collections on site. • Can be used for most waste streams, including organics.	• Containers on site can be switched to accommodate changes. • May be difficult to change the site layout after set up.

APPENDIX B - SUPPLEMENTARY PHOTOGRAPHIC EXAMPLES

Bag Collection

Bags and carts set out for collection in Milan, Italy. (Image courtesy of Amsa SpA)

Cart Collection

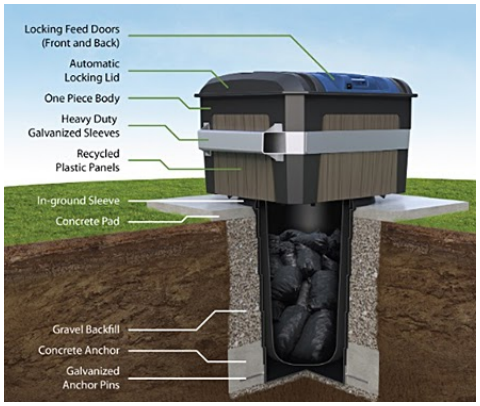
From left to right: 120L containers and 30L mini containers in Treviso, Italy (Image courtesy of Contarina SPA); Mini containers set out for collection in Barcelona Spain (image source: Area Metropolitana de Barcelona)); Examples of size options for organic, garbage and recycling in Toronto, Canada. (image source: Michalis Famelis on Flickr)

Front Load Bin Collection



From left to right: Outdoor collection area with recycling bins and green organics cart in Ottawa, Canada (image courtesy of the City of Ottawa); Bins on street to serve residents and public in Barcelona, Spain (image source: "Recycle or Bust: What's IN and What's OUT," article in Metropolitan Barcelona by Kurt Krumperman); Blue (recycling) and grey (garbage) bins alongside an organics cart located in a communal collection area in Seattle, USA (image courtesy of the City of Seattle).

Underground Collection Containers



From left to right: Underground garbage collection infrastructure beside above ground organics collection in Rotterdam, Netherlands (image courtesy of Gemeente Rotterdam); Mixed use collection in Ljubljana, Slovenia (image source: Mestna občina Ljubljana); Cross section of front load truck unloaded underground collection infrastructure (image source: Waste Connections).
Bottom: Crane unloaded underground collection infrastructure (image by the City of Edmonton).

Pneumatic Collection



From left to right: Pneumatic collection streetscape in Barcelona, Italy (image source: "Smartest City in the World," article by Jaro Tomik in LinkedIn Pulse); Diagram of pneumatic collection system (image source: "Vacuum waste: A tech whose time has finally come," article in Sidewalk Talk by Philip Preville) ; Collection receptacles in building courtyard in London, UK (image source: Sidewalk Talk) .

Mobile Collection

From left to right: EcoBus in Treviso, Italy collecting mini bins on fixed route; EcoStop mobile bin collection in historic centre in Treviso, Italy (images courtesy of Contarina SPA).

Waste Sorting Area Best Practices

From left to right: Waste sorting room in MetroVancouver, Canada (image source: [Waste Management Design Guidelines](), the City of Richmond, BC) ; Sorting room before and after application of best practices, London, UK (image source: [London Waste and Recycling Board/ReLondon]())

In-unit Resident Supports

From left to right: In-unit kitchen catcher with certified compostable bags in Milan, Italy (image courtesy of Amsa SpA) ; Reusable recycle bags provided as in-unit support in Ottawa, Canada (image courtesy of the City of Ottawa); Undersink sorting for three streams in Sweden (image source: "Malmö -Communication at the heart of food recycling," article in Beyond Food Waste by Kat Heinrich).

APPENDIX C - EXAMPLES FROM DEVELOPER STANDARDS

The following excerpts provide examples of comprehensive and informative developer standards from other jurisdictions that have source separated communal collection programs. These examples address best practices for a range of building types and set ups including the use of chutes and waste set out in mixed use buildings.

ATTACHMENT 2

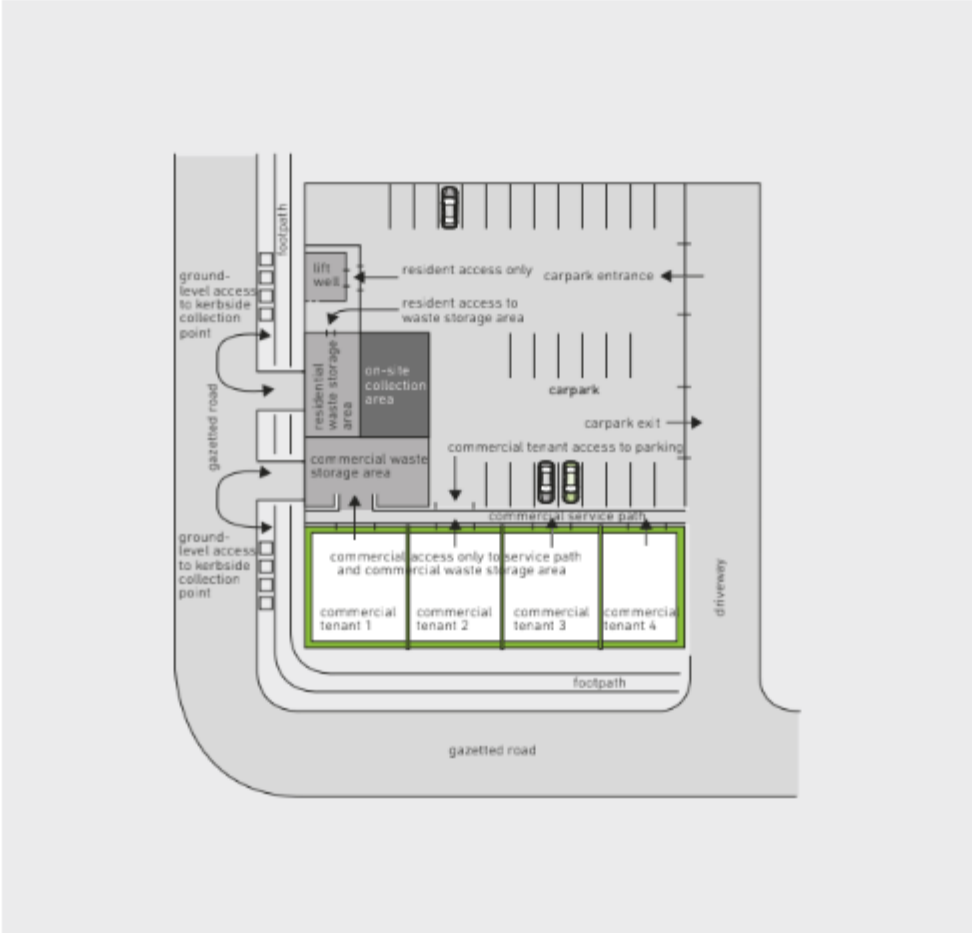
Guide to Estimating the Recycling and Garbage Bins Your Complex Needs for Weekly Collection

RESIDENTIAL BUILDING

NUMBER OF UNITS (2 residents per unit)	MIXED CONTAINERS	MIXED PAPER (Without a Cardboard Bin)	MIXED PAPER (With a Cardboard Bin)	FOOD SCRAPS & YARD TRIMMINGS (High participation)	CARDBOARD	GARBAGE (Moderate recycling)	GARBAGE (Extensive recycling)
	360 LITRE CART (#)			240 LITRE CART (#)	FRONT END BINS (# x SIZE)		
5-10	1	1	N/A	1	0	1 x 2 yd³	1 x 2 yd³
11-20	1	2	N/A	1	0	1 x 3 yd³	1 x 2 yd³
21-30	1	3	1*	1	1 x 3 yd³*	1 x 4 yd³	1 x 2 yd³
31-40	2	4	1*	2	1 x 3 yd³*	1 x 6 yd³	1 x 3 yd³
41-50	2	5	2*	2	1 x 3 yd³*	1 x 8 yd³	1 x 4 yd³
51-60	3	6*	2	3	1 x 3 yd³	1 x 8 yd³	1 x 4 yd³
61-70	3	7*	2	3	1 x 3 yd³	2 x 6 yd³	1 x 6 yd³
71-80	4	8*	3	3	1 x 3 yd³	2 x 6 yd³	1 x 6 yd³
81-90	4	9*	3	4	1 x 3 yd³	2 x 8 yd³	1 x 6 yd³
91-100	4	10*	3	4	1 x 3 yd³	2 x 8 yd³	1 x 8 yd³
101-110	5	11*	3	4	1 x 3 yd³	3 x 6 yd³	1 x 8 yd³
111-120	5	12*	4	5	1 x 3 yd³	3 x 8 yd³	1 x 8 yd³
121-130	6	13*	4	5	1 x 3 yd³	3 x 8 yd³	1 x 8 yd³
131-140	6	14*	4	6	1 x 4 yd³	3 x 8 yd³	2 x 6 yd³
141-150	6	15*	5	6	1 x 4 yd³	3 x 8 yd³	2 x 6 yd³
151-160	7	16*	5	6	1 x 4 yd³	4 x 8 yd³	2 x 6 yd³
161-170	7	16*	5	7	1 x 4 yd³	4 x 8 yd³	2 x 6 yd³
171-180	8	17*	5	7	1 x 6 yd³	4 x 8 yd³	2 x 8 yd³
181-190	8	18*	6	8	1 x 6 yd³	4 x 8 yd³	2 x 8 yd³

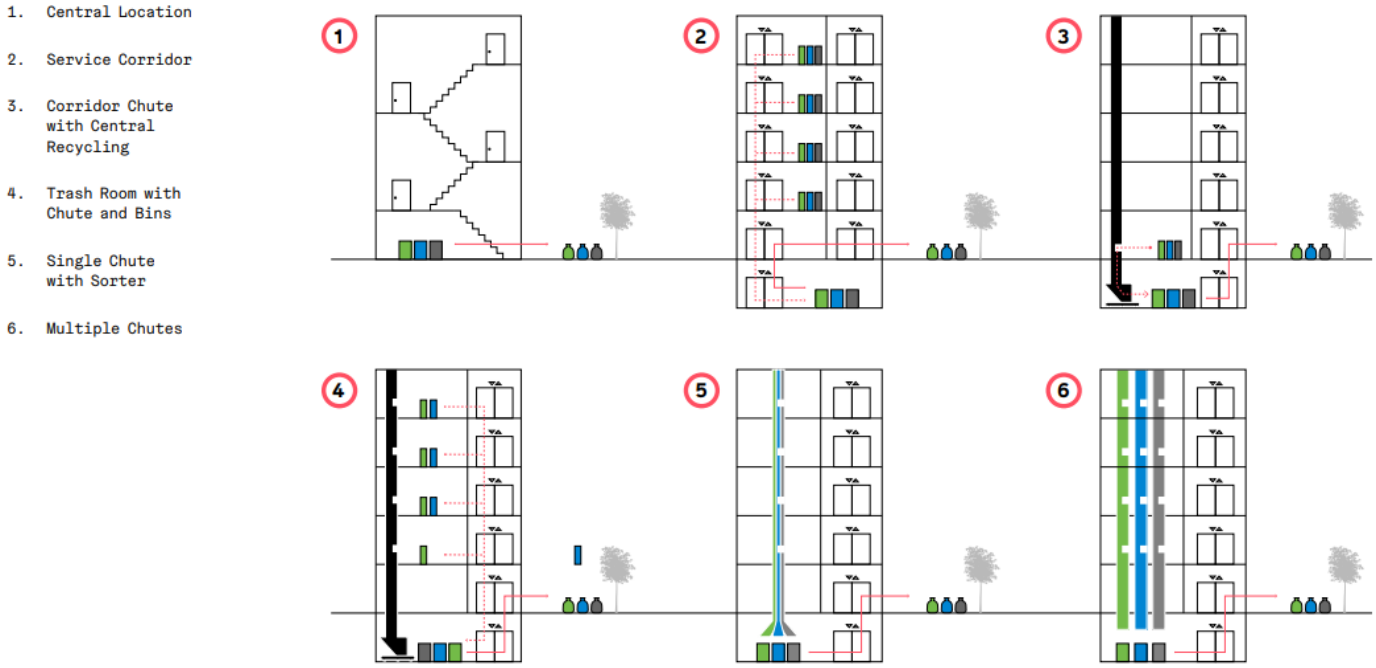
Estimation guide for weekly collection of up to six streams, Richmond, Canada (source: Waste Management Design Guidelines, the City of Richmond, BC).

FIGURE 11
SEPARATE COMMERCIAL AND RESIDENTIAL WASTE STORAGE AREAS



Better practice example for mixed use buildings (source: [Waste and recycling in multi-unit developments](), Victoria State, Australia).

Diagram showing three chute systems in multi-unit building (source: [Waste and recycling in multi-unit developments](), Victoria State, Australia).



Excerpt from "Zero Waste Design Guidelines" addressing OneNYC goals for colocation through different set ups in high rise buildings (source: Zero Waste Design Guidelines, New York City, USA).