Foth

Final Report

Residential Waste Characterization and Capture Rate Study:

Prepared in partnership with

MSW CONSULTANTS

City of Minneapolis Public Works

Minneapolis, MN

August 2022

Project I.D.: 0022M076.00

Solving our clients' toughest science and engineering challenges.

8550 Hudson Boulevard North
Eagle Point Office Center II, Suite 105
Lake Elmo, MN 55042
(651) 288-8550
foth.com

August 31, 2022

Kellie Kish and Jeff Jenks
City of Minneapolis Public Works
350 S. 5th St., Room 203
Minneapolis, MN 55415

Re: Transmittal of Foth's *Final Report*

Dear Kellie and Jeff:

Foth is pleased to submit this *Final Report: Residential Waste Characterization and Capture Rate Study* (*Final Report*). This culminates the project conducted in partnership with MidAtlantic Solid Waste Consultants, Inc. (MSW Consultants).

This *Final Report* complements MSW Consultant's *City of Minneapolis Residential Waste Characterization and Capture Rate Study: Methodology and Baseline Results* (*Sort Report*), which provides all of the required description of methods, detailed data, material category definitions, and technical analysis. This *Final Report* provides the executive summary plus discussion of proposed target capture rates by material, conclusions, and recommendations.

It was our pleasure serving the City of Minneapolis.

Sincerely,

Foth Infrastructure & Environment, LLC

Dan Krivit
Technical Environmental Planner

Bruce Rehwaldt, P.E.
Senior Client Manager
Licensed in MN, IA, WI, CA, AZ, NM, WY

cc: John Culbertson and Joe Vetrano, MSW Consultants

Enclosure

Residential Waste Characterization and Capture Rate Study

Distribution

Transmitted via email to:
Kellie Kish (City of Minneapolis)
Jeff Jenks (City of Minneapolis)
John Culbertson (MSW Consultants)
Joe Vetrano (MSW Consultants)

Residential Waste Characterization and Capture Rate Study

Project ID: 0022M076.00

Prepared for

City of Minneapolis Public Works

350 S. 5th St., Room 203
Minneapolis, MN 55415

Prepared by

Foth Infrastructure & Environment, LLC

August 2022

8550 Hudson Boulevard North • Eagle Point Office Center II, Suite 105 • Lake Elmo, MN 55042 • (651) 288-8550
foth.com

Residential Waste Characterization and Capture Rate Study

Table of Contents

Tables

Residential Waste Characterization and Capture Rate Study

Executive Summary

The City of Minneapolis has a world-class residential curbside recycling and organics recovery program. Curbside recycling was launched in 1982 and citywide curbside organics collection was launched in 2016. This is the first comprehensive residential waste characterization and capture rate study conducted since the City's curbside organics service was launched. The City's Zero Waste plan adopted in November 2019 called for this type of waste characterization study. The City produced this project to research how best to enhance its residential curbside recycling and organics programs based on accurate data about waste characterization and capture rates of the targeted recoverable commodities.

This project was designed and planned by City staff leading the Solid Waste & Recycling Division (SW&R). The consultant team of Foth Infrastructure & Environment (Foth) and Mid MidAtlantic Solid Waste Consultants, Inc. (MSW Consultants) conducted the waste sort operations, data analysis, and report drafting in close coordination with SW&R staff. The field operations of sample collection and sort facility management by City staff was an essential element of the sort project.

MSW Consultants managed the sort operations, data analysis and authored the separate *Sort Report* with detailed summaries of results. Foth assisted with professional staff at the sort operations and authored this *Final Report* to complement the *Sort Report*.

This 2022 Study found that City capture rates reflect a mature, high-functioning residential recycling and organics collection program. The current total capture rate calculated through the methods of this 2022 Study is estimated at 14 percent of residential waste generated. This is an accurate and empirical measurement and indicates excellent progress, but also indicates significant potential for improvement. This *Final Report* includes a comparable estimate of the reasonably achievable total capture rate in ten years of 20 percent of residential waste generated. A series of assumptions were used to develop this estimate including individual commodity capture rates with significant but reasonable increases. This item by item approach using standardized capture rate methods of calculation should be helpful to the City's planning of recycling and composting program improvements.

This 2022 Study found that about 38,000 tons per year of recoverable recyclable and compostable materials are still being wasted in the residential garbage carts. The potential end market value of these recoverable recyclable and compostable materials that remain in the garbage carts is about $2.8 million per year.

The City has a model residential curbside organics recycling program with 51 percent of eligible households signed up for the voluntary, separate collection service. The City intends to continue to promote organics subscriptions and can use the details of this 2022 Study to target public and education messages more strategically.

Results from this 2022 Study indicate organics program subscribers have a much higher total average capture rate (including both recyclables and compostables) compared to non-subscribers. Also, the recycling contamination is much lower in the subscribers group compared to non-subscribers. Thus, the subscribers were found to be more active recyclers of traditional recyclables, in addition to participating in the organics program. This comparative data between subscribers and non-subscribers is rich with potential implications for new City public education and outreach initiatives to improve overall recycling and organics recovery well into the future.

Acknowledgements

The consultant project team of Foth and MSW Consultants would like to thank City of Minneapolis Recycling Coordinator Kellie Kish, Business Application Manager Jeff Jenks, the City's cart retrieval crews, and the operations staff at the North Minneapolis Solid Waste & Recycling Operations Facility for their assistance during various stages of this project. This study would not have been successful without their ongoing cooperation.

List of Abbreviations, Acronyms, and Symbols

ASTM	ASTM International (formerly the American Society for Testing and Materials)
BPI	Biodegradable Products Institute
C&D	construction & demolition
City	City of Minneapolis
COC	contaminant of concern
EPR	extended producer responsibility
Final Report	*Final Report: Residential Waste Characterization and Capture Rate Study*
Foth	Foth Infrastructure & Environment, LLC
HDPE	high-density polyethylene
HERC	Hennepin Energy Recovery Center in Minneapolis
HHW	household hazardous waste
ID	identification
lbs	pounds
MMSW	mixed municipal solid waste
MOE	margin of error
MRF	material recovery facility
MSW Consultants	MidAtlantic Solid Waste Consultants, Inc.
OCC	old corrugated cardboard
PET	polyethylene terephthalate
PP	polypropylene
PS	polystyrene
SSO	source-separated organics
SW&R	Solid Waste & Recycling
TPY	tons per year
WLA	waste load area

Definitions

The following definitions are the general terms used in this *Final Report*. Additional material category definitions are included as Appendix B of MSW Consultants' *Sort Report.*

Capture Rate	Calculated percentage of a targeted recyclable or compostable material that is actually being recycled or composted through the available, local recycling infrastructure ("captured" in the City's recycling programs and other collection systems). Calculated by dividing the amount of the targeted material collected divided by the amount of total generated for that same material.
Compostables	Targeted, recoverable organic materials as defined by the City that are accepted at local composting facilities. Generally, includes yard waste.
Contaminants as Collected	Non-targeted items collected in the City's curbside recycling and organics programs that are not recyclable or compostable; Includes non-targeted items erroneously placed in the recycling or organics carts by residents.
Diversion Rate	The total% of materials reused, recycled, composted or recovered through waste to energy facilities divided by the total amount of solid waste generated.
Final Report	This 2022 report authored primarily by Foth (*Final Report: Residential Waste Characterization and Capture Rate Study)*
Garbage	Mixed municipal solid waste as collected by the City. Also referred to as "Refuse."
Generation	The total amount of targeted materials recycled or composted plus the amount of the same materials disposed.
Organics	Food waste and non-recyclable paper targeted by the City of Minneapolis for their curbside or drop-off organics recycling programs; not including yard waste. Sometimes referred to as "Source separated organics" (SSO).
Other Divertible Materials	Other recoverable items collected by the City's other separate collection programs such as mattresses and large item pickups (appliances, furniture, large scrap metal, etc.)
Other Recycling Materials	These are potentially recyclable materials not collected as part of the City's curbside collection programs. Sometimes referred to as items that are recovered by "Recycling Beyond the Cart".
Other Waste	Solid Waste that has no feasible recycling or diversion outlet now or in the foreseeable future.
Processing Residuals	Rejected waste that is disposed and not recycled as an output from MRF processing operations. Processing residuals are affected by contaminants as collected but are not synonymous. Processing residuals are also affected by MRF equipment, design, and overall facility operation.
Project	This full Residential Waste Characterization and Capture Rate Study for the City of Minneapolis including both the MSW Consultants' *Sort Report* and this *Final Report.*
Recyclables	Traditional curbside materials (e.g., glass, paper, plastics, etc.) targeted by the City of Minneapolis for their curbside recycling program; not including organics or yard waste.

Definitions (continued)

Recycling	Separation, collection and processing of both traditional recyclables and organic materials. Also has the meaning prescribed in Minnesota statutes and in the Hennepin County Solid Waste Management Master Plan.
Recycling Rate	The total percentage of all residential solid waste generated that is ultimately recovered through collection and processing of recyclable or compostable material.
Refuse	Mixed municipal solid waste as collected by the City. Also referred to as "Garbage".
Residential Solid Waste	All mixed municipal solid waste generated from residents served by the City of Minneapolis solid waste and recycling system, including garbage, recyclables, organics, yard waste, large item/bulky waste, etc.
Single-stream Recycling Collection	The City's curbside collection and processing system for traditional recyclables whereby all targeted materials (paper, cans, glass, plastics, etc.) are sorted by residents and placed into the recycling cart. This excludes organics and yard waste by definition.
Sort Report	The separate 2022 report by MSW Consultants *(City of Minneapolis Residential Waste Characterization and Capture Rate Study: Methodology and Baseline Results)* prepared for the City of Minneapolis (August 30, 2022) which documents all of the methods, detailed technical findings, calculations, and statistical analyses of the waste composition sort.
Source-Separated Organics (SSO)	As defined by the City of Minneapolis' organics recycling program, includes food waste and non-recyclable paper but not yard waste. Also referred to as "Organics" or "Organic recycling materials."
2016 Study	A similar Waste Characterization and Recycling Analysis study conducted for Hennepin County by a larger consultant team including Foth and MSW Consultants (September 2016). Includes a corresponding set of two separate documents: *2016 Sort Report* and *2016 Final Report*.
2022 Study	This entire City of Minneapolis Residential Waste Characterization and Capture Rate Study project, including both the 2022 *Sort Report* and this 2022 *Final Report*.
Voucher Program	City of Minneapolis program which provides eligible residents with "vouchers" to redeem at no additional cost for disposal or recycling of C&D and other materials and residential solid waste at the South Transfer Station.
Waste Load Area (WLA)	Refers to the three geographic collection areas of the truck loads sampled within the 2016 Hennepin County Waste Characterization Study. WLAs were not used in this 2022 Study.
Waste-to-Energy	Resource recovery facilities that process and/or combust waste (e.g., mixed municipal solid waste [MMSW]) into a form of energy.

1. Introduction

The City of Minneapolis (City) Public Works Division of Solid Waste & Recycling (SW&R) manages and operates collection of garbage, recycling, organics recycling, yard waste, and large items from all buildings with four or fewer dwelling units within the City per City ordinance. Its customers also have access to use vouchers to bring excess garbage, construction & demolition (C&D) debris, and other items to the City's South Transfer Station. This *Residential Waste Characterization and Capture Rate Study Final Report* (*Final Report*) *is* focused on analysis of potential enhancements to the residential curbside recycling and organics programs only; yard waste, large items, C&D debris, etc. are outside the scope of this project.

In April 2022, the City retained the project team of Foth Infrastructure and Environment (Foth) and MidAtlantic Solid Waste Consultants, Inc. (MSW Consultants) to perform a new waste characterization and capture rate study (2022 Study). The goals, scope, and objectives of this 2022 Study are consistent with the City's Zero Waste Plan adopted by the City Council in November 2017. City SW&R staff planned and produced this 2022 Study, for which funding was provided both by the City and Hennepin County.

This 2022 Study consisted of sorting materials from garbage, recycling, and organics recycling carts picked up from the homes of individual customers. Sorting waste directly from residential homes was intended to provide an accurate depiction of the capture rates of the City's residential recycling and organics collection programs and the effectiveness of its educational programs and identify priority materials to focus future outreach and education activities. This method also allowed the 2022 Study to characterize the materials in each of the three streams (garbage, recycling, organics), including contaminants placed erroneously in the recycling and organics carts. The goals are to better identify the material items that have the greatest potential for diversion and to target major contaminants of concern (COCs) for processing.

In 2016, Hennepin County contracted with a similar consultant team, including Foth and MSW Consultants, to characterize residential garbage collected from three waste load areas (WLAs) in Minneapolis (2016 Study).[1] As part of the 2016 Study, annual recycling collection tonnage information was used to estimate a capture rate of recyclables and organic materials. It is important to note that the 2016 Study was performed as the City had just begun rolling out its residential organics recycling program. This 2022 Study is similar to the 2016 Study, with several significant differences in objectives and methods.

A separate *City of Minneapolis Residential Waste Characterization and Capture Rate Study: Methodology and Baseline Results* (*Sort Report*) was authored by MSW Consultants and records the detailed waste characterization methodology, results, and conclusions. This *Final Report*, authored by Foth, provides the executive summary of the overall 2022 Study with a broader discussion of results, especially on contamination and target capture rates, additional conclusions, and recommendations for enhanced City recycling and organics program performance.

[1] Hennepin County *2016 Minneapolis Residential Solid Waste Composition Analysis and Recycling Program Evaluation (*2016 Study) conducted by the consultant team of Foth, MSW Consultants, Louis Berger, and GRG Analysis:

Hennepin County, Minnesota, 2016. "Sorting out our waste problem: Insights from Hennepin County's waste sort."

Foth Infrastructure & Environment, LLC, 2016. *2016 Minneapolis Residential Solid Waste Composition Analysis and Recycling Program Evaluation Final Report.* September 26, 2016.

MSW Consultants, Inc. *Hennepin County – City of Minneapolis Residential Waste Characterization and Recycling Analysis ("2016 Sort Report").* September 2, 2016.

2. Methods

The first project phase involved the performance of a four-week waste characterization study throughout the month of May 2022. City staff collected garbage, recycling, and organics carts from about 700 households scattered evenly throughout the City, as randomly selected by City staff. Under collaboration with City staff, the consultant project team conducted the sort operations at the City's SW&R Maintenance Facility located at 2710 Pacific Street.

The consultant sort crew consisted of a joint team of professional field staff from MSW Consultants and Foth, as well as independent sort laborers recruited specifically for this 2022 Study. City staff and MSW Consultants provided overall work site setup and training of the sorting teams. City staff, MSW Consultants, and Foth supplied professional management staff to supervise the sorting at each sort table

City of Minneapolis staff were integral to the sampling and sort operation. The City's project manager/recycling coordinator provided significant training, oversight, and sort labor through most of the sorting operations.

MSW Consultants developed the sorting plan to meet the City's technical specifications and, subsequently, performed the statistical analysis for the waste characterization study phase of the project. MSW Consultants completed the detailed *Sort Report*, providing all necessary material category definitions, description of methods, data analysis, and summary presentation. This *Final Report* complements the MSW *Sort Report*.

2.1 Comparison to the 2016 Study

There are several significant quantitative and qualitative differences between the 2016 Study and this 2022 Study. The similarities and, especially, the differences in sample selection and collection methods need to be considered when trying to compare the results.

The methods of sampling were significantly different for the 2016 Study. The 2016 Study relied on conventional back-of-truck sampling to determine the composition of residential garbage through actual sorts, as conducted in a corner of the facility tipping floor at the Hennepin Energy Recovery Center (HERC). In 2016, samples were collected from randomly selected packer trucks from the Minneapolis residential garbage routes as delivered to the HERC for disposal representing materials after collection operations. The 2016 Study was based solely on sorting of garbage only.

In 2016, the County also wanted to research how results vary by neighborhood. Therefore, three waste load areas (WLAs) were selected from three different neighborhoods to represent the range of demographics throughout the City. In this 2022 Study, City staff wanted to randomly select multiple samples (households) from throughout the City, instead of just three neighborhoods. See the MSW Consultants *Sort Report* Appendix A for a map of the 2022 Study sample distribution.

For this 2022 Study, carts were delivered "as-is" to the project sort location (without compaction), using City trucks with stake bed flatbeds and a lift gate. This 2022 Study is based on the sorting of materials directly from garbage, recycling, and organics carts from randomly selected households representing materials before collection operations.

The material sort categories and associated definitions, while consistent, were not the same between the 2016 Study and this 2022 Study. See Table 2-1 (located behind the "Tables" tab) for a list of the "new" sort categories as used for this 2022 Study.

Also, the 2016 Study relied on tonnage reports from truck scale data from the City's recycling, organics, yard waste, and large-item collection programs to calculate capture rates. This 2022 Study was focused

more exclusively on the curbside recycling and organics collection programs only and did not address recovery the other outlets for recovery (yard waste, voucher program, large item collections, etc.)

Finally, it is important to note that the County's 2016 study was performed as the City had just begun rolling out its residential organics recycling program. The City's curbside organics recycling program has been in operation for nearly six-years, and voluntary subscriptions have grown steadily, reaching to the current level of about 51 percent of eligible residential households for this 2022 Study.

Wherever possible, the MSW Consultants *Sort Report* provides in-depth comparisons between this 2022 Study and the 2016 Study of the waste characterization and capture rate results (see the multiple *Sort Report* tables and graphs comparing the results). However, the consultant team believes that the differences in methodology between the 2016 Study and this 2022 Study may not allow for direct comparison of selected material categories such as organics/food waste. The following differences in methods are the basis for this professional judgement:

- In the 2016 Study, the compaction of the garbage in the packer truck samples increased the amount of organics in the fines and 2016 supermix categories.
- The same type of organic material within the supermix categories in the 2016 Study were more likely to have been in the 2022 Study garbage cart samples as targeted organics.

Also, in the 2016 Study design and material category definitions, there was more food waste material sorted into other unique categories. For example, the 2016 Study categories, such as supermix—organics; supermix—indistinguishable; other compostable organics, and other materials not elsewhere classified, likely contain much of the food waste that was sorted into wasted food and food waste in this 2022 Study. Supermix was defined in 2016 as mixed materials having particle sizes smaller than 2 inches. In this 2022 Study, materials were sorted down to particle sizes in the range of 0.5- to 0.25-inch inch and were sorted as fines. These methodological differences cannot be reconciled and contribute to the differences in the results between the two studies. Consequently, exact comparisons between the two studies are somewhat limited (e.g., organics composition, organics capture rates, etc.).

The 2016 Study used annual tonnage data as reported by the City to extrapolate capture rates from the garbage waste sort data. No source-separated recyclables or organics materials were sorted for the 2016 Study. The 2016 Study addressed four City collection programs: recycling, yard waste, organics, and the City's voucher program. The 2016 Study also generally addressed "recycling beyond the cart" and other recycling drop-off activities by residents who self-haul materials such as metal scrap to scrap dealers, clean plastic film recycling at retail establishments, electronics recycling, household hazardous waste (HHW) recycling/disposal, and donations of useable clothing and other household goods to reuse outlets.

In contrast, this 2022 Study addresses the City's residential curbside recyclables and organics collection programs only. Recycling through yard waste collection, the City's voucher program, and "recycling beyond the cart" are not included this 2022 Study.

At a more basic level, the two studies had different project goals and research objectives that led the County in 2016 and the City in 2022 to select different waste characterization methodologies. The County was interested in exploring whether residential recycling rates could theoretically achieve the 75 percent County and State total recycling goals. The 2016 Study found conclusively that, even with perfect participation and set-out rates, the City of Minneapolis cannot achieve 75 percent recycling with residential curbside recycling alone.

Throughout this *Final Report* and the *Sort Report* it is important to keep in mind all percentages are in terms of percent by weight.

Finally, the County wanted to find out about what people are buying and where waste is generated in the home. Therefore, the County specified a series of secondary "subsorts" that were conducted to further classify selected materials by:

- Retail origin (e.g., grocery, beauty and health, household essentials, etc.).
- Material sub-type (e.g., different types of plastic film, mixed paper, and boxes).

See Table 3-5 for a complete list of the subsort categories for the 2016 Study.

This 2022 Study included a unique set of subsorts designed and sorted by City staff. Subsorts in this 2022 Study (performed by City staff) included:

- Straws and utensils;
- Batteries; and
- Paper to-go cups and containers.

See the MSW Consultants *Sort Report* for the results of this 2022 Study subsort.

A major component of the 2022 Study was the selection of randomly selected households identified as "organics program subscribers" and, by default, the selection of the other sample households identified as "non-subscribers" to the organics recycling program. While randomly selected by the City, the number of subscriber versus non-subscriber households was approximately the same (354 targeted subscriber households versus 346 targeted non-subscriber households). More details about these and all other methods are contained in the MSW Consultants *Sort Report*.

This separation of samples into two groups, subscribers versus non-subscribers, is a major upgrade in methodology and study design compared to the 2016 Study. This 2022 Study compares composition and capture rates by specific material type for the two population groups. The findings and conclusions in this *Final Report* are often based directly on this critical comparison of data between organics subscribers and non-subscribers.

3. Results

3.1 Characterization of Materials Still Disposed in the Garbage

Table 3-1 displays extrapolated tons per year (TPY) by type of waste steam (garbage, recycling, organics) and reformatted data, as originally presented in the *Sort Report*. See the *Sort Report* for more details on the methods, definitions, and sources for this data. Table 3-1 re-ordered the list of material items from most to least amounts in the garbage carts (labeled as "Refuse" in Table 3-1 and in the *Sort Report*). These items are targeted for recovery by the City and do not include the non-recoverable materials.

Table 3-1 indicates that the total tonnage of the recyclable and compostable materials still in the garbage carts is about 38,000 TPY. Listed below are the five individual materials with the highest volume that could be isolated for enhanced, targeted recovery efforts by the City. The list below is in order of largest tonnages still in the garbage carts. The percent of current composition in the garbage carts in the list below is from the *Sort Report* Table 3-1.

- Wasted food, with a current capture rate of 7.5 percent and a total of about 19,400 TPY still remaining in the garbage carts, or about 25 percent of the current composition in the garbage carts.
- Food waste, with a current capture rate of 41.1 percent and a total of about 4,900 TPY still remaining in the garbage carts, or about 6 percent of the current composition in the garbage carts.
- Compostable paper, with a current capture rate of 8.5 percent and a total of about 2,600 TPY still remaining in the garbage carts, or about 3 percent of the current composition in the garbage carts.
- Cardboard/Kraft paper, with a current capture rate of 53.9 percent and a total of about 2,300 TPY still remaining in the garbage carts, or about 3 percent of the current composition in the garbage carts.
- Mixed recyclable paper, with a current capture rate of 39.5 percent and a total of about 2,100 TPY still remaining in the garbage carts, or about 3 percent of the current composition in the garbage carts.

3.2 Potential Value of Materials Still Disposed in the Garbage

Table 3-2 displays Foth's estimated potential value of the recyclable and compostable materials remaining in the garbage carts in terms of potential $ per year. These value estimates are based on two sources of commodity price information.

- First, to calculate estimated value of the traditional recyclables remaining in the garbage carts, industry-published market prices were used. Five-year averages from RecyclingMarkets.net price data through July 30, 2022, were used as an approximate benchmark of prices. Foth compiles a database from RecyclingMarkets.net to provide historical price trend analyses. For this 2022 Study, Foth used RecyclingMarkets.net's regional price averages for the Chicago – Midwest/Central region.

- Second, for compostable materials, Foth used an assumed price for finished compost of $30 per ton ($15 per cubic yard). This price point is very approximate, as there is no standard industry-published index or "compost" standard specification. Foth based this rough price estimate on recent compost price surveys of composting facilities located in the greater Twin Cities Metropolitan Area.

The prices represent the value of commodities after processing. For example, the RecyclingMarkets.net prices represent processed materials (e.g., sorted, baled, etc.) as marketed by materials recovery facilities (MRFs). The compost price represents a finished compost product (e.g., fully mature compost, screened, etc.) sold in bulk form (i.e., not bagged), picked up from the composting facility. Therefore, these are "gross revenue" values to the processors (not prices paid to the City). Nonetheless, these price estimates can provide a meaningful measure of the value of recyclables and compostables that remain in the City's garbage carts today.

Table 3-2 re-ordered the list of materials from the most potential value per year to the least potential value. These items are targeted for recovery by the City and do not include the non-recoverable materials or recyclable materials that do not have reasonably equivalent market prices using the RecyclingMarkets.net published index.

Table 3-2 indicates that the total potential value of the recyclable and compostable materials still in the garbage cart is about $2.8 million per year. The five highest-value individual materials that could be isolated for enhanced, targeted recovery efforts by the City are (in order of largest potential value per year):

- Aluminum cans, with a current capture rate of 51.1 percent and a total potential value of about $590,00 per year for these materials (about 440 TPY) remaining in the garbage carts, or about 21 percent of the total value of recyclables/organics remaining in the garbage carts.

- Wasted food, with a current capture rate of 7.5 percent and a total value of about $581,000 per year in potential value for this material (about 19,400 TPY) remaining in the garbage carts, or about 21 percent the total value of recyclables/organics remaining in the garbage carts.

- Other aluminum, with a current capture rate of percent and a total value of about $260,000 per year for these materials (about 200 TPY) remaining in the garbage carts, or about 9 percent of the total value of recyclables/organics remaining in the garbage carts.

- Cardboard/ Kraft paper, with a current capture rate of 53.9 percent and a total value of about $210,000 per year for these materials (about 600 TPY) remaining in the garbage carts, or about 8 percent of the total value of recyclables/organics remaining in the garbage carts.

- #1 polyethylene terephthalate (PET) bottles, with a current capture rate of 42.3 percent and a total value of about $200,000 per year for these materials (about 600 TPY) remaining in the garbage carts, or about 7 percent of the total value of recyclables/organics remaining in the garbage carts.

3.3 Contamination Analysis

3.3.1 Contaminants in the Recycling Carts

Table 3-3 itemizes the detailed composition of the materials in all recycling carts reformatted by contaminant groups. This is the same data as presented in the *Sort Report* Table 3-5 but reformatted to categorize the materials by three contaminant groups and one recyclable/reusable group. The four categories in this *Final Report* Table 3-3 are:

- Contaminants in All Recycling Carts Categorized as Garbage;
- Items in All Recycling Carts Categorized as Recyclables + Reusable + Misthrows;
- Contaminants in All Recycling Carts Categorized as Targeted Organics; and
- Contaminants in All Recycling Carts Categorized as Yard Waste Misthrows.

Once categorized by group, the materials were then re-sorted for presentation in Table 3-3 of this *Final Report* by the largest contributors, based on the percent of the total amount of materials in the recycling carts. This reformatted data may help focus future discussions on the top contaminants in the recycling carts. These top contaminants may be addressed through more specific education and outreach efforts by the City. For example, the top five contaminants categorized as garbage found in the recycling carts in this 2022 Study were:

- All other packaging containers (2.7 percent of the recycling cart);
- Paper cups and to-go containers (2.2 percent);
- Cutlery and straws (2.0 percent);
- Wasted food (1.7 percent); and
- Other not elsewhere classified (0.9 percent).

3.3.2 Contaminants in the Organics Carts

Table 3-4 itemizes the detailed composition of the materials in the organics carts reformatted by contaminant groups. This is the same data as presented in the *Sort Report* Table 3-5 but reformatted to categorize the materials by three contaminant groups and one targeted organics group. The four categories in this *Final Report* Table 3-4 are:

- Contaminants in the Organics Carts Categorized as Garbage;
- Contaminants in the Organics Carts Categorized as Recyclables + Reusable + Misthrows;
- Items in the Organics Carts Categorized as Targeted Organics; and
- Contaminants in the Organics Carts Categorized as Yard Waste Misthrows.

Targeted Organics are also listed in Table 3-4 to provide relative comparison to the contaminant groups and line-item contaminant materials.

Once categorized by group, the materials were then re-sorted for presentation in Table 3-4 of this *Final Report* by the largest contributors based on the percent of the total amount of materials in the organics carts. This reformatted data may help focus future discussions on the top contaminants in the organics carts. The top contaminants may be addressed through more specific education and outreach efforts by the City. For example, the top five contaminants categorized as garbage found in the organics carts in this 2022 Study were:

- Pet waste (1.6 percent of the total materials in the organics cart);
- Textiles: all other / not wearable (0.8 percent);
- Film: other/not recyclable (0.6 percent);
- Paper cups and to-go containers (0.6 percent); and
- Other not elsewhere classified (0.6 percent).

The top five recyclable materials incorrectly placed in the organics carts (i.e., “recyclable misthrows”) were actually a larger fraction of “contaminants”:

- Glass (3.0 percent of the materials in the organics cart);
- Cardboard/ Kraft paper (3.0 percent);
- Boxboard/paperboard (0.5 percent);
- Mixed recyclable paper (0.4 percent); and
- Textiles – wearable (0.3 percent).

The second (cardboard/kraft paper) and third (boxboard/paperboard) recyclable material items may be compostable but were placed in the wrong cart. These items are more valuable as a recyclable material and may, by association, “attract” other types of paper that are not compostable. Cardboard/kraft paper and newspaper placed in organics carts were considered recovered in this 2022 Study for purposes of calculating capture rates.

Food & beverage glass is clearly a contaminant in compost and rejected material in composting facilities. Glass in compost is one of the most significant contaminants in today’s food scraps collection and composting operations; however, food and beverage glass is highly recyclable if placed in the correct recycling cart.

3.4 Capture Rate Analysis

Table 3-6 displays the current and proposed "reasonably achievable" capture rates for targeted, recoverable materials from the City's residential curbside recycling and organics programs. This list is based directly on the MSW Consultants *Sort Report* (Table 4-1 – "Current Capture Rates and Recycling Rate").

City staff and our consultant team met to review the current capture rates resulting from this 2022 Study and discuss potential proposed target capture rates for each recyclable or compostable material. This process of developing "reasonably achievable" target capture rates by commodity was based on the following assumptions and decision-making criteria:

- Consider a ten-year planning/visioning horizon (i.e., proposed target capture rates by 2033).
- Be aspirational but ***reasonable***. Set proposed target capture rates somewhat higher than the current total capture rates. Consider going even slightly higher that the current "subscribers" capture rates for most non-organics materials.
- Consider the *full, citywide* population with all its complexities. The proposed target capture rates are most comparable to the current total capture rates (not just the subscribers). All factors need to be considered, such as recycling participation rates, organics sign-up rates and historical trends, and variance in capture rates by individual households.
- Use the realistic/practical lens of current (and continued) City staffing shortages that will mean only the top priority program activities (e.g., targeted public education and outreach) can be reasonably expected to be accomplished in the near term.

Some of the sort categories in the 2016 Study were more generic compared to this 2022 Study (e.g., all high-density polyethylene [HDPE] plastic items; aluminum). Therefore, to try to compare capture rates to the 2016 Study, the following 2022 Study capture rates are combined:

- #2 HDPE natural combined with #2 HDPE pigmented = a weighted average 2022 capture rate of 44 percent compared to the 2016 Study all HDPE items (bottles + non-bottles) capture rate of 55 percent.
- Aluminum cans combined with All other aluminum = a weighted average 2022 capture rate of 43 percent compared to the 2016 Study all aluminum items capture rate of 41 percent.

Organics capture rates may not be directly comparable between the two studies due to different sampling and sorting methods. However, it is interesting to note that the 2022 capture rate for total targeted organics (all subcategories of compostable organics) shows a weighted average of 18 percent in Table 3-6. The 2016 Study capture rate reported 4 percent for total organics (including source-separated organics [SSO] plus supermix organics). The biggest reason for this difference should be that the citywide curbside organics collection program had not yet fully launched by May 2016 when the 2016 Study sorting operations were conducted. The City now has a 51 percent organics program subscription rate of all eligible households throughout Minneapolis.

Table 3-7 displays the detailed background capture rate data and other assumptions used to reach the "Reasonably Achievable Recycling Rate."

3.4.1 Traditional Recyclables

The estimated "reasonably achievable" capture rates listed in Table 3-6 and Table 3-7 for each commodity are affected by a variety of real-world constraints that were considered when the extended project team (including City and consultant staff) developed these rates.

Many of the recyclable commodities listed in Table 3-6 and Table 3-7 are, or could be, handled and recycled outside of the City's residential recycling collection program. For example, a large share of aluminum cans will continue to be collected separately and sold by residents at local metal scrap dealers and other aluminum redemption centers. These other types of drop-off systems and other forms of "beyond the cart" recycling will always exist and should continue to be encouraged, even if measurement is more difficult.

Other real-world constraints that were considered include:

- Residents' purchasing, waste generation, and recycling behaviors.
- The cost and feasibility of collection services.
- Public education and outreach.
- Sorting and processing operations at the MRF, including specifications of acceptable recyclables and contaminants as collected.

Other constraints are the challenges of drop-off and other separate collection programs. For example, plastic grocery bags and other flexible film plastic are collected at many of the larger grocery and retail store chains. These retail drop-off bins are the preferred path for recyclable residential film plastic. The recovery of film plastic via retail drop-off bins at stores is limited by the lack of convenience and awareness.

Another significant constraint considered in developing the "achievable" target capture rates in Table 3-6 and Table 3-7 was the lack of robust end-market demand for some of the commodities. Each commodity has a unique industry and recycling infrastructure. There are practical limits on how much of the recyclable or compostable material generated can reasonably be expected to be recovered. In-depth analysis of each industry by commodity was beyond the scope of this Study; instead, the target capture rates were proposed based on the collective professional judgement of the extended project team.

3.4.2 Residential Organics Recycling

The proposed target capture rates for organic materials are aspirational but deemed reasonable. City staff are confident the basic curbside organics recycling program policies and procedures will remain relatively constant for the next ten years. For example, the program will likely remain voluntary, whereby residents must actively sign up using a simple online form or other means. Organics carts and "welcome kits" are only provided to subscribers, not citywide. Also, the program will likely remain as "no additional cost" to residents; every customer pays for the service as part of their base solid waste and recycling fee paid through the City's utility billing system.

The rate of new signups has remained remarkably constant since the citywide launch in 2016. Theoretically, this sign-up rate should level off at some point in the medium- to long-term future. However, to set the proposed target capture rates for organics materials shown on Table 3-6 and Table 3-7, it was assumed that the organic program sign-up rate for new customers would remain constant for the next two to three years or more.

Other assumptions were implied during the extended team discussions about organics capture rates in the future. For example, it was assumed that the local composting facilities receiving Minneapolis organics would continue to accept the same line of compostable feedstock items as they do today. However, if local composters decide to discontinue accepting Biodegradable Products Institute (BPI)-certified compostable plastic packaging, this could have a dramatic impact on future organics capture rates. Similarly, other changes to organics collection operations or the composting industry could easily impact future target capture rate assumptions for organic materials.

4. Conclusions

This 2022 Study used unique waste characterization and capture rate methods. The material categories were initially based on the list from 2016 Study, but this 2022 Study used significantly different methods leading to important advantages. This 2022 Study used the garbage, recycling, and organics carts as the waste sampling units from randomly selected residential households scattered throughout the City. The materials were sorted directly from the three types of carts and more directly represented items as set out by residents. The 2016 Study used the ASTM International (ASTM) standard method of taking random samples from selected loads of garbage after being dumped out of the packer trucks. Several operational factors impact the quality of material using this ASTM method, including commingling of commodities during collection loading/truck compaction; unloading onto a concrete tipping floor; glass breakage; and other sources of contamination. Therefore, the 2016 Study method does not represent the exact same form of garbage as set out by residents. Also, the 2016 Study did not sort recyclables or organics; annual tonnages of these materials (including recyclables composition data from the City's MRF), as reported by the City, were used for capture rate extrapolations.

In this 2022 Study, the three types of waste materials (garbage, recycling, and organics) were sorted separately using the same specified material category definitions for all three types. This side-by-side sampling and sorting results in a much more precise comparison of waste composition of materials in the garbage carts, recycling carts, and organics carts.

The City's subscription-based method for the organics recycling program allowed City staff to select about half of the randomly sampled 700 households to be organics recycling program subscribers ("subscribers") and the other half non-organics program subscribers ("non-subscribers"). This study method allowed for analyzing the garbage and recycling waste composition, directly comparing these two subgroups of households. The results indicate subscribers have a much higher total average capture rate (37 percent) compared to non-subscribers (20 percent). Also, the recycling contamination[2] is much lower in the subscribers group (7 percent) compared to non-subscribers (23 percent). Thus, the subscribers were found to be higher performing recyclers of traditional recyclables, in addition to participating in the organics program. This comparative data between subscribers and non-subscribers is rich with potential implications for new City public education and outreach initiatives to improve overall recycling and organics recovery well into the future.

Table 3-1 indicates that the total tonnage of the recyclable and compostable materials still in the garbage cart is about 38,000 TPY. The five highest-volume individual materials that could be isolated for enhanced, targeted recovery efforts by the City, in order of largest tonnages still in the garbage carts, are:

- Wasted food;
- Food waste;
- Compostable paper;
- Cardboard/Kraft paper; and
- Mixed recyclable paper.

This 2022 Study indicates that the total potential, theoretical value of the recyclable and compostable materials still in the garbage cart is about $2.8 million per year. Table 3-2 in this *Final Report* displays the line-item potential values ($ per year) by commodity for all targeted materials. The five-highest-value individual materials that could be isolated for enhanced, targeted recovery efforts by the City, in order of largest potential value per year, are:

- Aluminum cans;
- Wasted food;

[2] For purposes of this higher-level discussion in this Conclusions section, "contamination" is defined as the materials in the "Not Targeted in the City's Curbside Programs" as shown in Table 3-7 and Table 3-8 of the *Sort Report*.

- Other aluminum;
- Cardboard/Kraft paper; and
- #1 PET bottles.

The average prices by commodity over the past five years as reported by RecyclingMarkets.net were used to calculate the estimated annual potential value of the traditional recyclables in Table 3-2**.** A regional average price of $30 per ton was used to estimate the value of finished compost for compostable materials.

One of the other key objectives of this 2022 Study was to analyze the level and type of contamination in the recycling and organics carts. Table 3-3 in this *Final Report* itemizes all sorted categories from all recycling carts as re-ordered by relative amounts from largest to smallest. The top five contaminants found in the recycling carts, in order of largest amounts, were:

- All other packaging containers;
- Paper cups and to-go containers;
- Cutlery and straws;
- Wasted food; and
- Other not elsewhere classified.

Table 3-4 in this *Final Report* itemizes all sorted categories from the organics carts as re-ordered by relative amounts from largest to smallest. The top five contaminants found in the organics carts were:

- Glass;
- Pet waste;
- Textiles – total of wearable and all other textiles;
- Film – other not recoverable; and
- Paper cups and to-go containers.

The City may be able to use this 2022 Study to target communications about specific contaminants that are of greatest concern to the recyclers and composters that receive and process these materials. The City may wish to share the results of this 2022 Study with those vendors and request comments and feedback.

The City conducted further analysis on selected "sub-sorted" materials, including straws and utensils, batteries, and paper to-go cups and containers. These materials were set aside for separate subsorting and weighing by City staff after the conclusion of the regular sorting operations conducted by the consultant team. One objective of this subsort was to further quantify the composition of BPI-certified compostable packaging versus non-BPI-certified packaging. Another objective was to otherwise evaluate how much packaging is compostable versus plastic-lined and, therefore, deemed not compostable.

There is an important conflict between two competing recycling program design objectives. The first objective is to maximize the recovery of items that are recyclable or compostable. The second objective is to minimize the contamination of the recycling and organics streams. One potential program design principle that could be adopted to resolve this conflict is to continue to put more emphasis on the quality of recycling materials (both traditional recyclables and organics). This would mean allocating more public education resources on reducing contamination.

5. Recommendations

The consultant team and City staff discussed the following recommendations.

1. As a general recycling planning principle to enhance long-term program sustainability, the City should continue to prioritize improved quality of recoverable materials (recyclables and organics). This should be based on the concept of continuous improvement and finding the best balance in working on both objectives of quality and quantity. Going forward, the City could continue to invest public education resources on the goal and specific objectives of reducing contamination. This could be simultaneous to continued work on increasing participation. Also, the City should very carefully evaluate the long-term impacts on potential contamination before further expanding the list of items included in the recycling carts or organics carts.

   In future public education and outreach campaigns, the City could consider more focused targeting of:

   a. Highest-value, highest-volume, recoverable materials that were still found in the garbage carts (e.g., aluminum cans; #1 PET bottles, and wasted food).
   b. Highest-volume contaminants found in the recycling carts (e.g., other packaging containers that are not recyclable; cutlery and straws; and wasted food).
   c. Highest-volume contaminants found in the organics carts (e.g., pet waste, textiles, and non-compostable plastic film items).

2. The City should maintain and continuously refine the current program policy of tagging and removing recycling or organics carts due to contamination.

3. The City should support state-level extended producer responsibility (EPR) program with robust outreach and education to increase recovery and reduce contamination in recycling and organics recycling programs.

4. The City should continue its use of community-based social marketing techniques to enhance participation and improve the quality of materials set out for recycling and organics recovery. To illustrate how this might look, residents could be asked to “pledge” to focus on recovery of selected materials or reducing contamination. For example, individual pledge campaigns could be developed specifically for aluminum cans, cardboard, and/or food scraps.

5. The City should consider other forms of voluntary financial incentives and social recognition strategies to encourage higher-performing recycling behaviors. For example, the City could set up a customized form of the “Get Caught Recycling” concept used by other cities in the past. To illustrate how this might look, recycling and garbage carts could be randomly sampled and sorted to find a household with the highest capture rate and lowest contamination rate. A prize and social media recognition announcement could perhaps serve as the reward for the winner. While the chances of winning may only be slightly better than winning the lottery, the incentives to improve recycling behaviors could be similar. The City could consider how best to leverage the leadership potential of residents who participate in the organics recycling program. These subscribers are the higher-performing households not only in organics recovery but also in recycling of traditional recyclable materials. There may be additional cost-effective means to use subscribers as opinion leaders (e.g., household case studies, personal stories, and other recognition strategies, etc.) that go beyond the City’s current strategies (e.g., as block leaders and lawn signs, etc.).

6. City staff should carefully evaluate the history of organics program subscription rates (i.e., number of “new” households that sign up each year since the citywide rollout in 2016). Staff continue to evaluate demographics of lower sign-up areas and target educational efforts where

there are the greatest opportunities to increase signups. This analysis could help refine the theories of the most sensitive variables for additional new subscriptions (e.g., language barriers, cultural norms, hassle factor, "yuck factor," awareness, etc.). Even as sign-up rates plateau, the City should balance sign-up promotions based on equity considerations with maintaining and enhancing organics quality by reducing contamination. There may likely be higher promotion costs per signup going forward.

7. The City should conduct the "rate study" outlined in its Zero Waste Plan (November 2017) to provide a greater financial incentive intended to enhance waste reduction and recycling behaviors. The current $3 per month price difference between a small garbage cart and a large cart is not nearly adequate to significantly change behavior. If the City decides to increase this price difference, the new garbage price schedule should be rolled out gradually over several years, coupled directly with enhanced public education about how to prevent increased contamination of the recycling and organics streams.

8. The City should continue to evaluate supporting state mandatory source separation requirements. Perhaps the policy could target the higher-value, higher-volume materials on a phased implementation schedule. To illustrate how the City might approach such a state policy, aluminum cans could be banned from garbage by 2028. Intensive public education and outreach would be conducted in the year leading up to the ban. An additional, complementary example could be to ban cardboard/kraft paper from garbage by 2031. And finally, wasted food could be banned from garbage by 2034.

9. If material disposal bans are enacted, the City could use current procedure to identify contamination in recycling and organics carts and illegal materials in garbage carts. This involves collection crews looking in carts before emptying them and visually inspecting materials immediately after emptying a cart. Regardless of the monitoring methods ultimately selected, it should be fair, equitable, safe to operate, and cost-effective.

10. The City should plan to repeat this 2022 Study in about five years, using most of the same capture rate methods (i.e., sorting from all three cart types: garbage, recycling, and organics) and using two populations: organics subscribers versus non-subscribers. The organics recycling program will then be more mature at about 11 years old. The waste sort categories should be reevaluated to make sure the next waste characterization and capture rate study uses definitions that are mostly consistent with this 2022 Study. Careful planning of any subsorts should be integral to the overall study design. In general, more lead time should be scheduled to provide for more thorough sort operations design, planning, and preparations. Training of the sort leaders and line crew should include a comprehensive communications plan, including initial training during the first morning of operations (e.g., enhanced education and behavior reinforcement on the specific material definitions).

Tables

Table 2-1
List of "New" Sort Categories for 2022 Study
(Compared to sort categories used in the 2016 Study)

New Category for 2022 Study	Material Description or Subcategory [Notes compared to 2016 Study categories]
Shredded paper	
Paper cups and to-go containers	Plastic-lined to-go containers (not compostable)
#1 PET fluff	
#2 HDPE Natural	[2016 Study grouped as HDPE differently into bottles and non-bottles]
#2 HDPE Pigmented	
Other Aluminum	
Cardboard can	
Film plastic	Recoverable film/bags
	Other film
Multi-layer pouches	
Cutlery and straws	
Organics	Wasted food
	Food waste
	Other compostables
	Compostable paper
	Compostable plastic
	#7 compostable plastic (BPI certified)
	Compostable bags (BPI certified)
Textiles	Wearable
	All Other

Notes:
BPI = Biodegradable Products Institute
HDPE= high-density polyethylene
PET = polyethylene terephthalate

Prepared by: DFK
Checked by: BDR

Table 3-1
Composition of Recoverable Materials in the Garbage Carts

Material Category	Extrapolated Annual Generation (TPY)				Capture Rate (percent of total generation)
	Refuse	Recycling	Organics	Total Generation	
Wasted food	19,366.8	187.7	1,586.3	21,140.7	7.5%
Food waste	4,852.3	53.9	3,419.3	8,325.5	41.1%
Compostable paper	2,592.7	70.3	248.0	2,911.0	8.5%
Cardboard/Kraft paper	2,282.1	2,471.8	200.0	4,953.9	53.9%
Mixed recyclable paper	2,072.2	1,368.6	27.7	3,468.6	39.5%
Food & beverage glass	1,795.1	2,521.7	202.5	4,519.3	55.8%
Boxboard/paperboard	906.0	667.3	32.7	1,606.1	41.6%
#1 PET bottles	599.0	443.7	7.3	1,050.1	42.3%
#5 PP containers	458.2	150.2	3.2	611.6	24.6%
Aluminum cans	441.1	470.2	9.0	920.3	51.1%
#1 PET non-bottles	431.9	191.0	3.6	626.6	30.5%
Other compostables	418.1	33.1	348.7	799.9	43.6%
Steel cans	369.5	150.6	2.5	522.6	28.8%
#2 HDPE pigmented	201.0	133.1	4.8	339.0	39.3%
Other aluminum	194.0	20.8	0.5	215.4	9.7%
Newspaper	189.6	505.6	0.6	695.8	72.7%
Cartons	154.4	139.8	3.2	297.3	47.0%
#2 HDPE natural	111.7	112.7	0.0	224.4	50.2%
Cardboard cans	65.9	14.8	2.2	82.8	17.9%
#7 compostable bags	13.7	3.1	12.3	29.2	42.3%
Compostable plastics	9.7	2.0	12.3	23.9	51.2%
Total	**37,525.0**	**9,712.1**	**6,126.9**	**53,364.0**	

Notes:
% = percent
HDPE= high-density polyethylene
PET = polyethylene terephthalate
PP = polypropylene
TPY = tons per year

Prepared by: DFK
Checked by: BDR

Source: MSW Consultants *Sort Report*, Table 3-1 and Table 4-1.

Table 3-2
Potential Value of Recoverable Materials
In the Garbage Carts

Material Category	Refuse (TPY)	Five-Year Average Price ($/ton)	Potential Value ($/year)	Capture Rate (percent of total generation)	Percent of Total Value
Aluminum cans	441.1	$1,334	$588,583	51.1%	21%
Wasted food	19,366.8	$30	$581,003	7.5%	21%
Other aluminum	194.0	$1,334	$258,928	9.7%	9%
Cardboard/Kraft paper	2,282.1	$91	$207,457	53.9%	8%
#1 PET bottles	599.0	$328	$196,620	42.3%	7%
#5 PP containers	458.2	$326	$149,422	24.6%	5%
Food waste	4,852.3	$30	$145,570	41.1%	5%
#1 PET non-bottles	431.9	$328	$141,776	30.5%	5%
Mixed recyclable paper	2,072.2	$57	$118,964	39.5%	4%
#2 HDPE natural	111.7	$1,024	$114,389	50.2%	4%
#2 HDPE pigmented	201.0	$422	$84,874	39.3%	3%
Compostable paper	2,592.7	$30	$77,781	8.5%	3%
Steel cans	369.5	$172	$63,434	28.8%	2%
Boxboard/paperboard	906.0	$33	$30,179	41.6%	1%
Other compostables	418.1	$30	$12,543	43.6%	0%
Newspaper	189.6	$57	$10,887	72.7%	0%
#7 compostable bags	13.7	$30	$412	42.3%	0%
Compostable plastics	9.7	$30	$290	51.2%	0%
Food & beverage glass	1,795.1	($18)	($32,755)	55.8%	-1%
Total	**37,525.0**		**$2,750,358**		100%

Notes:
$/ton = cost per ton
$/year = cost per year
% = percent
HDPE= high-density polyethylene
PET = polyethylene terephthalate
PP = polypropylene
TPYP = tons per year

Prepared by: DFK
Checked by: BDR

Source: MSW Consultants *Sort Report*, Table 3-1 and Table 4-1.

Table 3-3
Contaminants in All Recycling Carts:
Items by Category

(In percent of total weight in the recycling carts)

Category	Material Category	Mean	MOE	Lbs/Set-out
Contaminants in All Recycling Carts Categorized as Garbage				
Plastic	All other packaging containers	2.745%	3.856%	0.590
Paper	Paper cups and to-go containers	2.172%	3.152%	0.467
Plastic	Cutlery and straws	1.981%	3.091%	0.426
Other waste	Other not elsewhere classified	0.889%	0.380%	0.191
Plastic	Film: other	0.863%	0.627%	0.185
Paper	Non-Recoverable paper	0.832%	0.259%	0.179
Plastic	Durable plastic items	0.385%	0.149%	0.083
Glass	Non-recoverable glass	0.365%	0.153%	0.079
Plastic	All other plastic	0.345%	0.097%	0.074
Other waste	Pet waste & bedding	0.331%	0.321%	0.071
Plastic	#1 PET - fluff	0.228%	0.334%	0.049
Plastic	#6 PS - rigid	0.227%	0.058%	0.049
Paper	Shredded paper	0.226%	0.111%	0.049
Other waste	Diapers & feminine hygiene products	0.176%	0.125%	0.038
Plastic	#6 EPS	0.141%	0.065%	0.030
Other waste	Small furniture and household goods	0.138%	0.184%	0.030
Other waste	Fines	0.120%	0.048%	0.026
Textiles	Textiles - all other	0.100%	0.070%	0.021
Paper	Plastic-coated paper	0.089%	0.059%	0.019
Household Hazardous Waste	Batteries	0.050%	0.065%	0.011
Plastic	Multi-layer pouches	0.024%	0.010%	0.005
Plastic	#3 PVC	0.010%	0.008%	0.002
Household Hazardous Waste	Sharps	0.000%	0.000%	0.000
Other waste	Small household appliances		*Not Found*	
Other waste	Tires/rubber		*Not Found*	
	Sub-Total Garbage	**12.436%**		**2.674**

Table 3-3 (continued)

Category	Material Category	Mean	MOE	Lbs/Set-out
Items in All Recycling Carts Categorized as Recyclables + Reusable + Misthrows				
Glass	Food & beverage glass	22.293%	2.386%	4.793
Paper	Cardboard/Kraft paper	21.851%	2.833%	4.698
Paper	Mixed recyclable paper	12.099%	1.567%	2.601
Paper	Boxboard/paperboard	5.900%	0.596%	1.268
Paper	Newspaper	4.470%	0.945%	0.961
Metal	Aluminum cans	4.156%	0.507%	0.894
Plastic	#1 PET bottles	3.923%	0.447%	0.843
Plastic	#1 PET non-bottles	1.689%	0.635%	0.363
Metal	Steel cans	1.331%	0.178%	0.286
Plastic	#5 PP containers	1.328%	0.238%	0.285
Paper	Cartons	1.236%	0.501%	0.266
Plastic	#2 HDPE pigmented	1.177%	0.168%	0.253
Plastic	#2 HDPE natural	0.996%	0.142%	0.214
C&D debris	Mixed C&D debris	0.408%	0.466%	0.088
Textiles	Textiles - wearable	0.398%	0.388%	0.086
Metal	Other scrap steel	0.355%	0.200%	0.076
Metal	Other aluminum	0.184%	0.060%	0.040
Metal	Mixed metal	0.167%	0.138%	0.036
Other waste	Electronics	0.150%	0.139%	0.032
Metal	Cardboard cans	0.131%	0.059%	0.028
Plastic	Recoverable film/bags	0.099%	0.024%	0.021
Household Hazardous Waste	HHW	0.050%	0.031%	0.011
Metal	Non-ferrous metal	0.036%	0.018%	0.008
	Sub-Total Recyclable + Reusable + Voucher	**84.4%**		**18.153**
Items in All Recycling Carts Categorized as Targeted Organics:				
Organics	Wasted food	1.659%	0.687%	0.357
Organics	Compostable paper	0.622%	0.123%	0.134
Organics	Food waste	0.476%	0.267%	0.102
Organics	Other compostable	0.293%	0.158%	0.063
Plastic	#7 compostable bags	0.028%	0.035%	0.006
Plastic	Compostable plastics	0.018%	0.011%	0.004
	Sub-Total Organics	**3.1%**		**0.666**
Items in All Recycling Carts Categorized as Yard Waste Misthrows:				
Organics	Yard waste	0.041%	0.037%	0.009
	TOTAL	**100.0%**		**21.501**

Notes:
% = percent
C&D = construction and demolition
HDPE= high-density polyethylene
HHW = Household Hazardous Waste
lbs = pounds
MOE = margin of error
PET = polyethylene terephthalate
PP = polypropylene
PS = polystyrene
PVC = polyvinyl chloride

Prepared by: DFK
Checked by: BDR

Table 3-4
Contaminants in the Organics Carts:
Items by Category

(In percent of total weight in the organics carts)

Category	Material Category	Mean	MOE	Lsb/Set-out
Contaminants in the Organics Carts Categorized as Garbage				
Other waste	Pet waste & bedding	1.556%	1.232%	0.134
Textiles	Textiles - all other	0.788%	1.084%	0.068
Plastic	Film: other	0.591%	0.386%	0.051
Paper	Paper cups and to-go containers	0.535%	0.375%	0.046
Other waste	Other not elsewhere classified	0.518%	0.719%	0.045
Other waste	Diapers & feminine hygiene products	0.416%	0.420%	0.036
Other waste	Fines	0.179%	0.165%	0.015
Plastic	Durable plastic items	0.163%	0.218%	0.014
Plastic	All other plastic	0.157%	0.189%	0.014
Plastic	#6 EPS	0.144%	0.221%	0.012
Paper	Non-Recoverable paper	0.075%	0.064%	0.006
Plastic	#1 PET - fluff	0.069%	0.111%	0.006
Paper	Plastic-coated paper	0.047%	0.040%	0.004
Plastic	Cutlery and straws	0.018%	0.016%	0.002
Paper	Shredded paper	0.016%	0.026%	0.001
Plastic	All other packaging containers	0.015%	0.013%	0.001
Plastic	Multi-layer pouches	0.010%	0.017%	0.001
Plastic	#6 PS - rigid	0.003%	0.003%	0.000
Plastic	#3 PVC	*Not Found*		
Glass	Non-recoverable glass	*Not Found*		
Household Hazardous Waste	Batteries	*Not Found*		
Household Hazardous Waste	Sharps	*Not Found*		
Other waste	Small household appliances	*Not Found*		
Other waste	Small furniture and household goods	*Not Found*		
Other waste	Tires / rubber	*Not Found*		
	Sub-Total Garbage	**5.298%**		**0.457**

Table 3-4 (continued)

Category	Material Category	Mean	MOE	Lsb/Set-out
Items in the Organics Carts Categorized as Recyclables + Reusable + Misthrows				
Glass	Food & beverage glass	3.000%	3.138%	0.259
Paper	Cardboard/Kraft paper	2.963%	1.476%	0.256
Paper	Boxboard/paperboard	0.485%	0.354%	0.042
Paper	Mixed recyclable paper	0.411%	0.337%	0.035
Textiles	Textiles - wearable	0.304%	0.492%	0.026
Metal	Other scrap steel	0.156%	0.239%	0.013
Metal	Aluminum cans	0.134%	0.168%	0.012
Plastic	#1 PET bottles	0.109%	0.098%	0.009
Plastic	#2 HDPE Pigmented	0.072%	0.075%	0.006
Plastic	#1 PET non-bottles	0.053%	0.040%	0.005
Paper	Cartons	0.047%	0.045%	0.004
Plastic	#5 PP containers	0.047%	0.042%	0.004
Metal	Mixed metal	0.047%	0.077%	0.004
Metal	Steel cans	0.037%	0.061%	0.003
Metal	Cardboard can	0.032%	0.041%	0.003
Paper	Newspaper	0.008%	0.014%	0.001
Metal	Other aluminum	0.008%	0.009%	0.001
Plastic	Recoverable film/bags	0.002%	0.003%	0.0002
Plastic	#2 HDPE Natural	*Not Found*		
Metal	Non-ferrous metal	*Not Found*		
Other waste	Electronics	*Not Found*		
Household Hazardous Waste	HHW	*Not Found*		
C&D Debris	Mixed C&D Debris	*Not Found*		
Sub-Total Recyclable + Reusable + Voucher		**7.9%**		**0.683**
Items in the Organics Carts Categorized as Targeted Organics:				
Organics	Food waste	50.6%	6.9%	4.37
Organics	Wasted food	23.5%	5.9%	2.03
Organics	Other compostable	5.2%	4.6%	0.45
Organics	Compostable paper	3.7%	1.1%	0.32
Plastic	#7 compostable bags	0.2%	0.2%	0.02
Plastic	Compostable plastics	0.2%	0.1%	0.02
Sub-Total Organics		**83.3%**		**7.188**
Items in the Organics Carts Categorized as Yard Waste Misthrows:				
Organics	Yard waste	3.4%	2.1%	0.30
TOTAL		**100.0%**		**8.625**

Notes:
% = percent
C&D = construction and demolition
HDPE= high-density polyethylene
HHW = Household Hazardous Waste
lbs = pounds
MOE = margin of error
PET = polyethylene terephthalate
PP = polypropylene
PS = polystyrene
PVC = polyvinyl chloride

Prepared by: DFK
Checked by: BDR

Table 3-5
List of Subsort Categories for 2016 Study

(See MSW Consultants *2016 Sort Report*[3] Table 2-6 and Table 2-7 for more details)

Subsort Category	Material Category
Plastic bottles and non-bottle containers	Grocery
	Beauty, health, and pharmacy
	Household essentials
	Other
Film plastic	Flexible packaging
	Other packaging
Plastic durables	Kitchen
	Tableware
	Home décor
	Home storage
	Home improvement
	Patio and garden
	Automotive
	Toys
	Sports, fitness, and outdoors
	Other
Compostable papers	Certified foodware
	Non-certified foodware
	Non-packaging
Other compostables	Compostable plastic
	Other
Textiles	Accessories
	Home
	Other

Prepared by: DFK
Checked by: BDR

[3] MSW Consultants, Inc. *Hennepin County – City of Minneapolis Residential Waste Characterization and Recycling Analysis. ("2016 Sort Report");* September 2, 2016.

Table 3-6
Proposed Target Capture Rates of Individual Materials
To Reach "Reasonably Achievable"
Residential Curbside Recycling Rate

	Material	Total Generation (TPY)	Current Total Capture Rate (All HHs)	Current Capture Rate (Subscribers)	Current Capture Rate (Non-Subscribers)	Proposed Target Capture Rate	Calculated Future TPY Recycled or Composted
	Targeted Paper	**11,297.9**	**47.9%**	**59.0%**	**36.9%**	**64%**	**7,237**
1	Newspaper	695.8	72.8%	81.5%	65.8%	90%	626
2	Mixed recyclable paper	3,468.6	39.5%	53.5%	27.4%	60%	2,081
3	Boxboard/Paperboard	1,606.1	41.5%	47.7%	37.2%	55%	883
4	Cartons (Aseptic)	297.3	47.0%	64.4%	26.7%	60%	178
5	Corrugated/Kraft paper	4,953.9	53.9%	64.4%	43.0%	70%	3,468
	Targeted Plastic	**2,851.7**	**36.8%**	**45.0%**	**30.9%**	**50%**	**1,428**
6	#1 PET Bottles	1,050.1	42.3%	52.5%	37.6%	55%	578
7	#1 PET Non-Bottles	626.6	30.5%	49.5%	16.4%	50%	313
8	#2 HDPE Natural	224.4	50.2%	51.6%	51.1%	55%	123
9	#2 HDPE Pigmented	339.0	39.3%	44.0%	37.5%	50%	170
10	#5 PP Containers	611.6	24.6%	30.4%	19.4%	40%	245
	Targeted Metals	**1,741.1**	**38.5%**	**42.9%**	**34.3%**	**56%**	**982**
11	Steel Cans (Tin)	522.6	28.8%	24.5%	38.0%	50%	261
12	Aluminum Cans	920.3	51.1%	63.5%	42.0%	70%	644
13	Other Aluminum	215.4	9.7%	12.0%	8.7%	20%	43
14	Cardboard Cans	82.8	17.9%	33.1%	11.4%	40%	33
	Targeted Glass	**4,519.3**	**60.3%**	**62.3%**	**50.3%**	**70%**	**3,164**
15	Glass	4,519.3	55.8%	62.3%	50.3%	70%	3,164

Table 3-6 (continued)

	Material	Total Generation (TPY)	Current Total Capture Rate (All HHs)	Current Capture Rate (Subscribers)	Current Capture Rate (Non-Subscribers)	Proposed Target Capture Rate	Calculated Future TPY Recycled or Composted
	Targeted Organics (a.k.a., "SSO")	**33,230.2**	**18.0%**	**36.4%**	**N/A**	**25%**	**8,202**
16	Compostable paper	2,911.0	8.5%	18.8%	N/A	15%	437
17	Compostable plastics	23.9	51.5%	83.4%	N/A	65%	16
18	#7 compostable bags	29.2	42.1%	71.2%	N/A.	55%	16
19	Wasted food	21,140.7	7.5%	19.2%	N/A	15%	3,171
20	Food waste	8,325.5	41.1%	64.4%	N/A	50%	4,163
21	Other compostables	799.9	43.6%	64.3%	N/A	50%	400
	Non-Recoverable	52,996.9					
	TOTAL	**106,637.1**					**21,013**
					Calculated Proposed Target Total Recycling Rate	**19.7%**	

Notes:
% = percent
a.k.a. = also known as
N/A = Not applicable (i.e., there are no organics cart materials from non-organics subscribers)
HDPE= high-density polyethylene
HH = household
PET = polyethylene terephthalate
PP = polypropylene
SSO = source-separated organics
TPY = tons per year

Prepared by: DFK
Checked by: BDR

Table 3-7
Target Capture Rate Assumptions Used to Calculate the "Reasonably Achievable" Recycling Rate

(Capture rates in percent of the total amount generated for each individual commodity)

Material (ID)	Target Capture Rate	Comments, Assumptions, etc.
Newspaper (1)	90%	Total 2022 capture rate @ 73%. (2015 capture rate was 91%.) 2022 Subscribers @ 82%; Non-subscribers @ 66%. Nearly fully "mature". There will always be some material loss due to waste (e.g., pet bedding, bacon grease can liners, etc.)
Mixed Recyclable Paper (2)	60%	Total 2022 capture rate @ 40%. (2015 capture rate was 39%.) 2022 Subscribers @ 54%; Non-subscribers @ 27%. Growth opportunity. This is a generic category of other readily recyclable paper grades (office paper, magazines/catalogs, boxboard/paperboard, and other mixed recyclable paper). Markets need to be strengthened.
Boxboard/Paperboard (3)	55%	Total 2022 capture rate @ 44%. 2022 Subscribers @ 48%; Non-subscribers @ 37%. Uncoated boxboard such as cereal, cracker, shoes boxes, and paper cores (from paper towel, toilet paper, wrapping paper, aluminum foil, and plastic wrap). This material category definition was intended to include wet strength boxboard (e.g., refrigerator boxes holding beer, pop, water, etc.). It can be challenging to communicate all types of boxboard that are recyclable versus garbage.
Cartons (Aseptic) (4)	60%	Total 2022 capture rate @ 48%. (2015 capture rate was 7%.) 2022 Subscribers @ 64%; Non-subscribers @ 27%. Moderate growth opportunity, but the relative share of cartons (e.g., milk cartons, juice boxes, etc.) is very small (0.04%) within the overall amount of solid waste currently generated. City (w/ Carton Council) has pushed in past, still very little significant change in capture rate…
Corrugated cardboard (OCC) (5)	70%	Total 2022 capture rate @ 54%. (2015 capture rate was 49%.) 2022 Subscribers @ 64%; Non-subscribers @ 43%. Growth opportunity. Evolving consumer purchasing behaviors predict increasing amounts of residential corrugated cardboard will be generated (i.e., the "e-commerce effect).

Table 3-7 (continued)

Material (ID)	Target Capture Rate	Comments, Assumptions, etc.
#1 PET bottles (6)	55%	Total 2022 capture rate @ 43%. (2015 capture rate for #1 PET bottles was 52%) 2022 Subscribers @ 53%; Non-subscribers @ 38%. Significant growth opportunity, especially for the ubiquitous PET beverage bottles. There are also PET non-bottle containers (e.g., PET clamshells for deli food, etc.) that can be readily recycled if cleaned of food residue.
#1 PET non-bottles (7)	50%	Total 2022 capture rate @ 31%. (2015 capture rate for #1 PET non-bottles was 52%) 2022 Subscribers @ 50%; Non-subscribers @ 16%. Non-bottle containers (e.g., PET clamshells for deli food, etc.) can be readily recycled if cleaned of food residue.
#2 HDPE natural (8)	55%	Total 2022 capture rate @ 50. 2022 Subscribers @ 52%; Non-subscribers @ 51%. Significant growth opportunity, especially for the HDPE beverage containers (e.g., milk jugs) and household cleaning bottles (e.g., laundry soap,).
#2 HDPE pigmented (9)	50%	Total 2022 capture rate @ 41%. 2022 Subscribers @ 44%; Non-subscribers @ 38%. HDPE non-bottle containers (e.g., yogurt tubs, cottage cheese tubs, other food tubs, etc.) can be readily recycled if cleaned of food residue.
#5 PP containers (10)	40%	Total 2022 capture rate @ 25%. 2022 Subscribers @ 30%; Non-subscribers @ 19%. This subcategory includes all bottles, jars, tubs, lids, cups, clamshells, trays, etc. that bears the plastic code label #5 or "PP".
Steel cans ("Tin") (11)	50%	Total 2022 capture rate @ 29%. (2015 capture rate was 58%.) 2022 Subscribers @ 25%; Non-subscribers @ 38%. Moderate growth opportunity. The sort exercise found cans used to contain spoiled food or kitchen grease, which rendered some of the cans unrecyclable.

Table 3-7 (continued)

Material (ID)	Target Capture Rate	Comments, Assumptions, etc.
Aluminum cans (12)	70%	Total 2022 capture rate @ 52%. (2015 capture rate was 41%.) 2022 Subscribers @ 64%; Non-subscribers @ 42%. Growth opportunity. A large but unknown amount of aluminum cans will continue to be sold by Minneapolis residents at various redemption centers or donated to charities. This is in part due to the relatively high value per pound of this easily recognized commodity.
Other aluminum (13)	20%	Total 2022 capture rate @ 10%. 2022 Subscribers @ 12%; Non-subscribers @ 9%. This subcategory includes clean aluminum foil, trays, and tins (with no food residue).
Cardboard cans (14)	40%	Total 2022 capture rate @ 21%. 2022 Subscribers @ 33%; Non-subscribers @ 11%. These “cans” have a steel bottom and boxboard sides (Pringles, mixed nuts, juice concentrate, crescent rolls, etc.).
Food & beverage glass (15)	70%	Total 2022 capture rate @ 60%. (2015 capture rate was 85.8%.) 2022 Subscribers @ 62%; Non-subscribers @ 50%. 2022 capture rates measured much lower than in 2015. There will always be some loss due to breakage in the home or during collection. A more significant question affecting recyclability is how glass is handled by the MRF and the extent to which it ends up as a component of processing residuals.
Compostable paper (16)	15%	Total 2022 capture rate @ 11%. 2022 Subscribers @ 19%. Non-recyclable compostable paper. Includes napkins, paper towels, and tissues; uncoated paper plates, and food containers; paper egg cartons; pizza boxes; soiled paper bags. Does not include fast food wraps, plastic coated paper, coffee cups, cartons, or freezer boxes. Unlined molded pulp.
Compostable plastics (17)	65%	Total 2022 capture rate @ 60%. 2022 Subscribers @ 83%. Cups, utensils, containers labeled PLA #7 or BPI certified.
#7 Compostable bags (18)	55%	Total 2022 capture rate @ 53%. 2022 Subscribers @ 71%. BPI certified compostable plastic bags.

Table 3-7 (continued)

Material (ID)	Target Capture Rate	Comments, Assumptions, etc.
Wasted food (19)	15%	Total 2022 capture rate @ 8%. 2022 Subscribers @ 19% Uneaten food/ food that could have been eaten before being put into the organics. Includes: ½ a fruit, veggies, or more remaining of item; ½ a loaf of bread; leftovers (this category has been broken out from the 'food waste' category in Hennepin County sort). When feasible, food will be removed from containers (e.g., Tupperware, carry-out containers, etc.) and the food will be placed in the Wasted Food category and the container will be placed in the appropriate category. ½-full water bottles also sorted here.
Food waste (20)	50%	Total 2022 capture rate @ 42%; 2022 Subscribers @ 64%. Food preparation wastes, food scraps, bones; eggshells; coffee grounds, filters, and tea bags. Meat trimmings, shells, etc.—all inedible parts of food.
Other compostables (21)	50%	Total 2022 capture rate @ 48%; 2022 Subscribers @ 64%. Includes houseplant trimmings, cotton balls, hair and nail clippings, Q-tips with paper stems, wood chopsticks, popsicle sticks, toothpicks.

Notes:
% = percent
BPI = Biodegradable Products Institute
HDPE= high-density polyethylene
HHW = Household Hazardous Waste
ID = identification
PET = polyethylene terephthalate
PP = polypropylene
PS = polystyrene
PVC = polyvinyl chloride

Prepared by: DFK
Checked by: BDR

Source: Minneapolis staff and Consultant Team analysis (August 2022)