OCRRA

Onondaga County Resource Recovery Agency

2019 Waste Characterization Study

April 30, 2020

Final Report

MSW CONSULTANTS

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This study would not have been successful without their ongoing cooperation.

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CHAPTER 1– INTRODUCTION

1.1 BACKGROUND

The Onondaga County Resource Recovery Agency (OCRRA) is a non-profit public benefit corporation that, since its inception in 1990, has managed the disposal of residential and commercial municipal solid waste (MSW), recyclables, and construction and demolition (C&D) debris for thirty-three (33) of the thirty-five (35) municipalities in Onondaga County. The Town and Village of Skaneateles are not included in the OCRRA service area.

OCRRA has a history of conducting waste composition studies dating back to 1987, with the most recent update completed in 2005 (2005 Study). There have been numerous changes since 2005 that have impacted the composition of the OCRRA System's waste stream. The shift from print media to digital media, and the ongoing conversion to lighter-weight packaging have impacted recycling programs not just in Onondaga County, but nationally. Since 2005, ongoing public education as well as advancement of recycling instruction in the school systems continues to shape public participation in diversion programs. Further, expansion of source-separated organics collection programs have begun to target previously disposed materials for composting.

OCRRA retained MSW Consultants to perform a comprehensive waste characterization study update. To complete the study, MSW Consultants utilized industry standard methodologies, including ASTM D 5231-92 (2016), "*Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste*" and the State of California's official characterization methodology.

The objectives of this study were to:

- Develop an accurate composition profile of the disposed waste stream generated by residential households and commercial businesses in the County. The study updated and expanded upon the results of the 2005 study, namely by
  - Increasing the number of MSW and recycling samples that were collected in 2005 and broadening the study scope to include visual surveys of C&D Debris.
  - Presenting residential recycling Capture Rates in addition to the Diversion/Recycling Rate.
- Obtain composition profile data for additional material streams that were not captured in the 2005 Study, including recycling from multi-family residential sources.
- Identify the extent to which materials that could be recycled within the County's recycling program are in fact being captured in the recycling program.
- Identify other constituents in the disposed waste stream that could be targeted in new recycling, organics, source reduction, or reuse programs.
- Measure and evaluate the degree and type of contamination found in the recycling stream to inform future public education efforts aimed at reducing contamination.

1.2 COMPARISON TO PREVIOUS STUDIES

From the outset, it was the intent of OCRRA that the 2019 Study be performed so that the results could be compared to the 2005 Study results. With the assistance of OCRRA, MSW Consultants crafted a Study Design that would make this comparison possible, while acknowledging that 14 years have elapsed since the 2005 Study, therefore introducing variables to make such comparisons more challenging due to the magnitude of changes to the waste stream over that time period.

Additionally, the 2019 Study was expanded from the 2005 Study. Similarities and differences (including new initiatives) are described below and addressed in greater detail in the body of the report.

1.2.1 Similarities Between Studies

- **Host Facilities**: Both the 2005 and 2019 Studies performed most of the sample collection and sorting at the following facilities:
  - Covanta-Onondaga Resource Recovery Facility (RRF); and
  - Rock Cut Road Transfer Station
  - Recycle America Materials Recovery Facility (MRF); in 2005, residential recycling samples were also collected and sorted at Syracuse Recycling and Recovery facility (formerly Naef Recycling), which has since ceased operations.

  Additional facilities particular to the 2005 and 2019 Studies are included in the summary of study differences.
- **Definitions of MSW Waste Sectors:** The 2005 and 2019 Studies retained two similar generator sectors for MSW: Residential and Institutional/Commercial/Industrial (referenced simply as "Commercial" in 2005).
- **Obtaining Samples from Inbound Trucks**: Both studies relied on systematic protocols to select a vehicle for sample collection and sorting. Both studies used some variation of "nth truck" selection methodologies and random grab sample collection to obtain sample materials from the tipped load.

1.2.2 Differences Between the Studies

- **Additional Host Facilities**: The 2005 Study also performed the collection and sorting of dual stream recycling samples at the Syracuse Recycling and Recovery facility (formerly Naef Recycling) in East Syracuse. OCRRA switched exclusively to single-stream in 2011. Syracuse Recycling was destroyed by fire in 2013 and was never rebuilt. The 2019 Study included visual sample analysis of C&D loads; therefore, the Ley Creek Transfer Station was included as a host facility for this purpose in 2019.
- **Seasonality**: The 2005 Study was performed over a two-week period, with one week in September 2005 dedicated to characterizing MSW, and one week for recyclables in October of 2005. For the refuse and recyclables characterization, the 2019 Study was performed over two, two-week seasons in June and September of 2019. During each of these seasons, the first week focused upon the characterization of refuse, and the second on the characterization of recyclables. In addition, the 2019 Study included a visual characterization of C&D debris, which was also performed over two seasons during June and October 2019, each sampling period lasting for a total of three days.
- **Definitions of Generator Sectors**
  - **MSW**: While the 2005 and 2019 Studies had two generator sectors in common, namely residential refuse and commercial refuse (Institutional/Commercial/Industrial or "ICI," in 2019), the 2019 Study also added a Multi-Family refuse sector.
  - **Recycling**: The 2005 Study included a dual stream recycling sector as well as a single-stream sector (these sectors were not weighted by percentage in the results). The 2019 Study consisted of single-stream curbside residential and single stream multi-family residential sectors.
  - **C&D Debris**: The 2019 Study was expanded to include an evaluation and estimation of the quantity and nature of C&D Debris in the OCRRA System.
- **Acceptance Threshold for Sampling by Generator Sectors**: During the 2019 Study, a generator sector was assigned to vehicle loads if 80% or more of the material in that load was from a specific generator sector (Single family residential, ICI, and multi-family). If the truck did not contain at least 80 percent from one of the generator sectors, the load was deemed unacceptable. For the 2005 Study, a 60 percent threshold was used to determine the appropriate generator sector.
- **Sample Collection Targets**: In the 2005 Study, 90 samples were collected from three generator sectors, Single-Family Residential Refuse (26 samples), Commercial Refuse (22 samples), and

Residential Recycling (42 samples). In 2019, 338 samples of waste were proportionally allocated and collected across a wider array of generator sector types, including Single-Family Residential Refuse (40 samples), Multi-Family Residential Refuse (16 samples), ICI Refuse (44 samples), Single-Family Recycling (92 samples), Multi-Family Recycling (13 samples), and C&D Debris (133 samples).

- **Sample Weights**: In 2005, a volumetric standard of three cubic yards was used as a minimum sample collection size for refuse. As such, refuse sample weights ranged from 84 lbs to 579 lbs. In 2019, a 200-lb sample size minimum was established for refuse, with an upper limit of 250 lbs. Recycling samples collected during the 2019 Study ranged from 100 to 150 lbs.
- **Material Categories**: For the 2019 Study, the sorting of refuse and residential recyclables, and the visual survey of C&D Debris, utilized a list of material categories developed by OCRRA and MSW Consultants. The categories used for refuse and recyclables were in general conformance with those categories used in the 2005 study, with some additions and consolidation.
- **Determination of the Residential/ICI Split for OCRRA MSW**: The 2005 Study completed a one-month review of vehicle traffic flows at the Covanta-Onondaga facility, which was used only to determine the vehicle selection strategy (n^{th} truck) that would be implemented during the 2005 characterization study. These vehicle counts reportedly did not include a gate survey that identified vehicles by generator sector. By contrast, the 2019 Study included one week of gate surveys, which was performed by OCRRA to characterize inbound wastes by generator sector. The results of the gate survey were used in 2019 to conduct a weighted averaging analysis on the aggregate County-wide waste composition results included in Appendix A.

1.3 ORGANIZATION OF THIS REPORT

In addition to this Introduction, this report is divided into the following sections:

- **Chapter 2 - Methodology:** This section presents an overview of waste generation and disposal data available from disposal facility reports and has been supplemented with direct facility surveys. Also provided in this section is the sampling plan that was developed to guide the study process and to provide statistically defensible data. Additionally, this section summarizes the field data collection and analytical methods applied in the study.
- **Chapter 3 - Results**: This section presents results of the composition of disposed aggregate[1] OCRRA System waste as well as the separate compositions of residential, multi-family and ICI generator sectors. For recycling, detailed composition results are provided for the single-stream (residential) aggregate, as well as for single-family and multi-family generator sectors. Also included in this section are the composition results of the C&D Visual Survey. All results in this section are presented in both tabular and graphical format to highlight findings of interest. Finally, results between generator sectors are compared, along with results from the 2005 Study, as applicable, to indicate how the waste stream has changed or remained the same over time.
- **Chapter 4 Conclusions and Recommendations**: This section presents conclusions that can be drawn from the 2019 Study as well as recommendations for usage of the data and for future study.
- **Appendices**: Of particular importance is Appendix A that provides detailed composition tabular data. These tables are referenced extensively in the Results chapter of this report. Other supplemental data and analysis are contained in subsequent appendices.

[1] "Aggregate" refers to the combination of single family residential, multi-family residential, commercial and institutional municipal solid wastes taken as a whole.

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CHAPTER 2 – METHODOLOGY

2.1 MATERIAL STREAMS AND GENERATOR SECTORS

Within the OCRRA System, this study focused on the following material streams:

- Disposed Refuse,
- Single Stream Residential Recyclables, and
- Construction & Demolition (C&D) Debris.

Material streams were further categorized based on their Generator Sectors as defined below:

- The **Single-Family Residential** sector, which includes residential housing units with up to three dwelling units, was captured from waste collected in municipally-operated vehicles or from private (contracted) haulers, in which at least 80% or more of the waste was derived from single-family residential sources. Vehicles chosen for sample collection in the Single-Family Residential waste sector included side-loading and rear-loading packer trucks, which the driver verbally indicated that collected waste had come primarily from residential routes. (Refuse and recyclables were characterized from the Single-Family sector, but not C&D.)
- The **Multi-Family Residential** sector, which includes buildings with four or more dwelling units, was captured from waste brought to OCRRA permitted facilities by commercially or municipally operated vehicles, in which at least 80% or more of the waste was from multifamily residential sources. Specific to this study, multi-family waste was delivered to the sample collection site by designated vehicles, which collected from specialized routes around the county. Such trucks were identified in advance by all parties to ensure the that the truck would be properly identified and that multiple samples could be collected from the load. (Refuse and recyclables were characterized from the Multi-Family sector, but not C&D.)
- The **Institutional, Commercial, Industrial (ICI)** sector, which includes all non-residential establishments (such as businesses, institutions, and small industrial operations), was captured from waste brought to OCRRA permitted facilities by commercially operated vehicles, in which 80% or more of the waste was from institutional, commercial, or industrial sources. Vehicles chosen for sample collection in the ICI sector included roll-off compactor boxes and packer trucks, which the driver verbally indicated that collected waste had come primarily from routes serving ICI customers. (Only refuse was characterized from the ICI sector.)
- The **C&D** sector includes wastes generated primarily from the construction, demolition, and renovation of structures, and was treated as a separate generator sector entirely from the municipal solid waste originating from residential and ICI sources. C&D was identified during the study as loads that contained 80% or more of material generated from construction and demolition activities. C&D Debris also included "dry waste loads" which were primarily bulky waste loads managed as C&D loads. (Only disposed C&D debris was characterized.)
- **Unacceptable** – Loads that contained less than 80% of the targeted generator sector, and loads originating from outside Onondaga County, were not included in sample collection because of mixing of waste from multiple generator sectors. For example, transfer trailers were not included in this Study because they contain wastes mixed together from more than one generator sector.

2.2 WASTE GENERATION

2.2.1 OVERVIEW

OCRRA tracks the flow of all wastes handled by OCRRA annually. Interestingly, the quantity of materials managed by OCRRA has declined since the 2005 Study. Table 2-1 below provides a comparison of material quantities within the OCRRA Service Area for 2018 and 2005.

Table 2-1 Annual Material Quantities

Material Stream	2018 (tons)	2005 Study (tons)**
Refuse (MSW)	288,130	316,500
Residential Recyclables*	39,096	43,400
C&D Debris	54,832	63,000
Total Tonnage	382,058	422,900

*Residential and multi-family sources only
** Data from 2005

2.2.2 GATE SURVEY

During the week of October 14, 2019, OCRRA staff completed a scale house gate survey to establish a basis for the allocation of tons disposed within the OCRRA service area, between single-family residential, multi-family and ICI wastes so that the percent composition of each waste stream (determined by hand sorting) could be applied to total estimated tons by generator.

The gate surveys were completed at the Covanta-Onondaga RRF in Jamesville, New York. Surveys were only carried out on roll-offs and packer trucks carrying municipal solid waste (MSW). Loads containing bulky waste and C&D debris were excluded from gate surveys because hand sorting did not include loads carrying these materials, and therefore the MSW allocation was for single-family residential, multi-family and ICI waste only. Results of the gate survey are provided in Table 2-2.

Table 2-2 Gate Survey Results

Material Stream	Survey Tonnage	Percent of Total
Single-Family Refuse	2,089	45.2%
Multi-Family Refuse	321	7.0%
ICI Refuse	2,208	47.8%
Total Tonnage	4,618	100.0%

2.2.3 WASTE GENERATION SUMMARY

By applying the gate survey results to the MSW tonnage presented Table 2-1, a more detailed representation of annual tonnage by generator sector arises, as shown in Table 2-3 below. The quantities in this table are used for applying the results of the composition analysis in the Results section of the report.

Table 2-3 Waste Generation Summary

Material Stream	Gate Survey Percentage	2018 Tons
Single-Family Refuse	45.2%	130,350
Multi-Family Refuse	7.0%	20,025
ICI Refuse	47.8%	137,755
Single Stream Recyclables*	N/A	39,096
C&D Debris	N/A	54,832
Totals	100.0%	382,058

*residential and multi-family sources only

2.3 HOST FACILITIES AND SCHEDULE

2.3.1 FIELD DATA COLLECTION SCHEDULE

Table 2-4 summarizes the field data collection schedule for the 2019 Study. As shown, data were collected over two seasons, representative of late spring (June) and late summer (September). For comparison, the 2005 Study data collection was compiled during a single season in September-October 2005.

Table 2-4 Host Facilities and Field Data Collection Schedule

		Field Data Collection Dates	
Host Facility	Work Performed	Season 1	Season 2
Covanta Onondaga RRF	Refuse Sample Collection	June 10 - June 14	Sept. 9 - Sept. 13
Rock Cut Road Transfer Station	Refuse Manual Sorting		
Waste Management Recycle America MRF	Sample Collection & Manual Sorting of Single Stream Recyclables	June 17 - June 21	Sept. 16 - Sept. 20
Ley Creek Transfer Station	C&D Debris Visuals	June 19 - June 21	Oct. 22 - Oct. 24

2.3.2 SAMPLE COLLECTION TARGETS

The objective of the sampling plan for the waste characterization study is to obtain a representative distribution of samples from the targeted waste streams and generator sectors. As mentioned previously, two seasons of data collection were completed at different facilities as identified by OCRRA for the refuse, residential recycling, and C&D portions of the study. MSW Consultants utilized 2018 hauler weight data as reported by OCRRA to proportionally allocate samples across generator sectors.

Table 2-5 summarizes the number of samples planned for the study and also shows the actual number of samples obtained.

Table 2-5 Sample Collection Targets by Material Stream and Generator Sector

Material Stream	Generator Sector	Sample Type	Season 1		Season 2		Project Totals	
			Planned	Actual	Planned	Actual	Planned	Actual
Refuse	Residential	Manual	20	20	20	20	40	40
	Multi-family	Manual	8	8	8	8	16	16
	ICI	Manual	22	22	22	22	44	44
		Refuse Subtotal	*50*	*50*	*50*	*50*	*100*	*100*
Recycling	Residential	Manual	42	49	42	43	84	92
	Multi-family	Manual	8	4	8	9	16	13
		Recycling Subtotal	*50*	*53*	*50*	*52*	*100*	*105*
C&D Debris	C&D	Visual	60	71	60	62	120	133
		Grand Total	160	174	160	164	320	338

As shown in the table above, all targeted samples were obtained during the study, with the exception of several samples of multi-family waste. This was due to the difficulty in securing sufficient materials representing a dedicated collection route of multi-family facilities. In the professional opinion of MSW Consultants, a sufficient number of multi-family refuse samples were obtained to discern differences in material composition from these sectors.

2.3.3 Material Categories and Groups

For the 2019 Study, sorting operations utilized a predetermined list of material categories for refuse, residential recyclables and C&D debris. The categories are in general conformance with those categories used in the 2005 study, with some additions and consolidation. The following changes from 2005 were incorporated into the 2019 Study:

- Compostable Paper was added as a new category. Items from the 2005 "Other Paper" category, such as paper towels, napkins and tissue paper, along with the Corrugated Waxed OCC category, were consolidated as Compostable Paper.
- Mixed Recyclable Paper was added as a new category, and included the (soft-bound) Books and Paperboard categories from 2005.
- #1 PET Bottles category was slightly altered in 2019 to include an added designation for Non-Beverage PET Bottles.
- #3, #4, #6 and #7 Rigid Plastic Containers was added as a new category, consolidating the LHDPE #3, LHDPE #4, LLDPE #4, PVC #3 and the other composite categories from 2005. 2019 also expanded #5 rigid plastics into two new categories: #5 Dairy Tubs and #5 Other Containers.
- #6 EPS (Styrofoam) was added as a new category in 2019.
- The Poly (film) category from 2005 was subdivided in 2019 into the following new categories: Retail Film Bags, Commercial/Consumer Film (product film wrap), and All Other Film.
- The Other Plastics category from 2005 was subdivided into new 2019 categories that included Flex Packaging and Pouches, Durable/Bulky/Rigid Plastics, and Remainder/Composite Plastics.
- The metals group was largely similar, although the Automobile Parts category from 2005 was consolidated into the Other Ferrous category in 2019, and Aluminum Cans (bottle bill and non-bottle bill) were separated into categories for Beverage NYS Deposit, Beverage Non-NYS Deposit, and Non-Beverage subgroups.
- In 2005, glass containers were separated by Bottle Bill and (if non-bottle bill) by color. These designations were changed in 2019 to include NYS Deposit beverage bottles and Non NYS Deposit

beverage bottles. Two beverage subgroups were also added: Wine Bottles and Spirits (Liquor) Bottles, along with an All Other Glass Food Containers & Jars category. Finally, the Flat Glass and Other Glass categories from 2005 were categorized in 2019 to include a Ceramic Containers & Clay Products category, and Remainder/Composite Glass.

- The Organics material group was mostly unchanged from the 2005 Study, although the 2019 Study added a Remainder/Composite Organics category.
- Treated/Painted/Stained Wood and Clean Wood were added in 2019, subdividing the Wood category from 2005. The Rubble category from 2005 was separated into various construction and demolition categories in the 2019 Study, including Drywall, Asphalt Roofing Materials, Asphalt Paving/Brick/Concrete & Rock, Carpet & Carpet Padding, and Remainder/Composite C&D.
- The Household Hazardous Waste and Other Hazardous categories from 2005 were consolidated into Household Hazardous Waste in 2019. The 2019 Study also added a Medically-Related Wastes category to the hazardous materials group.
- The Electronics material category from 2005 was separated into two categories (TVs/Monitors/CRTs, and All Other Electronics) in 2019. .
- Bulky Materials were added as a new category in 2019, and the Miscellaneous category from 2005 was changed in 2019 to Other Materials Not Elsewhere Classified.
- The Recycling portion of the 2019 Study added a Newspapers in Sleeves category, as well as categories for Tanglers (of MRF equipment) and Bagged Material.

In addition, one of the objectives of this study was to identify constituents that could be diverted from the refuse stream through locally available means. Accordingly, each material was assigned a "recoverability class" which are defined below.

1. **Targeted Paper**: All cardboard and paper as targeted in OCRRA's curbside collection program.
2. **Targeted Containers**: Metal, glass, plastic and aseptic containers and packaging as targeted in OCRRA's curbside collection program.
3. **Compostables**: Food wastes, compostable papers, and compostable plastics that would be suitable for collection or drop-off at a local composting facility.
4. **Green Waste**: Yard-related wastes, such as leaves, grass, prunings, trimmings, and stumps. Green waste is not accepted in the waste stream, but is accepted at local drop-off facilities.
5. **E-Waste Recycling:** Although OCRRA does not accept e-waste at any of its drop-off locations, residents and businesses are made aware of the state's "take-back" program, and are encouraged to seek opportunities to return e-waste to the manufacturer.
6. **Metal Recovery:** This diversion class includes metals not targeted by the curbside recycling program. Such ferrous and non-ferrous scrap metals are recovered through pre-disposal collection centers within the OCRRA system, or by post-disposal through the waste-to-energy (WTE) process.
7. **Household Hazardous Waste (HHW) Program:** While not actually recovered for recycling, HHW was included as a separate class because it is identified as material that OCRRA is seeking to remove from the disposed refuse stream through its pre-disposal collection locations.
8. **Recoverable by Third Party**: Some materials are accepted by an existing network of third-party recyclers and/or brokers located within the county or immediately surrounding locales. So, while materials in this class could be classified as recyclable, actual recycling of these materials is predicated on the generator (or waste processor) separating these materials from the disposed waste stream and transporting the materials to an existing private recycler. For the purposes of this study, plastic retail bags, and textiles, carpeting/carpet padding, and clean wood are included as third-party recoverable.

9. **Not Currently Recyclable in Existing Markets**: Materials for which there is no curbside collection outlet for recycling, composting collection, or other diversion from disposal. It should be noted that this number is likely overstated. This is because there are items within this class that possibly can be diverted, but are not generated frequently enough, and for which no sort category was included in this study (or previous studies).
10. **Dirt & Fines**: Materials which fell through the ½" screen at the sorting table. Dirt and fines generally consisted of organic material, broken glass, or other small items that were too small to sort into a material category bin. Such materials were quantified within the "Dirt/Fines" sorting category.

Table 2-6 below shows the breakdown of the material categories within their respective material groups. Detailed material category definitions for each of these categories are provided in Appendix B.

Table 2-6 2019 Material Categories for Municipal Solid Waste (with Recoverability Designation)

Paper		**Glass**	
Newspaper	1	Glass Bottles - NYS Deposit	2
Magazines & Catalogs	1	All Other Glass Beverage - Non NYS Deposit	2
OCC and Kraft Paper	1	All Other Glass Food Containers & Jars	2
Compostable Paper	3	Wine Bottles	2
Aseptic & Gable Top Containers	1	Spirit (Liquor) Bottles	2
Mixed Recyclable Paper	1	Ceramic Containers & Clay Products	9
High Grade Office Paper	1	Remainder/Composite Glass	9
Other Non-Recyclable Paper	9	**Organics**	
Plastic		Food Waste	3
#1 PET Bottles (NYS Deposit)	2	Textiles & Leather	8
#1 PET Bottles Beverage (Non NYS Deposit)	2	Rubber	9
#1 PET Bottles Non-Beverage (Non NYS Deposit)	2	Diapers & Sanitary Products	9
#1 PET Non-Bottle Containers	2	Yard Waste	4
HDPE #2 Natural Bottles	2	Remainder/Composite Organics	9
HDPE #2 Colored Bottles	2	**Construction & Demolition Debris**	
HDPE #2 Non-Bottle Containers	9	Treated/Painted/Stained Wood	9
#3, #4, #6, and #7 Rigid Plastic Containers	9	Clean Wood	8
#5 Dairy Tubs	2	Drywall	9
#5 Other Containers	2	Asphalt Roofing Materials	9
Expanded Polystyrene (EPS)	9	Asphalt Paving, Brick, Concrete, and Rock	9
Retail Film Bags	8	Carpet & Carpet Padding	8
Commercial/Consumer Film (product film wrap, newspaper sleeves, drycleaner bags)	9	Remainder/Composite C & D	9
All other Film	9	**Household Hazardous Waste or HHW**	
Flex Packaging and Pouches	9	Household Hazardous Waste	7
Durable/Bulky Rigid Plastics	9	Batteries - All Types	7
Remainder/Composite Plastics	9	Medically-Related Wastes	7
Metals		**Electronics**	
Steel Cans & Lids	2	TVs, Monitors, CRTs	5
Aerosol Cans	2	All Other Electronics	5
Other Ferrous Metals	6	**Other Materials**	
Aluminum Beverage Cans (NYS Deposit)	2	Dirt/Fines	10
Aluminum Beverage Cans (Non NYS Deposit)	2	Bulky Materials	9
Aluminum Non-Beverage Containers	2	Other Materials Not Elsewhere Classified	9
Aluminum Foil & Trays	2		
Other Non-Ferrous Metals	6		

Recoverability classes were also developed for the different set of material categories that were used to characterize the C&D waste stream. C&D recoverability classes are shown in the list below.

1. **Broadly Recyclable**: C&D material constituents which can be recovered through commercial processing of mixed C&D loads throughout most markets.
2. **Recyclable in Select Markets**: C&D material constituents which can be recovered through commercial processing of mixed C&D loads in some areas.
3. **Boiler Fuel Feedstock**: C&D material (mostly wood) that can be used directly as a fuel, or converted to another form of fuel or energy product.
4. **Non-Recoverable:** C&D material for which there is no current infrastructure or market to divert from disposal.

Table 2-7 presents a list of material categories and respective recoverability designations that were used for the C&D composition analysis.

Table 2-7 2019 Material Categories C&D Debris (with Recoverability Designation)

Material	Designation
Paper	
Uncoated OCC - Recyclable	4
Other Paper	4
Plastics	
HDPE Buckets	4
Tyvek Building wrap	4
Film Plastic (ICI Film)	4
Plastic furniture	4
Durable plastic items	4
Composite/Other Plastic	4
Metal	
Ferrous Scrap	1
Non-Ferrous Scrap	1
Glass	
All Glass Materials	4
Organics	
Yard Waste	1
Dirt/Sand	4
C&D Materials	
Rock/Gravel	1
Concrete, Brick, Block	1
Asphalt	1
Gypsum Wallboard - Clean	2
Gypsum Wallboard - Painted	4
Roofing Shingles	2
Carpet	2
Carpet Padding	2
Ceramics/Porcelain Fixture	4
HVAC Ducting	4
Tires	4
Appliances	2
Remainder/Composite C&D	4
Wood	
Pallets and Crates	3
Untreated/Unpainted Wood	3
Treated/Painted/Stained Wood	3
Engineered Wood	3
Wood Furniture	4
Other Wood	3
Other Materials	
E-Waste	4
Bulky Items (inc. mattresses)	4
Mixed MSW	4

2.4 SAMPLE COLLECTION METHODS

2.4.1 VEHICLE SELECTION

During the collection of samples for manual sorting, MSW Consultants' Field Supervisor followed a systematic selection procedure to identify residential and ICI waste, and residential recycling vehicles. To calculate vehicle sampling frequency for each waste sector, the Field Supervisor established a sampling interval at each facility. Sampling intervals were determined by dividing the total expected number of loads for each sector arriving at the facility on the scheduled day – based on questions asked of each facility in the planning phase of the study - by the number of samples needed each day. The resulting number was the sampling frequency, which determined whether every third vehicle, every sixth vehicle, or every 20th vehicle was selected for sample collection. This strategy is commonly referenced as "selecting every n^{th} vehicle" within a waste sector and subsector. For the purposes of this study, the nth vehicle was typically "5", that is, every eligible 5^{th} vehicle was selected for sample collection. It should be noted that the nth vehicle on occasion may be altered to accommodate such field conditions as a lull in vehicle traffic. In such cases, the first eligible truck may be selected in order to keep the sort table busy.

Vehicles entering the host facility that meet the definition of the n^{th} vehicle were surveyed by the Field Supervisor. In order for a vehicle to be eligible for sample collection, the load must fit within the residential and ICI definitions. The Field Supervisor then collected data regarding the vehicle type, hauler, waste type, town or city of origin, and a net weight. The Field Supervisor was in direct communication with the scale house after selecting a vehicle for sample collection, and provided the appropriate identifying information (hauler name and truck number or license number) so that the scale house would be able to set aside documentation for the Field Supervisor to collect at the end of the day for all loads from which a sample was collected.

2.4.2 Collecting Grab Samples from Tipped Loads of Waste or Recyclables

Selected loads of waste or recycling were tipped in the designated area at each host facility. The manual sort area at the Rock Cut Road Transfer Station and Waste Management Recycle America MRF were both located within a safe area, under roof, with the tipping area designated nearby at both facilities. In the case of refuse, the tipping of targeted loads and subsequent sample collection was performed off-site at the nearby Covanta Onondaga facility.

From each selected load, one sample of waste was selected based on a systematic "grab" from the load, treating the tipped load as a clock face. For example, if the tipped pile is viewed from the top as a clock face with 12:00 being the part of the load closest to the front of the truck, the first sample was taken at the 12:00 position. Subsequent samples were then taken from 3 o'clock, 6 o'clock, and 9 o'clock. For the next four loads, the extraction point shifted to 1, 4, 7, and 10 o'clock, and so-on.

This concept of systematically rotating around subsequent loads is shown in Figure 2-1.

Figure 2-1 Systematic Sample Collection Guide for Tipped Loads

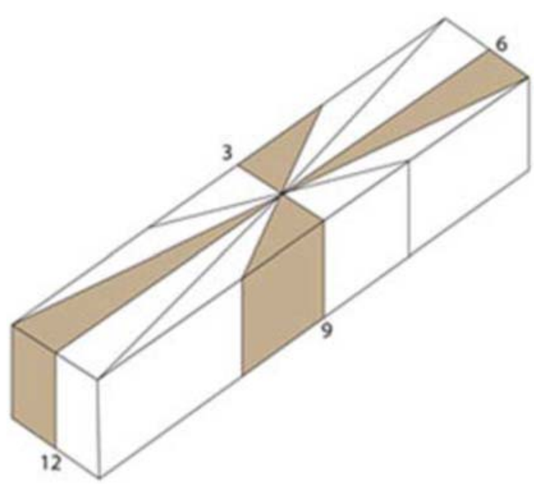


Figure 2-2 Photograph of a Tipped Load

From each sample extraction point, the loader operator was instructed to take a grab sample. From each grab, a sample weighing at least 200 pounds for refuse (100 pounds for recycling) was extracted from the pile and pre-weighed to verify that the minimum sample weight was achieved and to prevent sorting overly large samples, which would diminish sorting productivity. Bulky items and large quantities of homogeneous items may have been weighed and recorded at the tip floor, thereby eliminating the need to sort them at the sort table.

2.4.3 Transport of Refuse Samples

During the refuse sample collection portion of this study, OCRRA staff transported each collected sample of waste from the Covanta Onondaga facility to the Rock Cut Transfer Station across the road where the samples were manually sorted. Samples were collected in containers provided by MSW Consultants and transported by OCRRA with the use of a stake-body truck to the sort location. During the recycling portion of field data collection, samples were collected in an area of the MRF in close proximity to where the sort crew was stationed, and did not require transport.

2.4.4 Collection of Multi-Family Refuse and Recycling Samples

During the spring and fall 2019 field data collections, OCRRA, with the assistance of two private sector haulers, organized the collection of waste and recyclable samples from vehicles dedicated solely to collection from multi-family apartments. These vehicles were identified in advance such that the Field Supervisor, scale house, and loader operator could readily identify the truck upon arrival. Upon tipping its load, the Field Supervisor and loader operator collected the required number of random grab samples from the single load. This was accomplished by rotating the location of each grab sample around the clock face as previously described; although in this case, multiple multi-family samples were collected from a single load.

2.4.5 Tipping Floor Safety During Sample Collection

MSW Consultants performed the sample collection for the manual sorting at Covanta Onondaga RRF and the Waste Management Recycle America MRF. The Field Supervisor was the only staff member that was permitted on the tipping floor. At all times tipping floor protocols were followed, some of which were standard procedure, some of which were designed for this Study.

A meeting was held on the first day of each refuse sorting season to emphasize the elements of tipping floor safety and to ensure that all parties understood the sample collection and safety procedures. Daily safety meetings were held each morning thereafter.

2.4.6 Vehicle Selection – C&D Debris

MSW Consultants performed the visual characterization of C&D loads at the Ley Creek Transfer Station in Liverpool, New York. Similar to the refuse and recyclables sample collection strategy, the n^{th} vehicle method was used, based on the estimated daily arrivals of C&D debris loads to the facility.

MSW Consultants deployed one professional staff person to coordinate with the scale house, tip area spotter, and inbound deliveries to select loads for surveying. A front-end loader operator provided assistance in spreading the loads from time to time so that the entirety of the loads could be observed. On most occasions, the driver of the targeted vehicle was instructed to spread the load out during the tipping process.

2.5 MANUAL SORTING

2.5.1 Sorting Procedure

At the outset of each season, the Field Supervisor and/or Crew Chief conducted a detailed training session in the morning of the first day of the sort. The training covered all aspects of site safety and health guidelines, as well as the procedure of sorting and weighing samples. Guidance was provided throughout the manual sorting process to improve productivity. Training included:

- General facility overview;
- Learning and reviewing the material categories and definitions;
- Facility-specific health and safety requirements;
- Personal protective equipment (PPE) requirements;
- Waste handling techniques; and
- Productivity strategies and daily sorting quotas.

Figure 2-2 and Figure 2-3 present the typical layout of the sorting table and bins into which each material group was sorted. During this phase of field work, a well-organized sort area was crucial to efficient and accurate sorting. Generally, maintaining a consistent sort area improves safety by establishing boundaries for all workers to follow consistently.

Figure 2-3 Typical Manual Sorting Layout

Once the sample was acquired and placed on the sorting table, the material was sorted by hand into the predetermined material groups. Plastic 20-gallon bins with sealed bottoms were used to contain each material group. The sorting crew members typically specialize in categories of materials, such as papers, metal, or plastics.

During the sort, the Crew Chief monitored the homogeneity of material sorted into the component bins, identifying and re-sorting materials that may have been improperly classified. Open bins allow the Crew Chief to see the material at all times and verify the purity of each component as it is weighed, before recording the weight. The materials were sorted to particle sizes of 2 inches or less by hand, until no more than a small amount of homogeneous fine material ("mixed residue") remained. The layer of material ranging from 2-inch down to ½ inch was allocated to the appropriate categories based on the best judgment of the Crew Chief — most often a combination of Other Paper, Other Organics, or Food Waste. Note that the sorting method included the use of a customized, sturdy framed sorting table that includes a removable screen, which allows small particles of less than ¼" to pass through to a tray under the screen. These smallest particles were swept into the Dirt/Fines category as a final measure of sorting each sample.

2.5.2 Data Recording

The weigh-out and data recording process is a critical aspect of the data gathering and recording procedure. The Crew Chief oversees all weighing and data recording of each sample. Once each sample has been sorted, and mixed fines allocated into an appropriate category, the weigh-out is performed. Each bin containing sorted materials from each sample is carried over to the scale. Sorting laborers assist with carrying and weighing the bins of sorted material, and the Crew Chief records all data. The Crew Chief uses a tablet computer to record the composition weights. The tablet allows for samples to be tallied in real time so that field data collection can immediately identify and rectify errors associated with light sample weights. Each sample is cross-referenced against the Field Supervisor's sample sheet to assure accurate tracking of the samples each day. The real-time data entry system offers several important advantages:

- The system contains built-in logic and error checking to prevent erroneous entries.

- The system sums sample weights in real time so the Crew Chief can confirm achievement of weight targets for each and every sample.
- At the end of the workday, the tablet is synchronized with the cloud via cellular signal, providing data security.

During both seasons of the study, each sample was entered into an electronic form. The Crew Chief also carried paper field forms as a back-up in case the tablet computer encountered unforeseen technical difficulties. Screen shots of the tablet data collection forms are included in Appendix C.

Throughout the manual sorting process, the crew was under close supervision of the Crew Chief. The Crew Chief ensured the sorting protocol was being followed along with the proper health and safety requirements. Lastly the Crew Chief closely evaluated each individual sample to ensure that the material categories were properly understood and used by the sorting crew.

2.5.3 Site Maintenance & Cleanup

The Project Team were guests at each of the host facilities, and it was therefore critical to leave the work area clean and safe for subsequent operations. The sorting crew was responsible for keeping litter to a minimum. The Project Team also concluded each day of sorting operations with sufficient time to perform site clean-up. Clean-up included the following types of activities:

- Organized stacking and stowing of sorting supplies in a designated location;
- Removal of sorted wastes for proper disposal or processing (the host facility equipment operator helped with this);
- Sweeping and cleaning the sort area to prevent windblown litter and other situations that could attract vectors;
- Removal and disposal of day-use personal protective equipment and decontaminating personnel;
- Covering any unsorted samples with a secure tarp, to leave for sorting the next day; and
- Securing the work area and checking out with the Facility Manager each day.

2.6 VISUAL CHARACTERIZATION OF C&D DEBRIS

Visual surveying of C&D waste involves detailed volumetric measurements of the truck and load dimensions, followed by the systematic observation of the major material components in the tipped load. Results of the visual, volumetric estimates are then calibrated against the actual scale weight of the load.

MSW Consultants has developed an advanced tool for visual estimation of C&D and other bulky waste loads that has been refined and calibrated over multiple similar characterization studies. This process relies on a tablet computer to perform real-time density-to-weight calculations so that estimated composition and weight closely correlated to the actual weight of the load.

The visual estimation protocol used the following methodology:

- The dimensions of the incoming load were measured and recorded prior to tipping and (if possible) the percent fullness of the vehicle/container was estimated.
- The load was tipped. If it was a large load of non-homogeneous materials, the loader operator was asked to spread out the material so that it is possible to discern dense materials such as block, brick, and dirt that tend to sink to the bottom of the pile.
- A first pass was made around the load marking the major material groups that were present in the load—wood waste, organics, paper, etc. The percentage of the load made up of these major groups was estimated.

- A second pass was made around the load, noting the secondary material categories contained within each group – for example, within the Wood material group, secondary categories include wooden pallets, sawn lumber, OCC, etc. The percentage of the secondary material category within the primary material groups was then estimated.
- The app alerted the enumerator if there were any problems with the estimations, for example if the percentages did not sum to 100 percent.
- Finally, the app compared the volumetrically calculated weight of the load to the actual scale weight of the load. Possible sources of discrepancy could then be identified, and adjustments to volumetric estimates and/or density factors could be made to reduce the degree of difference. This last step is critical to the accuracy of the data.

2.7 DATA ANALYSIS

2.7.1 QA/QC Procedures

The collection process followed a well-established set of quality assurance/quality control (QA/QC) strategies to ensure data accuracy and integrity. The QA/QC process involved the following procedures:

- Assigning a unique combination sample number, facility of origin, date and time to each sample, and transferring that information to tablet computer that was used to record material weights for the sample.
- Encoding the type of waste load into the sample number. For example, on a particular date, samples of ICI waste could be numbered ICI-1, ICI-2, etc.
- Using a vehicle selection form to track the numbers of each type of load obtained and sampled.
- Verifying that data forms were obtained for each day the data collection crew was in the field.
- Designing the data entry databases to prevent out-of-range values for vehicle and sample characteristics such as vehicle type, net weight, etc.
- Random checks of computer-entered data against the Field Supervisor's tally sheets, to verify that all numbers were being entered correctly, and to look for any systematic or random errors.

2.7.2 Statistical Analysis

At the conclusion of each field data collection season, all data was statistically analyzed to determine the estimated weight and estimated mean percent associated with each material group in the samples. For both refuse and recyclables, the analysis produced estimates of the weight and percentage associated with each material group. Consistent with industry standards, the mean composition as well as the confidence intervals were calculated at a 90 percent level of confidence, as described below.

The analysis normalized each sample by converting the sample data from weight to percentage. A statistical analysis was then performed to calculate the mean composition for each of the material groups. The sample mean was determined by (i) summing the weight of each material in each sample; (ii) summing the total weight of all samples, and (iii) dividing the first value by the second value to determine the percent-by-weight composition.

The standard deviation, as well as confidence intervals at a 90 percent level as specified in our proposal, are provided for each material category, as statistically appropriate, as well as major material groups (e.g., "paper", "plastic", etc.).

The following statistical measures were calculated to determine the overall composition of each waste generator sector:

- **Sample Mean**: The sample mean (i.e., the mean calculated based only on the sample data), or average, composition is considered the "most likely" fraction for each material group in the waste stream. The sample mean is determined by (i) summing the weight of each material in each sample; (ii) summing the total weight of all samples, and (iii) dividing the first value by the second value to determine the percent-by-weight composition. Note that the sample mean, while a good estimate, is unlikely to be identical to the population mean value, (i.e., what the value would be if it were possible to have perfect information on the entire waste stream). The significance of the sample mean is enhanced by the standard deviation and confidence intervals as described below:

- **Standard Deviation**: The standard deviation measures how widely values within the data set are dispersed from the sample mean. A higher standard deviation denotes higher variation in the underlying samples for each material, while a lower standard deviation reflects lower variation among the individual samples. The standard deviation is stated in the same unit as the sample mean, which in this case is percent by weight.
- **Confidence Intervals**: When a sample of data is obtained, it is analyzed in an attempt to determine certain values that describe the entire population of data under analysis. For example, in a poll of likely voters, the intent of the poll is to determine the percentage of all voters who support a given candidate, not simply the percentage of voters in the poll who support that candidate. The percentage of voters who support a given candidate in the poll can easily vary from sample to sample; but the percentage of all voters who support that candidate is a fixed value. In our sample of incoming loads of waste, we are not primarily interested in the percentage composition of the sampled loads, but rather in trying to determine what the composition of the sampled loads tells us about the composition of all waste generated. A confidence interval is a statistical concept that attempts to indicate the likely range within which the true value lies. The confidence intervals reflect the upper and lower range within which the population mean can be expected to fall. Confidence intervals require the following:
    - The "level of confidence," or how sure one wants to be that the interval being constructed will actually encompass the population mean;
    - The sample mean, around which the confidence interval will be constructed;
    - The sample standard deviation, which is used as a measure of the variability of the population from which the sample was obtained; and
    - The number of sampling units that comprised the sample (i.e. sample size).

Consistent with industry standards, confidence intervals were calculated at a 90 percent level of confidence, meaning that we can be 90 percent sure that the mean falls within the upper and lower confidence intervals shown. (The converse is also true: that there is a 10 percent chance that the mean falls outside of the sample mean.) In general, as the number of samples increases, the width of the confidence intervals decreases, although the more variable the underlying waste stream composition, the less noticeable the improvement for adding incremental samples.

CHAPTER 3 – RESULTS

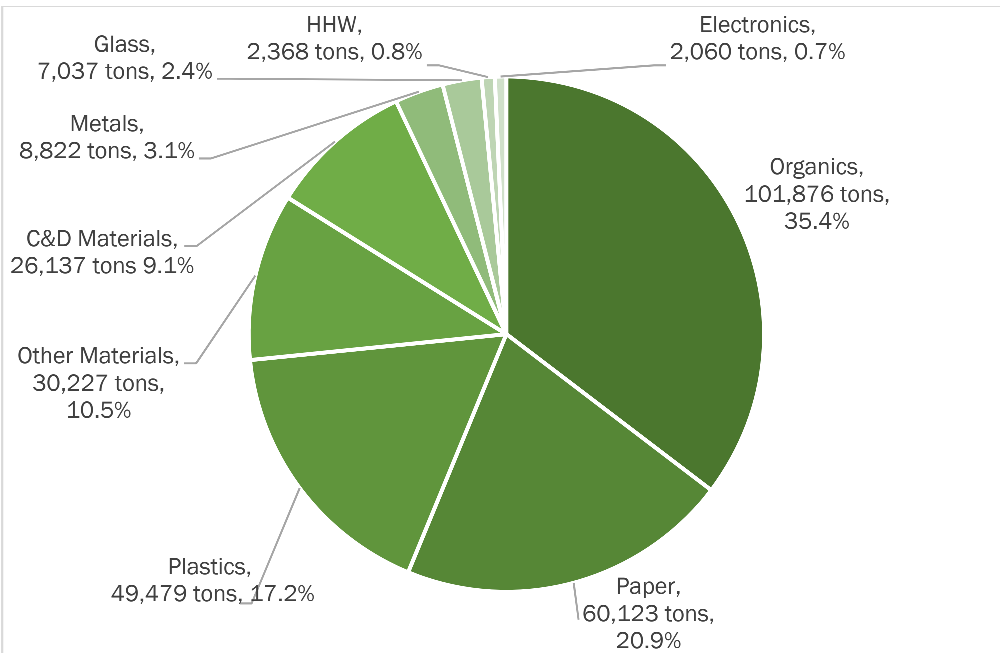
3.1 DISPOSED MSW COMPOSITION

This section provides detailed results of the composition of municipal solid wastes destined for disposal.

3.1.1 AGGREGATE MSW

In 2018, approximately 288,130 tons of MSW were disposed in the OCRRA System. Figure 3-1 provides a summary of the aggregate[1] MSW composition by major material group. As shown, organics comprise the largest fraction of the disposed MSW stream, followed by paper and plastics.

Figure 3-1 Aggregate Disposed Waste Composition



Note: Tonnages in this figure were derived by applying the 2019 composition results to reported 2018 quantities.

Figure 3-2 compares the composition of aggregate MSW from the 2019 and 2005 Studies, measured by percentage. Figure 3-3 shows the same comparison measured in tons. Note that the 2019 Study results reflect tonnages reported by OCRRA for 2018.

[1] "Aggregate" refers to the combination of single family residential, multi-family residential, commercial and institutional municipal solid wastes taken as a whole.

Figure 3-2 Comparison of Aggregate MSW Composition 2019 & 2005, Percentage Composition

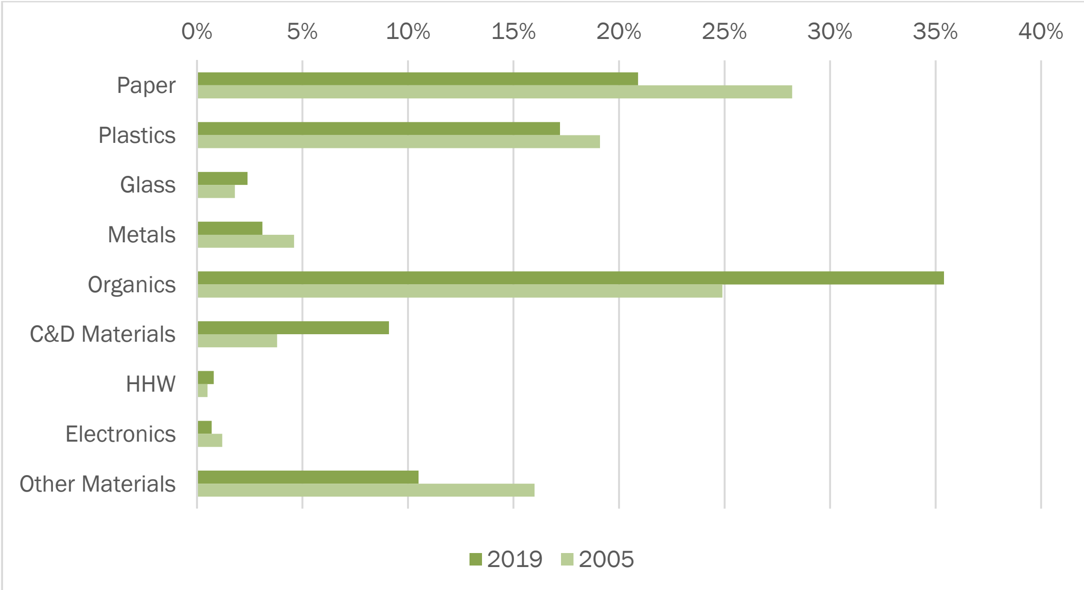
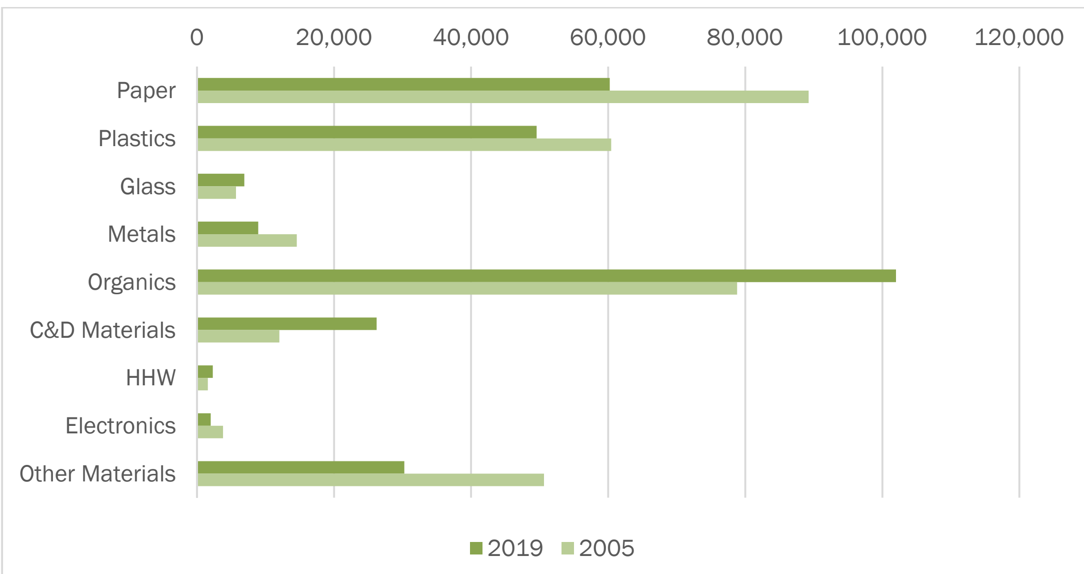


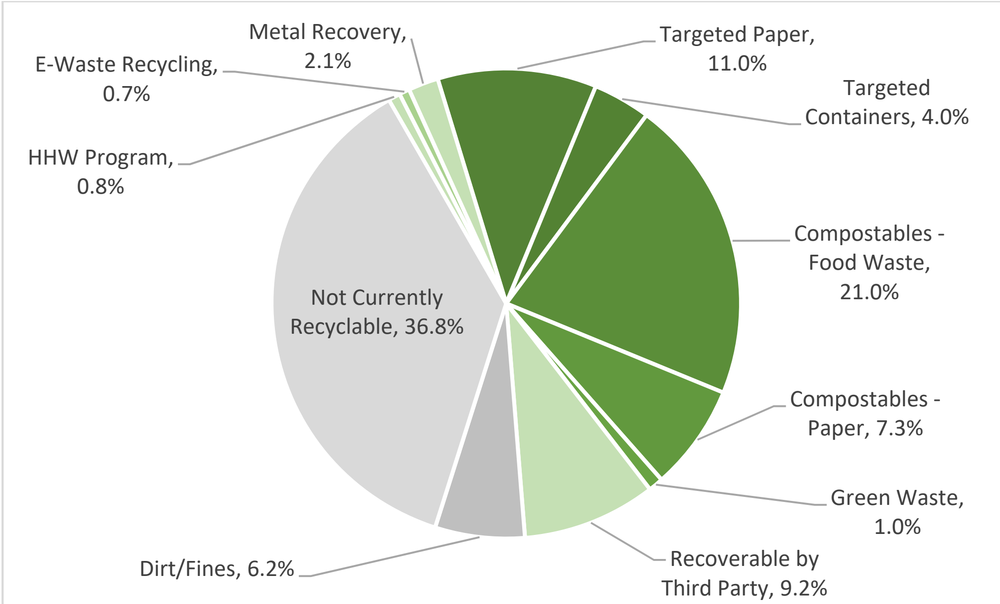
Figure 3-3 Comparison of Aggregate MSW 2019 and 2005, Estimated Tonnage



Note: Tonnages in this figure were derived by applying the 2019 composition results to reported 2018 quantities.

Figure 3-4 provides the recoverability of the aggregate disposed refuse stream as defined in Table 2-6. This graphic shows that about half of the materials being disposed could be diverted through existing recycling programs, composting programs, and third-party recovery programs. It should be noted that this graphic omits the impact of contamination (soiled or compromised recyclable material), and as a practical matter it is not possible for all of the divertible materials to actually be diverted due to human error, lack of participation, or the various challenges inherent in materials recovery processing.

Figure 3-4 Recoverability of Disposed Wastes



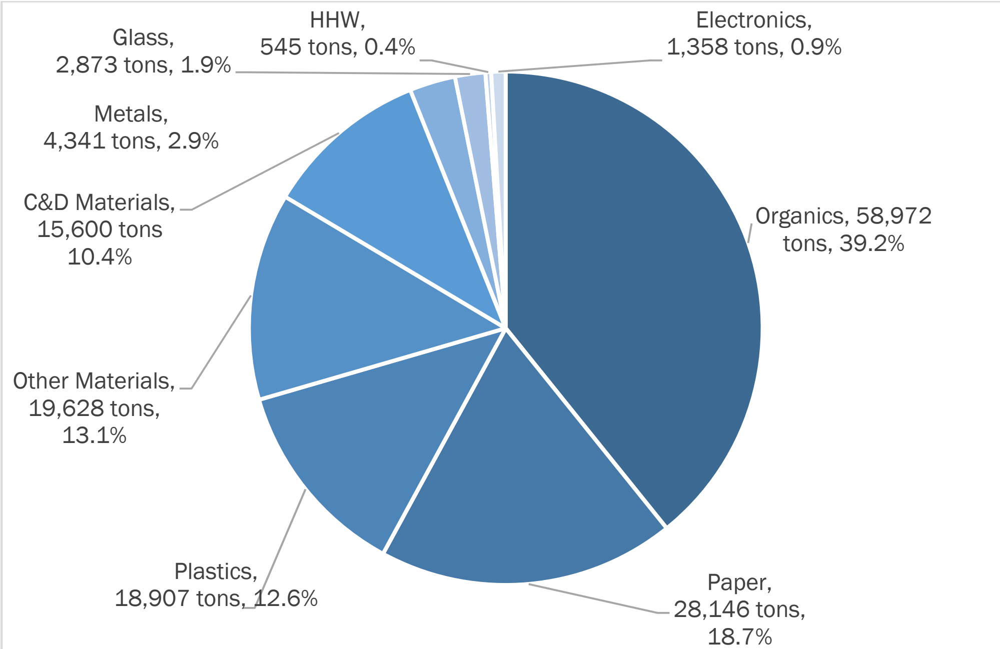
Please refer to detailed composition tables in Appendix A of this report for a complete statistical summary of material composition. The first of these tables, Table A-1, provides a detailed composition of the aggregate refuse stream, including the mean composition and confidence intervals calculated at a 90 percent level of confidence. The table provides adjusted percentages based upon a proportional allocation of the single family residential, multi-family residential, and ICI generator sectors. This table also allocates aggregate disposed refuse tonnage across the material categories.

3.1.2 Residential Waste Composition

The residential portion of the MSW stream is comprised of single and multi-family generators. According to OCRRA gate survey data, approximately 87% of the residential waste stream within the OCRRA System is from single-family households; while the remaining 13% is from multi-family households. (These proportions were also used to disaggregate single stream recycling tonnages, discussed in the next section.)

There was an estimated 150,371 tons of residential refuse disposed in the OCRRA System in 2018 (the most recent year for which tonnage data are available at the time this report was completed). Figure 3-5 summarizes the composition of the residential refuse stream by major material group. Similar to the Aggregate MSW composition, organics and paper are the two most common material groups in residential waste. It should be noted that Figure 3-5 presents the waste composition by material group only and is not intended to identify recyclable materials. The recoverability of materials in this waste stream is provided elsewhere in this section, and the complete composition data for individual material categories is presented in Appendix A.

Figure 3-5 2019 Residential Waste Composition by Material Group and Estimated Tons



Note: Tonnages in this figure were derived by applying the 2019 composition results to reported 2018 quantities.

Figure 3-6 below compares the composition of single and multi-family wastes by material group. Generally, single family wastes contain comparable percentages as found in multi-family wastes.

Figure 3-6 Comparison of Single Family and Multi-family Waste Composition

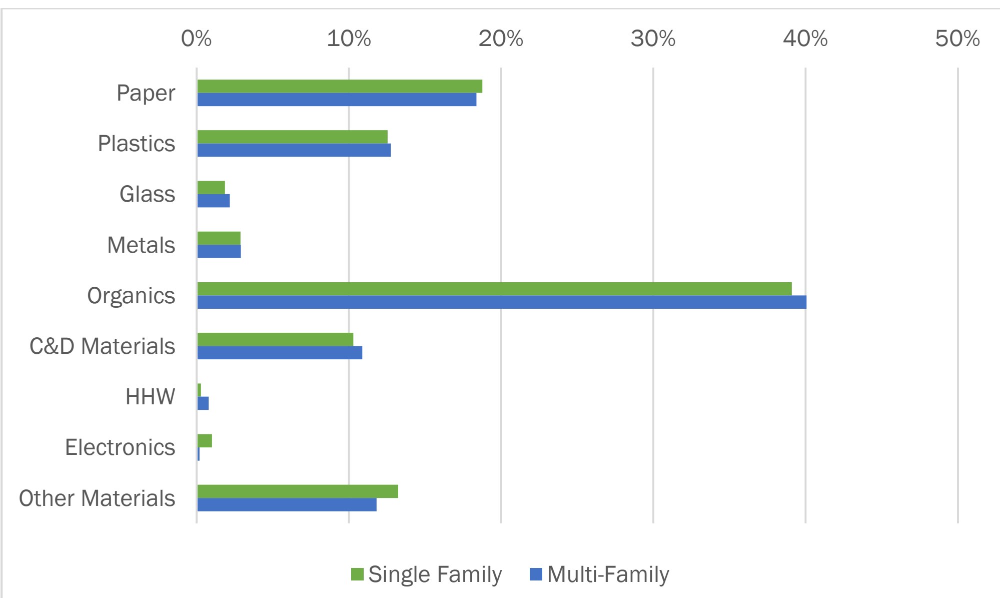


Figure 3-7 compares the composition of Residential wastes between 2019 and 2005. As shown, there has been a decrease in paper waste and plastics, and an increase in organic materials.

Figure 3-7 Comparison of Residential Waste 2019 and 2005, Percentage Composition

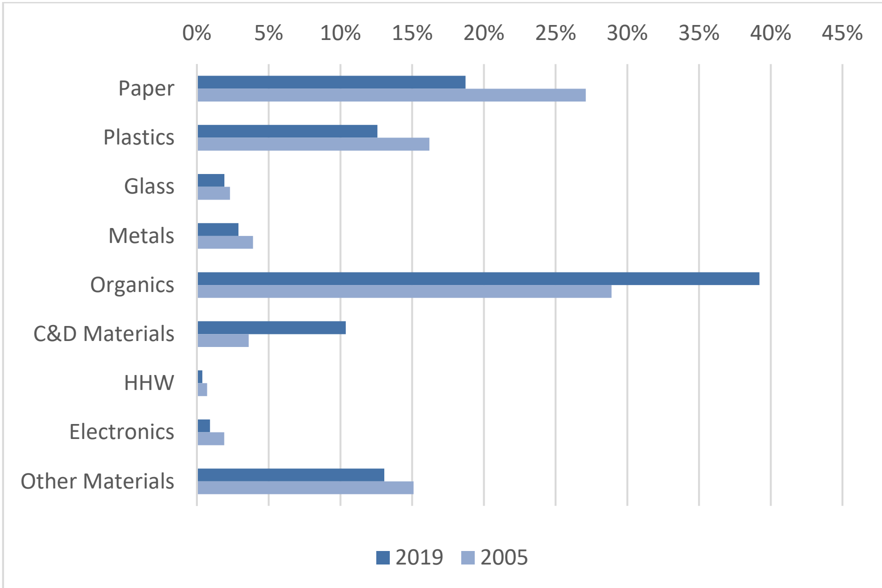
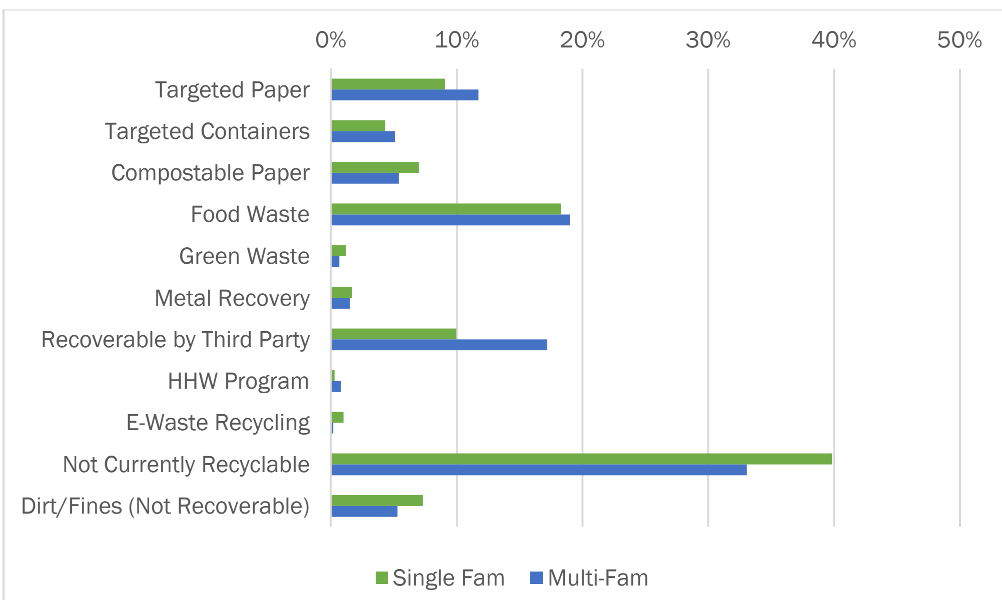


Figure 3-8 shows the recoverability of residential wastes. This graphic shows that slightly more targeted recyclable paper and containers are present in multi-family refuse. This finding correlates with the Capture Rate data (presented at the end of this Chapter), which shows that single family homes are doing a slightly better job of removing recyclables from the waste stream than multi-family residences. Both single and multi-family homes are disposing relatively low percentages of paper and containers materials targeted as acceptable curbside recyclables in the OCRRA system.

Figure 3-8 Recoverability of Single and Multi-Family Residential Wastes



Also note the figure above references "Recoverable by Third Party". As mentioned in Section 2.3.3, this includes plastic retail bags, textiles, carpeting/carpet padding, and clean wood. In Appendix A, Tables A-

2, A-3, and A-4 provide detailed compositions of the residential waste stream, with mean composition and confidence intervals of 90 percent. Disposed residential refuse tonnages are also included.

3.1.3 ICI Waste Composition

There were an estimated 137,755 tons of ICI refuse disposed in the OCRRA System in 2018. Figure 3-9 shows the breakdown by major material group in the ICI waste stream. Although organics still made up the largest fraction, ICI waste contained more paper and plastics as compared to residential waste. It should be noted that Figure 3-9 presents the waste composition by material group only and is not intended to identify recyclable materials. The recoverability of materials in this waste stream is provided elsewhere in this section, and the complete composition data for individual material categories is presented in Appendix A.

Figure 3-9 2019 ICI Waste Composition

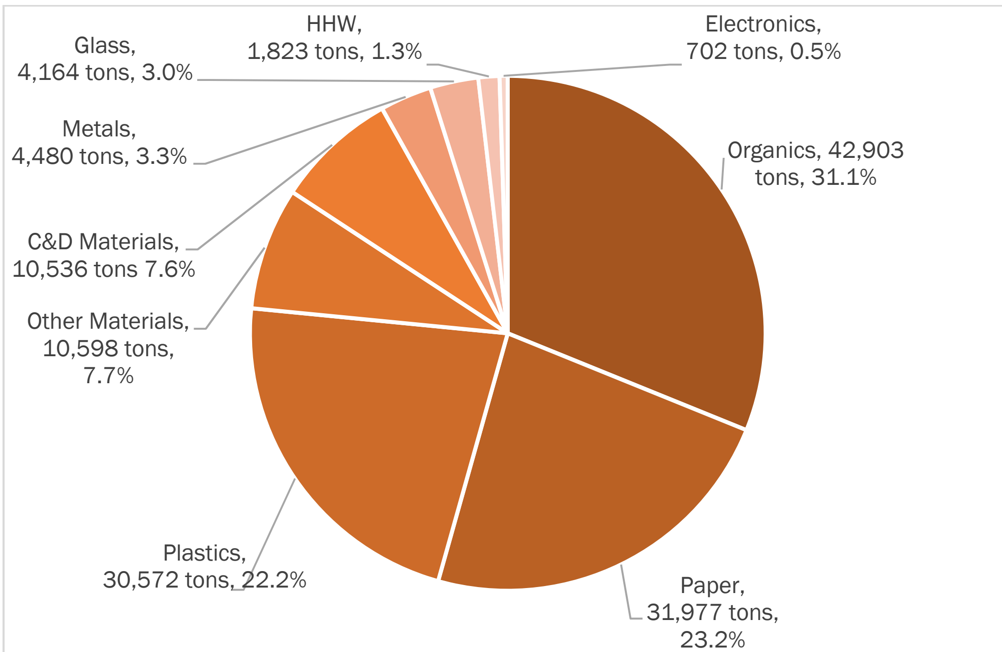


Figure 3-10 provides a comparison of ICI waste between the 2019 and 2005 Studies. The decrease in paper and increase in organics is again reflected.

Figure 3-10 Comparison of ICI Waste 2019 and 2005, Percentage Composition

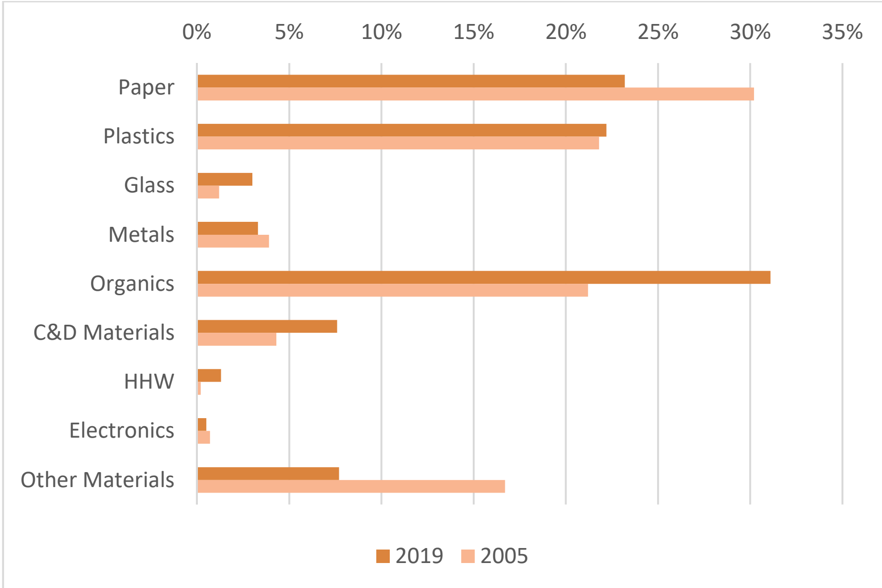
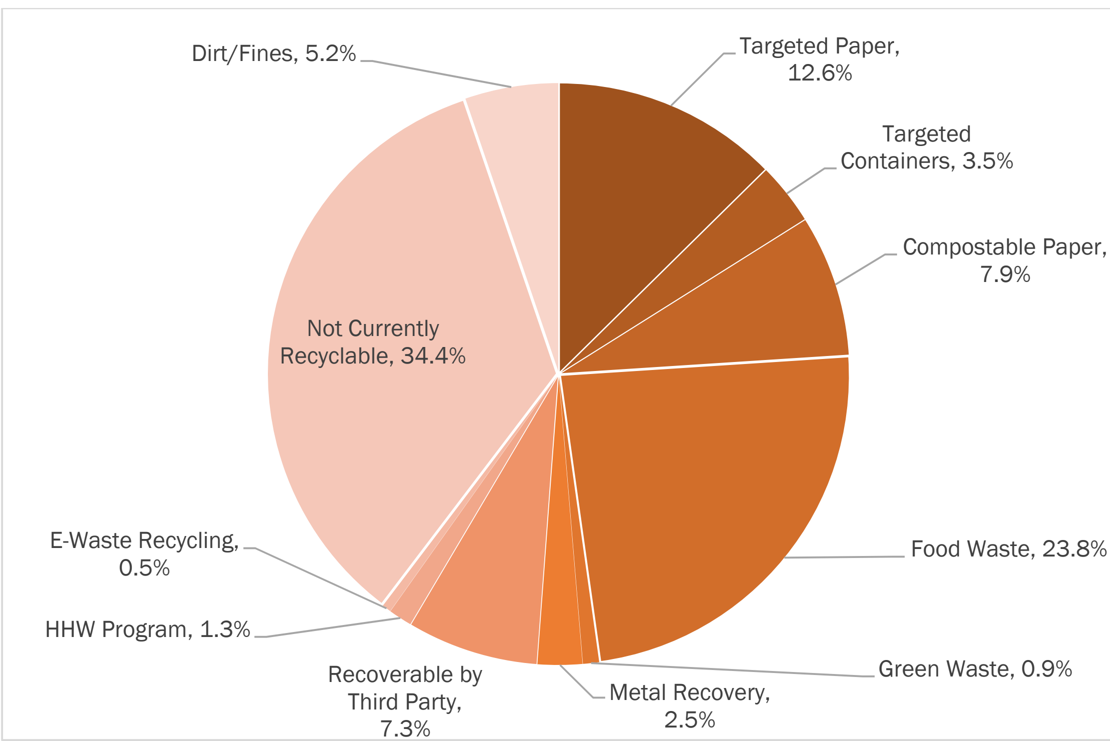


Figure 3-11 illustrates the recoverability of the ICI waste stream. As shown, about 50 percent of the stream could theoretically be diverted from disposal through composting or recycling measures.

Figure 3-11 Recoverability of Wastes in Existing ICI Waste Collection Program



Appendix Table A-5 provides the detailed composition of the ICI refuse stream, including the mean composition, confidence intervals, and allocated tonnages.

3.2 CONSTRUCTION AND DEMOLITION (C&D) DEBRIS

There were 54,832 tons of C&D debris disposed in the OCRRA System in 2018. Figure 3-12 presents the breakdown of C&D debris, using the same material groups as used for MSW. Not surprisingly, much of the composition is shown as material expected to be found in C&D waste, such as wood, concrete, roofing, gypsum board, etc.

Approximately one third of all C&D materials in the OCRRA System cannot be processed at the Waste to Energy Facility because of size, material type, or other limitations. Most of these materials pass through OCRRA's transfer station and are segregated, bulky materials. Metal items are removed and recycled. The materials that remain after this processing that cannot be sent to the Waste to Energy Facility are sent as "by-pass" waste to local landfills for final disposal. However, as can be seen in the next set of graphs, many of the materials that make up the C&D stream are potentially recoverable and alternative methods could be considered to further reduce the quantity of C&D materials that are ultimately disposed. Currently, OCRRA is recovering more than 3,000 tons of metal annually and diverting more than 5,000 tires for possible reuse and recovery. Most of the C&D recoverable materials include metal, cardboard, and wood by-products.

Figure 3-12 Composition of the C&D Waste Stream, Standard Categories

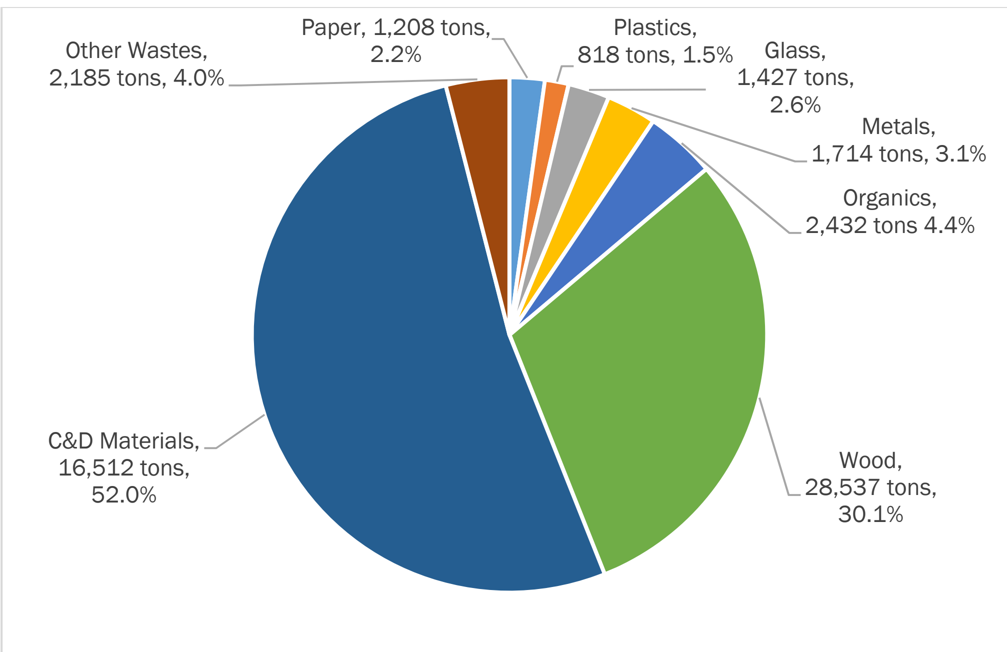
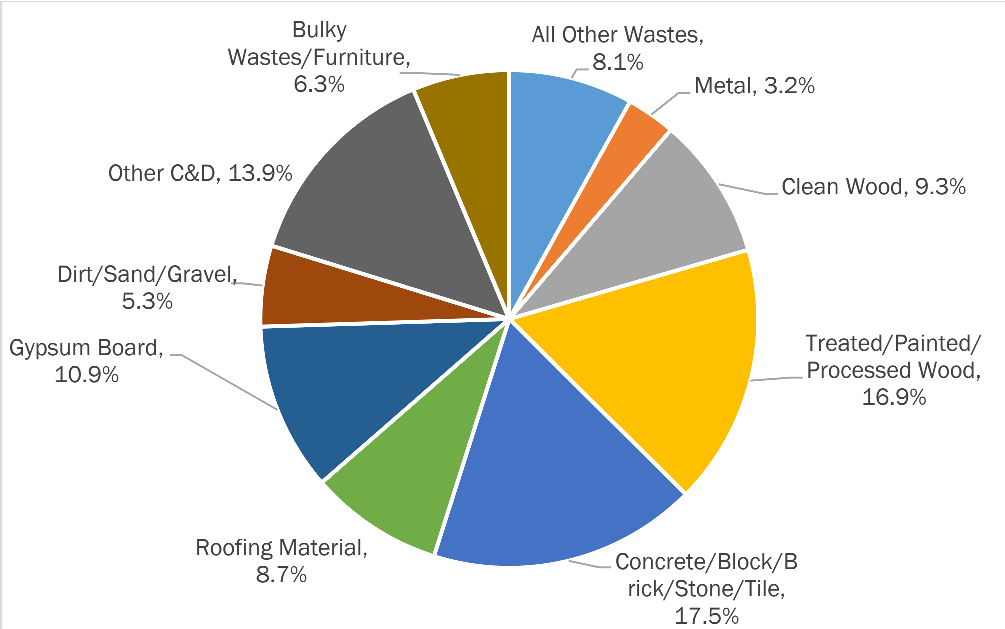


Figure 3-13 presents a more useful breakdown of C&D debris into appropriate material groups. This pie chart shows a broad mix of many constituents in C&D debris.

Figure 3-13 Composition of the C&D Waste Stream, Modified Categories

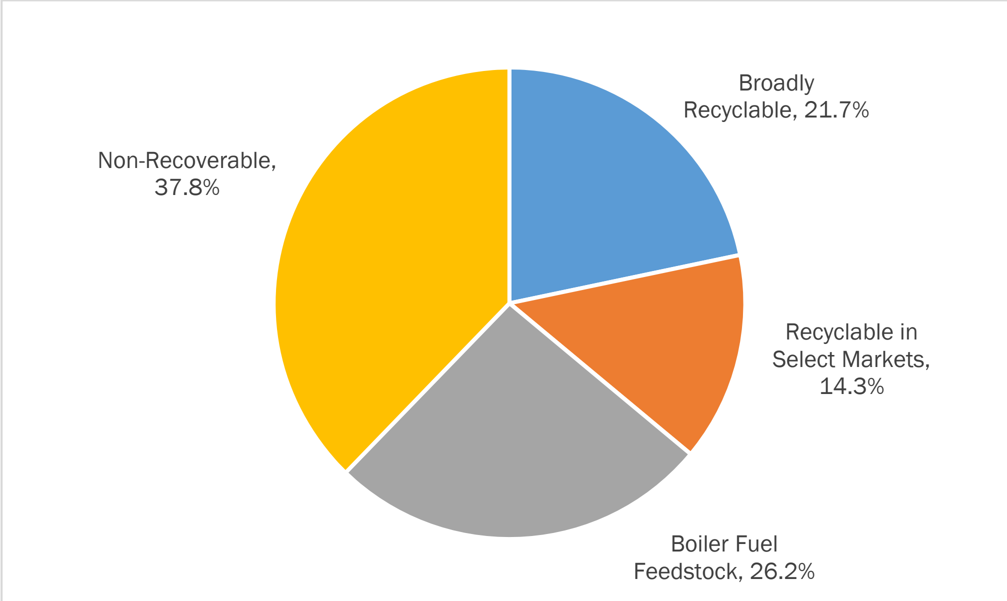


As a final analysis of this generator sector, Figure 3-14 presents the C&D data according to its recoverability as defined in Table 2-7. As suggested in the figure, almost two-thirds of the C&D materials produced within the OCRRA System would be recoverable if it were possible to source separate the materials or else process them through an industrial sorting facility.

For reference, recoverability definitions from Section 2.3.3 are provided below:

1. **Broadly Recyclable**: C&D material constituents which can be recovered through commercial processing of mixed C&D loads throughout most markets. These materials primarily are comprised of ferrous and non-ferrous metal scrap, yard waste, rock/gravel, concrete, brick, block, and asphalt.
2. **Recyclable in Select Markets**: C&D material constituents which can be recovered through commercial processing of mixed C&D loads in some areas. Such material may consist of clean gypsum wallboard, roofing shingles, carpeting and carpet padding, and appliances.
3. **Boiler Fuel Feedstock**: C&D material (wood pallets and crates, dimensional lumber, engineered wood, other wood products) that can be used directly as a fuel, or converted to another form of fuel or energy product.
4. **Non-Recoverable:** Material (from a C&D processing perspective) for which there is no current infrastructure or market to divert from disposal. Includes paper and plastic products, glass, dirt/sand, painted wallboard, ceramic fixtures, HVAC ducting, tires, combined/composite C&D materials, tires, E-Waste, bulky materials, and mixed MSW.

Figure 3-14 Recoverable C&D



Appendix Table A-6 provides the detailed composition of the C&D stream, including the mean composition, confidence intervals, and allocated tonnages.

3.3 RESIDENTIAL RECYCLABLES

In 2018, OCRRA reported 39,096 tons of residential recyclables.[2] In this report section, results are reported in aggregate (single and multi-family recyclables together), single family recyclables, and multi-family recyclables. As single and multi-family residential recycling are collected together in the OCRRA system, MSW Consultants applied the single family/multi-family proportions gathered during the refuse gate survey to calculate the weighted percentage means for each material category. Samples were collected from confirmed single-family residential routes; while multi-family samples were collected from dedicated routes arranged prior to field data collection.

It should be noted that the sample analysis excluded data received from one of the recycling haulers within the OCRRA system, as it could not be confirmed that the recyclables they collected were from exclusively residential sources.

3.3.1 INBOUND RECYCLABLES COMPOSITION

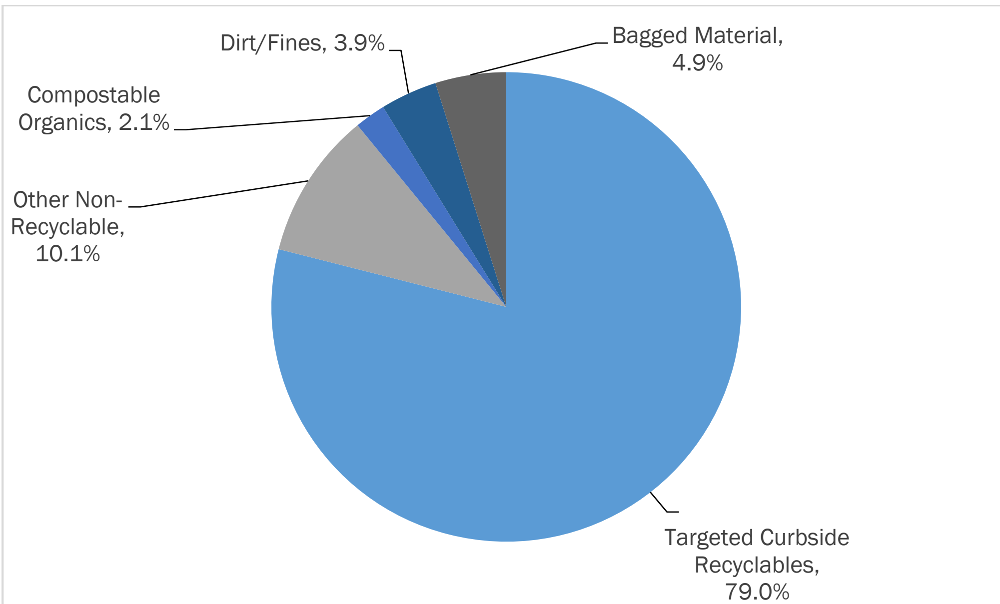
Figure 3-15 provides an unadjusted summary of residential recyclables (single and multi-family combined) encountered during the manual sort. As shown, roughly 79 percent of residential recyclables in the OCRRA System were properly deposited into recycling receptacles, with other, non-recyclable materials consisting of the following:

- **Bagged Materials**: materials in the recycling stream that have been collected in plastic bags. Such items, regardless of contents, are not accepted by the recycling processor. Our unadjusted results indicated that approximately 4.9% of curbside materials arriving at the MRF were composed of bagged materials.

[2] Reported in "2018 OCRRA Recycling Report" as submitted to NYSDEC

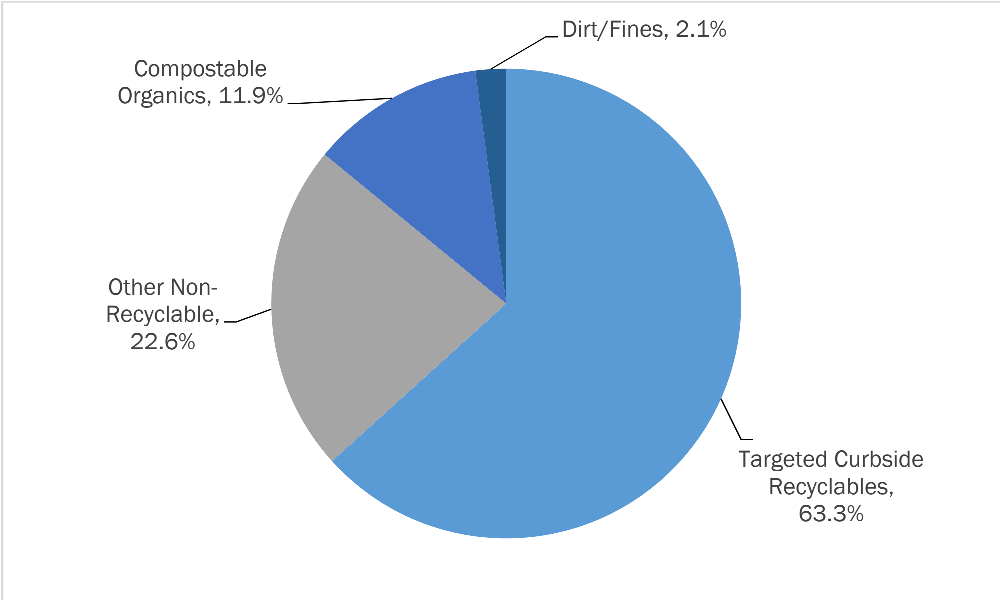
- **Compostable Organics**: compostable paper or food waste not accepted by the recycling processor.
- **Dirt/Fines**: Mix of particulate material that cannot be sorted into a specific category, and therefore is sorted into an aggregated "Dirt/Fines" category. This category includes some smaller particles that may have resulted from breakage during the collection and tipping process (i.e., contamination that was not the result of set-out behavior), as well as food waste residues and other small particles that were improperly placed in the recycling bin (contamination from improper set-outs).
- **Other Non-Recyclable Materials**: Other materials placed in recycling bins that are not accepted in the existing curbside collection program.

Figure 3-15 Residential Recycling Composition, Unadjusted



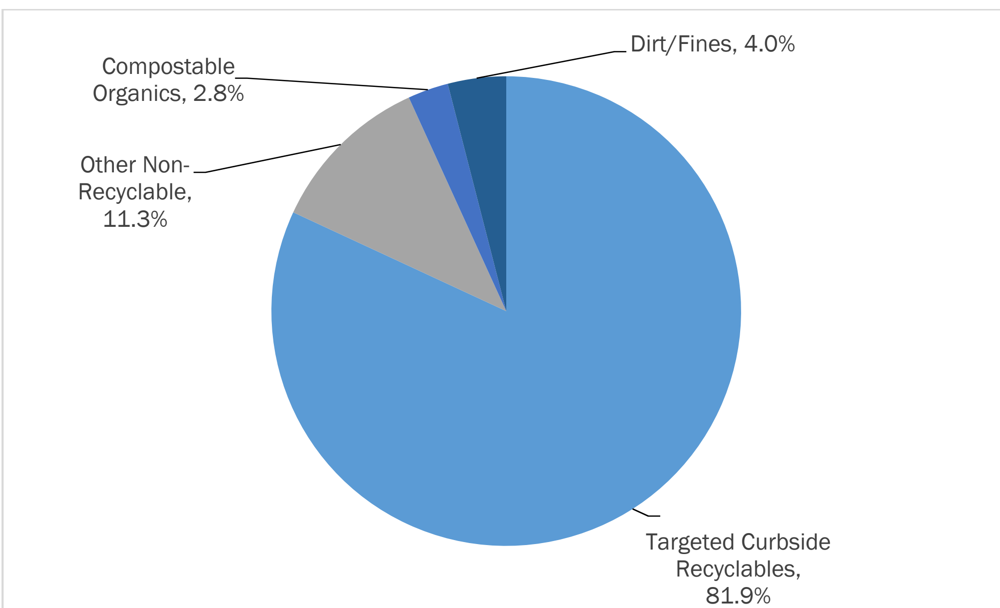
As explained in the Methodology section, bagged materials were initially sorted into a separate material category. Bagged materials were then stockpiled on-site according to disposition (single family bagged material or multi-family bagged material), and then sorted at the end of field data collection activities. Figure 3-16 provides a summary of aggregate bagged material. Not surprisingly the figure reflects a higher incidence of non-recyclable materials in the bags, which suggests that at least a fraction of the bagged materials contained trash rather than bagged recyclables.

Figure 3-16 Bagged Material Composition



As a final step, the bagged material was allocated back into the unadjusted recycling composition. The adjusted composition of inbound recycling is summarized in Figure 3-17. As a result of this adjustment, the incidence of recycled materials increased slightly compared to the unadjusted composition. Stated another way, there is a modest benefit in extracting recyclables from bagged wastes that arrive at the processing facility

Figure 3-17 Adjusted Residential Single Stream Recycling Composition



In Figure 3-18 below, a comparison of recyclables in single and multi-family samples is presented. This figure summarizes the higher recyclable content in single-family residential samples, and the higher rate of non-recyclable materials present in multi-family samples.

Figure 3-18 Comparison of Single Family and Multi-family Recycling Composition

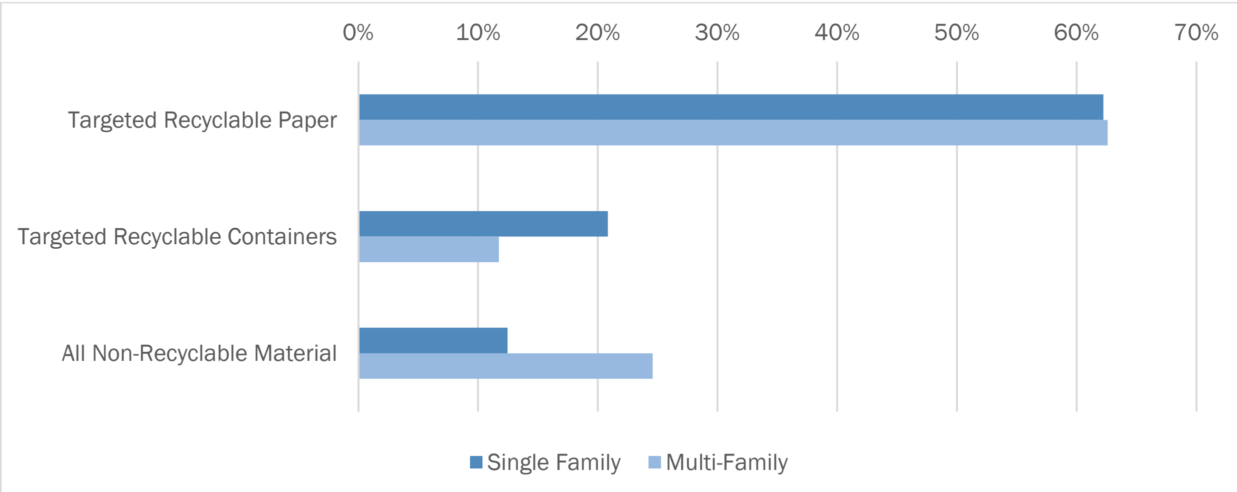


Table 3-1 identifies the overall most prevalent contaminants (i.e., items not accepted for recycling at the MRF) in the residential Recycling Stream, with comparisons to single and multi-family generator sectors. Note the significantly higher contaminants of Food Waste and Remainder/Composite Plastic in the Multi-Family recyclables.

Table 3-1 Most Prevalent Contaminants in Residential Recycling

Contaminant	Residential Percentage	Single Family Percentage	Multi-Family Percentage
Food Waste	1.8%	0.9%	6.7%
Remainder/Composite Glass	1.6%	1.7%	0.2%
Other Non-Recyclable Paper	1.4%	1.4%	1.0%
Remainder/Composite Plastic	1.4%	0.9%	3.6%
Compostable Paper	1.0%	0.7%	1.8%
All Other Film	0.8%	0.6%	1.2%
Other Ferrous Metals	0.6%	0.5%	0.9%
*Dirt & Fines**	*4.0%*	*4.4%*	*1.1%*
All Other Contaminants	*5.6%*	*3.1%*	*0.6%*
Totals	**18.1%**	**14.2%**	**17.2%**

* Table note: *Dirt & Fines* includes some smaller particles that may have resulted from breakage during the collection and tipping process (i.e., contamination that was not the result of set-out behavior), impacts from transport and processing, as well as food waste residues and other small particles that were improperly placed in the recycling bin (contamination from improper set-outs).

Figure 3-19 and 3-20 provide a comparison of Residential Recycling between the 2019 and 2005 Studies. As reflected in the refuse data, the most significant change was a decrease in paper from 74 percent in 2005 to 65 percent in 2019. This represents a decrease of about 5,800 tons annually, which is most likely due to reduction in daily newspaper publication from seven to three days per week.

Figure 3-19 Comparison of Residential Recycling 2019 and 2005, Percentage Composition

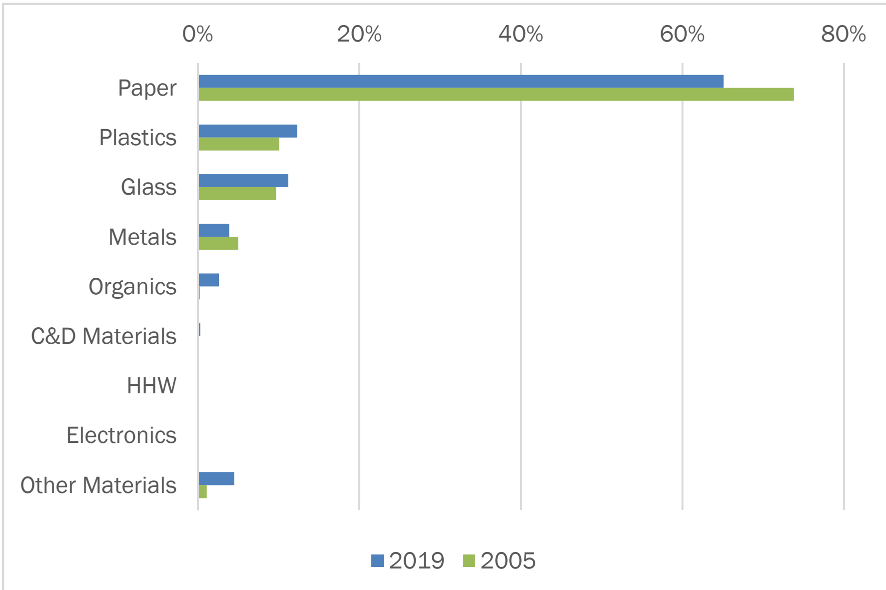
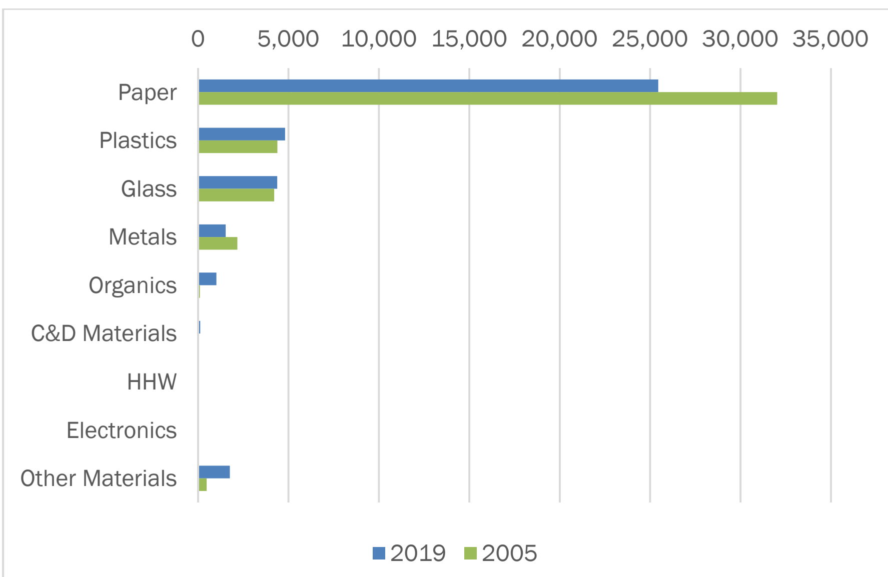


Figure 3-20 Comparison of Residential Recycling 2019 and 2005, Estimated Tonnage



In Appendix A of this report, Tables A-7, A-8, and A-9 provide detailed recycling composition results of Residential Recycling, Single Family Recycling, and Multi-Family Recycling. As these are the adjusted results, bagged materials have been allocated into the composition percentages.

3.3.2 Bagged Materials Composition

Figure 3-21 below presents a comparison, by general material category, of the composition of single and multi-family bagged materials. Significantly higher paper quantities were found in single family bagged materials, while multi-family bagged materials revealed significantly higher levels of organics.

Figure 3-21 Comparison of Curbside & Multi-Family Recycling Bagged Materials Composition

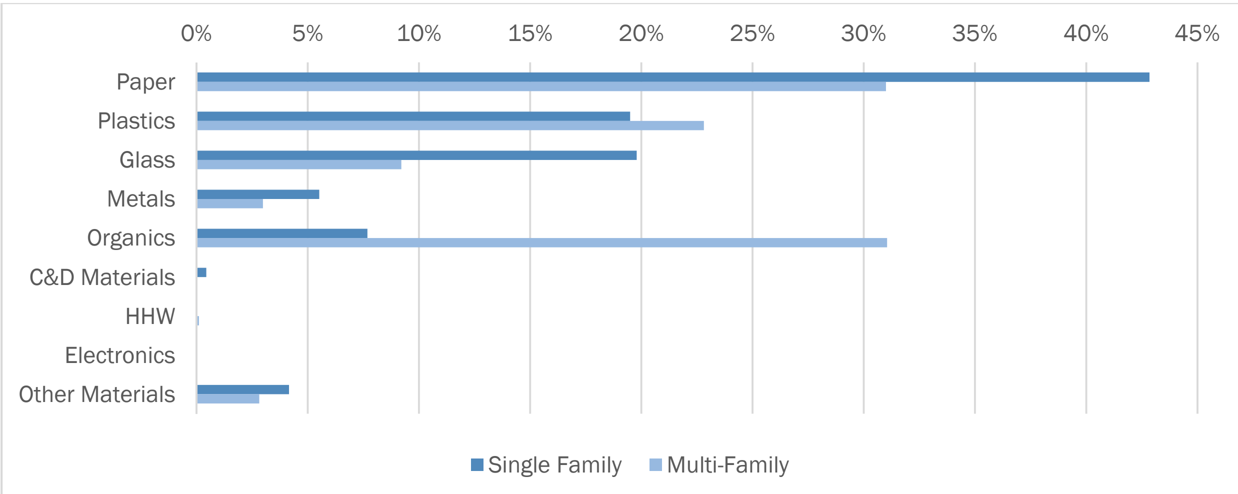
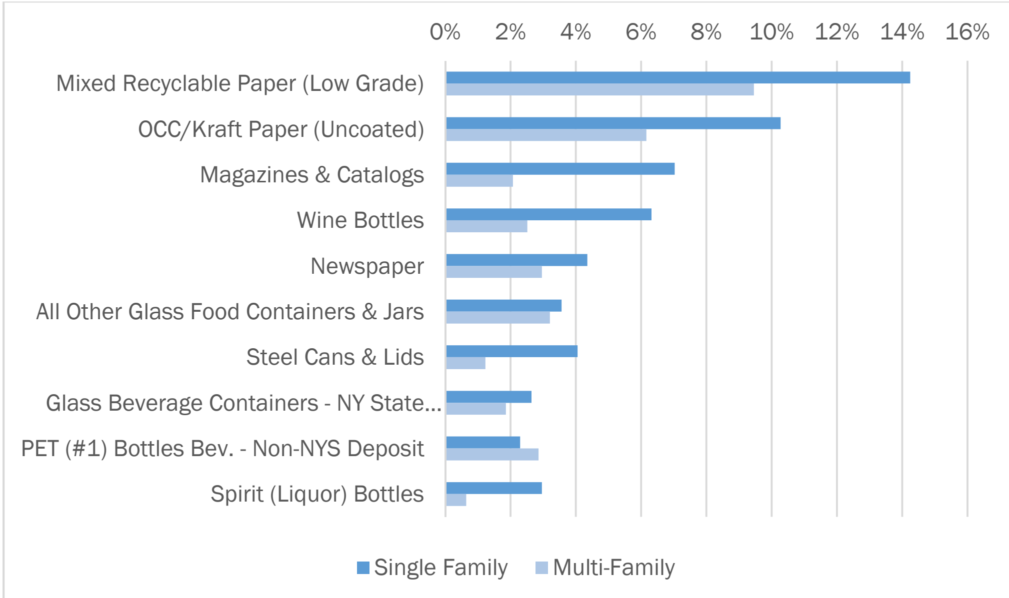


Figure 3-22 below presents a comparison of the top ten recyclable materials found in single and multi-family bagged materials. From this chart it can be seen that higher quantities of recyclables are present in single-family recycling than multi-family recycling. This could be due to a tendency among single-family residents to store recyclables in bags prior to placing them in collection carts and moving them to the curbside.

Figure 3-22 Top 10 Recyclable Materials in Bagged Materials - Comparison of Curbside and Multi-Family Results



Please refer to Table A-10 in Appendix A for a detailed composition table comparing single family and multi-family bagged materials.

Table 3-2 below presents the overall recycling rate from residential sources. This table provides the nominal recycling rate of 20.6% (amount of material diverted to the MRF), as well as the adjusted recycling rates of 16.9% and 17.7%, in which the tonnage of non-recyclable materials observed in the inbound residential recycling stream during the manual characterization were netted from the amount of material delivered to the MRF. Two rates were provided, one including Dirt & Fines and one excluding Dirt & Fines, since it is assumed a significant portion of this material results from the MRF process, and is not necessarily the result of improper set-out behavior (food waste residues and other small particles that were improperly placed in the recycling container).

Table 3-2 Residential Recycling Rates, 2018 Reporting

Stream	Tons	% of Total
Estimated Disposed Residential Refuse	150,370.7	79.4%
Residential Recyclables to MRF	39,096.0	20.6%
Total	**189,466.7**	**100.0%**
Residential Recyclables minus Non-Recyclables (including Dirt & Fines)	32,023.1	16.9%
Residential Recyclables minus Non-Recyclables (excluding Dirt & Fines)	33,592.6	17.7%

3.4 CAPTURE RATES

An important metric for recycling programs is the Capture Rate. The Capture Rate is defined as the percentage of a targeted recyclable material that is actually diverted in the recycling program. High capture rates indicate that the majority of available recyclables are being correctly recycled; conversely, low capture rates identify materials that are not being effectively recycled in the existing recycling program. Several organizations in the recycling industry, notably the Recycling Partnership (TRP), have been actively pushing for greater use of the capture rate to measure recycling program performance.

The capture rate for all residential recyclables was found to be 57.7 percent. While comparative capture rate data points are scarce, in the professional opinion of MSW Consultants a capture rate of 50 percent is roughly the average for curbside recycling programs. This suggests that Onondaga County's recycling program performance is above average compared to other communities nationally.

Figure 3-23 shows the capture rates for the materials targeted in the OCRRA recycling program. As shown, some constituents are captured at a high rate which suggests wide awareness of the recycling of those items. Other materials have lower capture rates, which suggests that recycling could increase within the current program parameters simply through wider participation in the program for all targeted materials. Low capture rates for certain beverage containers subject to the NY State Returnable Container Act (Bottle Bill) show positive impact of that separate material recovery system.

Figure 3-23 Capture Rate of Targeted Recyclables

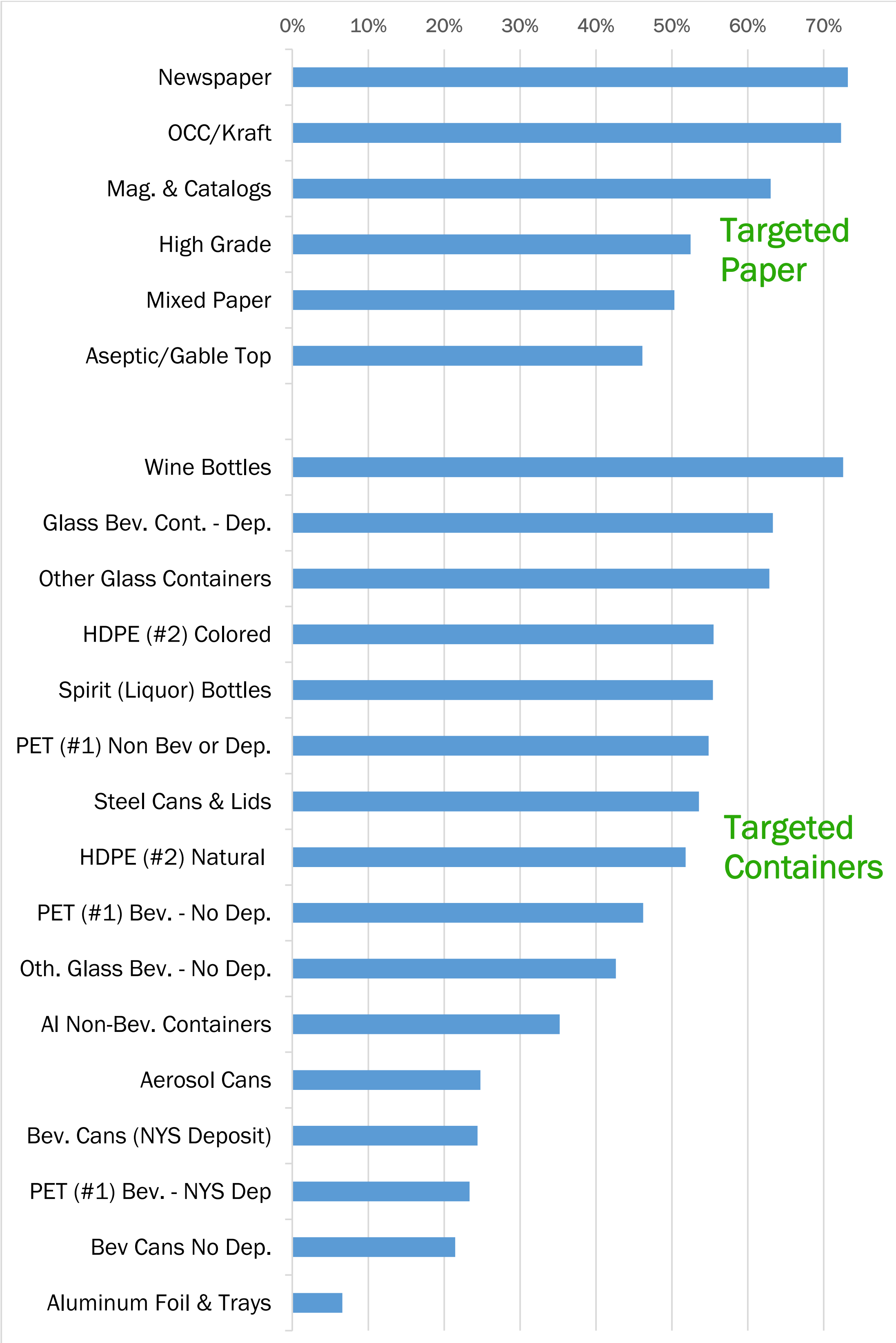


Table 3-3 provides capture rate data for combined residential recycling, as well as individually for the single and multi-family generator sectors.

Table 3-3 Recycled Material Capture Rates

	Residential Recycling Capture Rates		
Targeted Material	**Combined**	**Single Family**	**Multi-Family**
Paper			
Newspaper	73.8%	79.6%	54.9%
Magazines & Catalogs	64.1%	64.3%	62.0%
OCC/Kraft Paper	70.9%	70.5%	73.3%
Aseptic Boxes & Gable Top Cartons	46.3%	49.0%	30.1%
Mixed Recyclable Paper (Low Grade)	50.7%	52.5%	37.2%
Office Paper (High Grade)	49.2%	51.5%	12.4%
Containers			
PET (#1) Bottles Bev. - NY State Deposit	23.4%	22.9%	26.7%
PET (#1) Bottles Bev. - Non-NYS Deposit	47.0%	48.9%	29.6%
PET (#1) Bottles Non-Bev. - No Dep.	56.1%	60.7%	29.0%
HDPE (#2) Natural Bottles	52.1%	53.6%	40.0%
HDPE (#2) Colored Bottles	55.8%	56.7%	47.2%
#5 Dairy Tubs	30.0%	33.6%	13.9%
Steel Cans & Lids	54.3%	57.5%	26.4%
Aerosol Cans	24.0%	26.8%	10.5%
Al Bev. Cans (NYS Deposit)	23.9%	24.2%	22.5%
Al Bev. Cans (Non-NYS Deposit)	22.0%	21.6%	30.7%
Al Non-Beverage Containers	37.8%	37.1%	48.5%
Aluminum Foil & Trays	6.7%	7.1%	4.4%
Glass Bev. Cont. – Deposit	63.3%	65.0%	57.9%
All Other Glass Bev. Cont. - Non-Deposit	44.4%	45.2%	36.6%
All Other Glass Food Cont. & Jars	64.3%	67.1%	35.3%
Wine Bottles	73.9%	75.3%	50.1%
Spirit (Liquor) Bottles	57.4%	65.0%	23.3%

CHAPTER 4 – CONCLUSIONS & RECOMMENDATIONS

The 2019 Study significantly expanded the project scope compared to the 2005 and earlier studies. This was accomplished by increasing the number of samples collected from MSW and recycling sources that were collected in 2005, and broadening the study scope to include visual surveys of C&D Debris. The analysis of recycling composition included both unadjusted and adjusted recycling rates based on whether bagged materials were included or excluded, and detailed Capture Rates for targeted recyclables were provided in this update.

MSW Consultants offers the following conclusions and recommendations regarding OCRRA's 2019 Waste Composition Study.

4.1 CONCLUSIONS

- **Diversion Program Effectiveness:** Overall, the relatively low contamination rates and capture rates above 50 percent found in this study for the most prevalent materials in the recycling program suggest that OCRRA's recycling program is performing above the average U.S. curbside recycling program. Combined with metal recovery at the RRF and food waste composting at the Amboy Compost Site, OCRRA appears to be providing an effective diversion program to Syracuse areas residents and businesses.
- **Comparability to 2005 Study:** Despite the differences in data acquisition as described in the Methodology section of this report, a comparison between the two studies has revealed the following:
  - The most significant decrease in the refuse stream was in the paper material group, declining from almost 30 percent in the waste stream in 2005 to just over 20 percent in 2019. This is consistent with the findings of other recent waste composition studies in the nation, and coincides with the rise of digital media, which has led to a decline in the use of newspapers and office paper.
  - The prevalence of Food Waste in the aggregate waste stream increased significantly, from about 14.6 percent in 2005 to 21 percent in 2019.
  - In general, the presence of targeted recyclables in the waste stream decreased from 2005 to 2019 across the paper, plastics, and metals material groups, but increased slightly in the glass material group.
  - Levels of corrugated cardboard increased in the *residential recyclables* stream, from 11.1% in 2005 to almost 28% in 2019. This has been largely attributed to an increase in cardboard used in shipping and home delivery (the so-called "Amazon Prime effect").
- **Differences Between Generator Sectors:**
  - Generally, single and multi-family disposed wastes revealed a similar composition, but with slightly higher percentages of targeted recyclables in multi-family wastes.
  - As expected, ICI wastes differed most significantly from residential wastes in the higher percentages of OCC and food waste found in the ICI stream.
- **Opportunity for Increasing Diversion**: Generally, there is not a prevalence of targeted recyclables remaining in the waste stream; and capture rates are reasonably high for most materials. There may be some opportunity to capture additional OCC from the ICI stream, but increasing the capture of other commodities would be expected to provide only modest increases to diversion. Compostable organics, unsurprisingly, remain the most prevalent material type in the disposed waste stream that could potentially be diverted over time. OCRRA is well positioned to process and manage these materials given such existing resources as the Amboy food composting facility and the potential for additional progress through state programs such as the (pending) Food Recovery and Recycling Act. However, it was beyond the scope of this study to opine on the feasibility of increasing organics

diversion, and significant effort may be required to implement programs that significantly increase the diversion of food wastes and other compostable organics.

- **Composition of Residential Recyclables**: Overall, the study of OCRRA recyclables at the Waste Management Recycle America MRF revealed that approximately 82 percent of materials were characterized as targeted recyclable materials (paper or container), with approximately 14 percent characterized as non-recyclable (contamination), with an additional 4 percent attributed to dirt/fines likely from transport and processing impacts. The national average for recycling contamination is between 20 and 25 percent, which suggests that Onondaga County's recycling program is providing materials that are cleaner than average. The 2019 Study revealed some other significant findings:
  - Contamination rates were much higher among multi-family recycling samples (24 percent) than single family samples (12.5 percent).
  - Along with higher contamination rates, multi-family recycling samples had a higher prevalence of bagged materials than single-family samples (12.7 percent vs 3.7 percent). Characterization of these bagged materials revealed that residents are generally using bags to hold recyclable material (rather than discarding trash in the recyclables), but that multi-family households were more likely to place bags of actual trash (or else bags with high contamination) in the recycling stream.
- **Construction and Demolition Debris:** C&D debris was found to contain significant fractions of multiple materials, including Wood, Concrete/Brick/Block, Roofing Shingles, Wallboard; and smaller fractions of Paper, Plastic, Organics, and Glass. Of particular interest, C&D debris was assessed by its recoverability, revealing that almost two-thirds, or 62 percent, could potentially be recoverable. These materials consist of the following:
  - **Broadly Recyclable** materials such as scrap metal, yard waste and rock/gravel that are commonly recovered through commercial processing of C&D loads. Indeed, metal debris is currently recovered at the Ley Creek Transfer Station in Liverpool, NY.
  - Materials that are **Recyclable in Select Markets**, such as clean gypsum board, roofing shingles, appliances, carpeting and carpet padding that are recoverable in some areas by commercial processing of C&D loads;
  - **Boiler Fuel Feedstock**. C&D material (mostly wood) can be used directly as a fuel, or converted to another form of fuel or energy product.

4.2 RECOMMENDATIONS

- **Continue to Perform and/or Update Waste and Recycling Studies:** Such updates to information could be critical in informing upcoming wine/spirits legislation statewide, while also monitoring recycling successes or challenges, especially in light of ongoing efforts to remind residents to remove bagged materials from the recycling stream.
- **Consider Conducting Periodic Composition Studies at Waste Management Recycle America MRF**: Available industry data (beyond the results of this study) show that the mix of recyclable materials changes over time due to macroeconomic dynamics. This will continue to be felt as packaging shifts from heavier (glass, steel) to lighter (flexible films) materials; and as home delivery trends continue. Combined with fluctuations in secondary material prices, the mix and value of recyclables changes far more dramatically than the mix of refuse. Further, changes (especially increases) in contamination levels will directly impact recycling economics. For this reason, OCRRA should consider performing more routine composition monitoring of its single stream recyclables. Such composition data is critical to the management of processing contracts, as well as for financial planning for the Authority's recycling system.
- **Maintain Public Education and Focus on Minimizing Contamination**: Based on the system's current recycling performance, recycling education programs are evidently effective. Despite this

success, it will continue to be important to maintain this outreach, and to aggressively monitor, educate, and potentially enforce set-out requirements to minimize contamination in the recycling stream. An example of this is the pilot project where OCRRA staff placed tags on bagged materials at curbside as a friendly reminder to residents that recyclables should be loose, and not bagged, when placing them in the recycling containers.

- **Investigate Small Business OCC Diversion**: Relatively small fractions of most targeted recyclables were found to remain in the disposed waste stream. However, the ICI waste stream was found to contain 7.9 percent OCC, which is highly recyclable. Although it was beyond the scope of this study to investigate the basis for this finding, MSW Consultants hypothesizes that much of the OCC likely comes from small businesses that cannot justify onsite OCC recovery or even a separate container for OCC, either because they have not identified OCC recycling as an issue, do not want to incur the extra expense, or do not have space at their place of business to spot a separate OCC container. OCRRA may wish to investigate the generation and potential diversion of OCC from the small business sector in an attempt to incrementally divert OCC from the ICI stream.
- **Residential Curbside Source Separated Organics (SSO) Diversion**: OCRRA has an award-winning organics recovery processing operation at its Amboy Compost Site in Camillus. The operation focuses primarily on commercial and institutional food scraps, as well as food processing waste, and processes several thousand tons of such organics annually. This facility and program are already targeting the high-volume food waste generators of the region and converting these food scraps to compost. In other areas of the country (often with more aggressive state-level recycling and diversion regulations), capturing food scraps from the residential waste stream for composting, digestion, or other forms of energy recovery is the next logical, though highly challenging, step. While extensive groundwork would need to be laid for curbside SSO collection in Onondaga County, and despite the challenges such residential programs have faced elsewhere, such a program could have the potential to meaningfully reduce the disposal of food scraps and some compostable papers from the residential sector, as well as from other food-generating businesses such as smaller restaurants.

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