Commercial Organic Materials Characterization

King County
Department of
Natural Resources and Parks
Solid Waste Division

Waste **Prevention** | *Resource* **Recovery** | *Waste* **Disposal**

www.kingcounty.gov/solidwaste

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1. Summary

1.1. Background

As part of King County's Waste Monitoring Program in 2019, Cascadia Consulting Group conducted a characterization study focused on the organic materials coming from commercial businesses across King County, except for those from the City of Seattle. The County aims to better understand the incoming loads and Material Recovery Facilities (MRFs) that process recoverable material—including organic materials as well as single-stream curbside recyclables—from residential and commercial sources in King County. This document describes the methods and outcomes of this materials characterization study of incoming commercial organics loads destined for organics processing. (A second component of this study beginning in mid-2019 will address MRFs handling single-stream recyclables collected from King County residents and businesses.)

In this study, 40 samples of incoming commercial organic materials were collected and sorted in March 2019. These samples were derived from at least 40 randomly selected commercial businesses in King County subscribing to the organics collection service provided by Cedar Grove Composting, Inc. A special collection vehicle gathered organic materials set out from 8 to 10 randomly selected businesses each day and brought the material to the sorting location. The 40 samples were sorted into 23 material types divided into three material classes: compostable materials, recyclable materials, and other materials (see Appendix A for *Material Definitions*).

Cascadia analyzed the data from the study to develop estimated composition of incoming commercial organic loads. In addition, Cascadia calculated the composition by the three material classes. For each type of material composition estimate, Cascadia calculated confidence intervals around these percentages at a 90% confidence level.

1.2. Key Findings

The commercial organic materials characterization study results show the following:

- Compostable materials constituted the vast majority of the commercial organics stream. About 88% of the commercial organics was made up of compostable materials with an error range of ± 3.6%.
- The study categorized food found in the commercial organics stream into edible and non-edible portions, as defined in Appendix A. Overall, edible food represented about 33.4% of the commercial organic materials, while non-edible food represented 30.7% of the material stream.
- The top 5 material types by percent composition were edible mixed food (19.1% ± 3.0%), non-edible mixed food (14.4% ± 3.9%), non-edible fruits and vegetables (13.7% ± 2.6%), edible fruits and vegetables (11.2% ± 4.3%), and compostable paper (11.1% ± 1.9%).
- Compostable plastics, such as plastic bags and film, food packaging, and utensils and straws formed about 4.7% of the total commercial organic materials stream composition by weight.

- Recyclable materials made up about 8.8% ± 3.1% of the commercial organics stream. The large majority of this material, 7.3% ± 3.0%, was recyclable paper including non-coated paper and bleached polycoated paperboard cartons normally recycled in curbside collection programs when not significantly contaminated.
- Recyclable plastics, metals (ferrous and non-ferrous), and glass were each less than 1%.
- The remaining 3.4% ± 1.2% of the total composition was formed by non-compostable and non-recyclable materials. Other plastic represented the largest portion of these contaminants at 1.9% ± 0.4%.
- No yard waste or homegrown fruits and vegetables were found in the samples. These findings could be a result of a combination of factors such as business type and location, seasonality, random selection of businesses, and/or alternative yard waste collection arrangements.
- Quantities of organic materials collected from businesses in King County (outside Seattle) were estimated at approximately 37,000 tons in 2018, as collected by Cedar Grove, Recology, Republic Services, and Waste Management.
- The distribution of collection service levels, container sizes, and geographic locations suggests that sampling from Cedar Grove, which collects a large majority of the total commercial organic materials generated in the study area, provides a reasonable representation of the commercial organics stream in King County outside of the City of Seattle.

1.3. Overview of Report

This document is divided into the following sections:

- Section 1 provides the summary of the study.
- Section 2 includes the objective, the fieldwork schedule, and the methodology for sample selection and sorting.
- Section 3 details the data analysis procedures and the underlying calculations.
- Section 4 presents the study results.
- Appendix A describes the material categories and definitions used in the study.

2. Methodology

2.1. Objectives

Since 1990, the King County Solid Waste Division has conducted its Waste Monitoring Program to help plan for future community needs, improve services, and track progress toward recycling goals. The Program assesses how much and what types of materials King County's residents and businesses generate, dispose, and recycle. In 2019, the County aims to assess material flows—including organic materials as well as single-stream curbside recyclables—through local Material Recovery Facilities (MRFs) that process recoverable material from businesses and residents in King County. Cascadia Consulting Group conducted this organic materials characterization study on behalf of King County in 2019.

This organic materials characterization study is intended to create a detailed picture of the commercial organics stream in King County through the collection and sorting of materials from businesses in King County. This study aims to help the County identify recoverable materials, such as food scraps and other organics, and assess physical contaminants, such as plastics. This work is intended to support efforts to increase diversion, reduce contamination, and identify opportunities for strengthening markets for compost and recyclables.

2.2. Sampling Universe

The "sampling universe" refers to the population that was targeted for sampling. In this study, the sampling universe consisted of commercial businesses in King County that subscribe to commercial organics collection services. Commercial businesses that fall within the City of Seattle were excluded from the study. The study focused on samples derived from commercial businesses that subscribe to commercial organics collection services provided by Cedar Grove.

Quantities of organic materials collected from businesses in King County (outside Seattle) were estimated at approximately 37,000 tons in 2018. Cedar Grove is the single largest collector of commercial organics in King County, with a smaller remaining portion collected by franchised haulers (Recology, Republic Services, and Waste Management).

For this study, we assumed that the businesses that subscribe to other haulers are comparable to those who subscribe to Cedar Grove in terms of their size, solid waste profile and behavior, and service requirements. Considering the variation in container sizes and business locations, we believe that sampling from Cedar Grove was reasonably representative of the total commercially collected organic materials generated in King County outside of Seattle.

2.3. Sampling Schedule

Cascadia conducted the fieldwork for the study during the first quarter of 2019, from Monday, March 25, through Friday, March 29, 2019. We believe that this sampling period captured organics generation behavior by commercial businesses in the beginning, the middle, and the end of their typical business week in a "typical" time of the year (that is, non-holiday season) and after collection activities had returned to their standard pattern following the disruption of the large snowfall in February 2019.

Table 1 provides an overview of the fieldwork schedule. Sample collection typically occurred during the early morning of the fieldwork day. To optimize time and resources, some samples collected on the fieldwork day were sorted on the following day.

Table 1. Fieldwork Schedule

Fieldwork Day	Samples Collected	Samples Sorted (Sample Collection Day)
Monday, 3/25/2019	8	2 (Mon)
Tuesday, 3/26/2019	8	6 (Mon) + 4 (Tue)
Wednesday, 3/27/2019	8	4 (Tue) + 6 (Wed)
Thursday, 3/28/2019	8	2 (Wed) + 8 (Thu)
Friday, 3/29/2019	8	8 (Fri)
Total	**40**	**40**

2.4. Sample Selection

Sample selection process was divided into two processes:

- **Load selection**: The process of selection of businesses within King County that subscribe to Cedar Grove's organics collection service.
- **Sample collection**: The process of extracting sample from the special collection vehicle.

The following sections provide further details on these processes.

2.4.1. Load Selection

Cedar Grove provided Cascadia with a confidential list of businesses that subscribe to Cedar Grove's commercial organics collection service in King County outside of Seattle. This list was anonymized (did not contain business names) and included information such as service levels, collection days, and city. Cascadia used a Microsoft Excel workbook to filter the list of businesses by their collection days and randomly select 16 businesses (8 targeted businesses and 8 contingencies) for each sampling day.

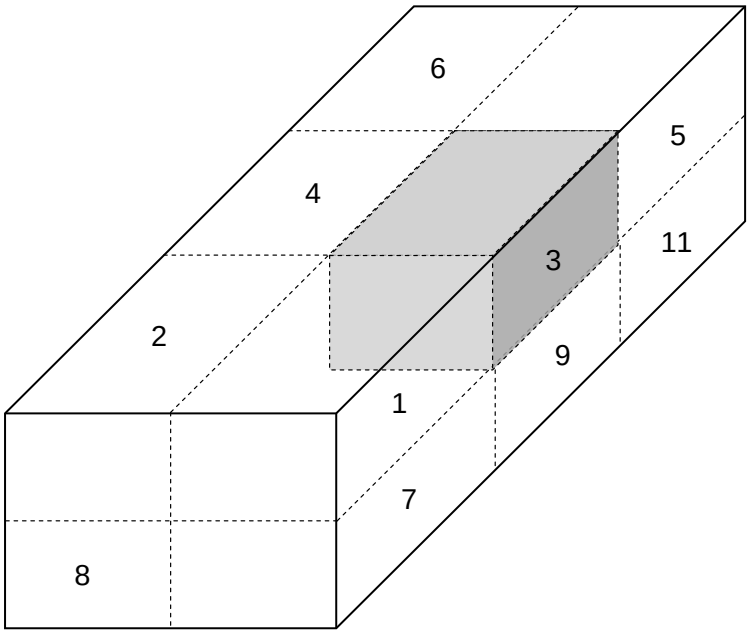
Cedar Grove arranged for a special sampling vehicle to collect material from the list of pre-selected businesses on each collection day. If the organics container was found empty at a given business, then the driver of the special collection vehicle collected from the next nearest business on the list. The special collection vehicle collected organic materials from at least 8 businesses on each collection day. After collection, the special collection vehicle delivered the collected material to the Cedar Grove headquarters location in south Seattle. The special collection vehicle was parked at the sorting location, and the samples were typically extracted from this vehicle for sorting on the following day.

2.4.2. Sample Collection

Upon arrival at the sorting location, the fieldwork crew notified the site supervisor that they were ready to receive the special collection vehicle. The site supervisor then instructed the driver to tip the contents of the truck on the tipping floor or a plastic liner.

An imaginary 16-cell grid was superimposed over the tipped material (Figure 1), to support random sampling across the load and avoid bias toward cells that were convenient to sample. The sampling crew extracted materials from 8 randomly selected cells from the grid. The crew followed standard sampling practices and extracted all the contents from the selected cell, approximately 200 to 225 pounds for each sample, either by hand or using shovels to collect materials from the tipping floor. If the designated cell was blocked due to site constraints, an alternate cell was randomly selected.

Figure 1. Grid Applied to Loads for Random Sample Selection



The tipped contents consisted of a mix of material in the organics bins from 8 to 16 businesses daily. The material was from these businesses was mixed together and also compacted to an extent. The mixing of material helped to extract a randomized sample that is not biased toward contents from one particular business.

The sampling crew noted that the contents within the cell selected for sampling often varied noticeably, either by the types of bags used and/or by the contents in the sample, such as coffee grounds or fruit and vegetable trimmings (Figure 2).

Figure 2. Material in Samples

After the crew extracted each sample, the collected contents were placed into 96-gallon carts (Figure 3). The field manager checked the weight of each sample using a pre-calibrated scale. If judged to be too light, additional material was pulled from the same cell area until the desired weight was achieved. Samples determined to be excessively heavy were reduced by removing a homogenous slice of material from the cart.

A sampling placard was placed in each cart for sample identification. The sample carts were stored at the sorting location. A total of 40 samples were extracted in this manner during the fieldwork event.

Figure 3. Samples Extracted in 96-gallon Toters

2.5. Sorting Samples

For sorting, the sample carts were emptied onto a tarp, one sample at a time. The sample identification placard was placed on the emptied material and the sample was photographed (Figure 4).

Figure 4. Extracted Sample with Sample ID

The material was then manually sorted into 23 material types (see Appendix A, Material Definitions).

Figure 5. Sample Sorting

Sorted materials were placed in plastic laundry baskets or barrels for weighing and recording (Figure 6).

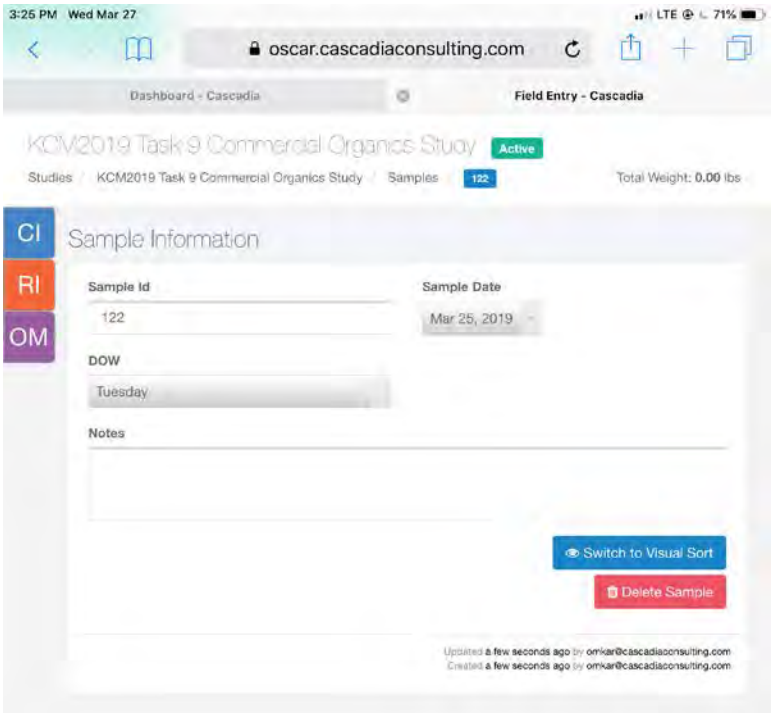
Figure 6. Sample Post-Sorting

The sorted material was weighed using a pre-calibrated scale (Figure 7).

Figure 7. Sample Weighing

The field manager verified the purity of each component as it was weighed and recorded on a digital sampling form on Cascadia's cloud-based database management system, OSCAR (Online Statistical Composition Analysis Repository), customized for this study (Figure 8).

Figure 8. OSCAR Digital Data Entry Form



During fieldwork, the field manager remained on-site during all sorting activities to ensure that the field crew followed approved fieldwork protocols and maintained consistency across samples and sampling events. The field manager ensured that data quality standards were maintained and safety procedures were maintained.

As sorting proceeded, the field manager continually monitored the homogeneity of material in the baskets and re-sorted any materials that were improperly classified. The field manager conducted ongoing quality control review of the entered data, flagging and resolving anomalies, to ensure completeness of information for each sample. In addition, the OSCAR database contains built-in logic and error-checking to prevent data-entry errors. It also sums sample weights so that the field manager can confirm weight targets are being met. The data are automatically synced to a cloud-based storage system, reducing data loss and transcription errors.

After completing the fieldwork on each day, the team cleaned the sorting location and the gear in preparation for the next day of sorting. The field crew collected all equipment at the end of the weeklong sampling event.

3. Data Analysis

3.1. Approach Overview

The following section describes the approach and the calculations that Cascadia used to derive detailed estimates of materials composition based on the sampling data.

The sample data from the sorting process for each sample included the sample ID number, date of collection, total sample weight, weight of each material type, and any notes.

The data was treated with a statistical procedure that provides the following composition information for each of the material types:

- **Estimates of average composition:** The composition data were presented in the form of a detailed table that lists the full composition for the 23 material types.
- **Estimated precision:** All estimates were presented along with statistical error and confidence intervals associated with all estimates at the industry standard 90 percent confidence level. The estimated percentages were rounded to the nearest tenth of a percent.

For example, the estimate of the amount of non-edible fruits and vegetables present in the material stream is 13.7%. The +/-2.6% figure reflects the precision of the estimate. This means that we are 90% certain that the true amount of this material is between 11.1% and 16.3%.

Material Type	Est. Pct.	+ / -
Fruits and vegetables, non-edible	13.7%	2.6%

3.2. Calculations

The following method was used to estimate the composition of materials.

3.2.1. Composition Estimates

The composition estimate for a given component *j* represents the ratio (*r*) of the component's weight to the total weight of all the samples; it is denoted by r_j. This estimate was derived by summing each component's weight across all samples and then dividing by the sum of the total weight of materials for all of the samples, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i} \quad (1)$$

Where:

- *i* denotes an individual sample
- *j* denotes the material component type
- c_j is the weight of the material type *j* in a sample
- *w* is the weight of entire sample
- r_j is the composition estimate for material *j* (*r* stands for *ratio*)
- *a* denotes a region of the state (*a* stands for *area*)
- *s* denotes a particular sector or subsector of the waste stream
- *n* denotes the number of samples in the particular group that is being analyzed at that step

For example, the following simplified scenario involves three samples. For the purposes of this example, only the weights of the component *recyclable paper* are shown.

	Sample 1	**Sample 2**	**Sample 3**
Weight (*c*) of recyclable paper	5	3	4
Total sample weight (*w*)	80	70	90

$$r_{paper} = \sum \frac{5+3+4}{80+70+90} = 0.05$$

The resulting composition is 0.05, or 5 percent. In other words, 5 percent of the sampled material by weight is recyclable paper (in this hypothetical example).

3.2.2. Precision Estimates

The confidence interval for this estimate was derived in two steps. First, the variance around the estimate was calculated, accounting for the fact that the ratio included two random variables (the component and total sample weights). The variance of the ratio estimator equation follows:

$$\mathrm{Var}(r_j) \approx \left(\frac{1}{n}\right)\left(\frac{1}{\overline{w}^2}\right)\left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n-1}\right) \quad (2)$$

Where:

$$\overline{w} = \frac{\sum_i w_i}{n} \quad (3)$$

For more information regarding Equation 2, refer to *Sampling Techniques, 3rd Edition* by William G. Cochran (John Wiley & Sons, Inc., 1977).

Precision levels at the 90 percent confidence level were calculated for a component's mean as follows:

$$r_j \pm \left(z\sqrt{\mathrm{Var}(r_j)}\right) \quad (4)$$

Where:

z = the value of the *z*-statistic (1.645) corresponding to a 90 percent confidence level.

4. Results and Discussion

The average weight of the samples was 206 pounds. Table 2 shows the estimated composition of the commercial organic materials stream. Key findings include the following:

- Compostable materials constituted the vast majority of the commercial organics stream. About 88% of the commercial organics was made up of compostable materials with an error range of ± 3.6%.
- The study categorized food found in the commercial organic materials stream into edible and non-edible portions, as defined in Appendix A. Overall, edible food represented about 33.4% of the commercial organics stream, while non-edible food represented 30.7% of the commercial organic materials.
- The top 5 material types by percent composition were edible mixed food (19.1% ± 3.0%), non-edible mixed food (14.4% ± 3.9%), non-edible fruits and vegetables (13.7% ± 2.6%), edible fruits and vegetables (11.2% ± 4.3%), and other compostable paper 11.1% ± 1.9%).
- Compostable plastics, such as plastic bags and film, food packaging, and utensils and straws formed about 4.7% of the total commercial organic materials stream composition by weight.
- Recyclable materials made up about 8.8% ± 3.1% of the commercial organics stream. The large majority of this material, 7.3% ± 3.0%, was recyclable paper including non-coated paper and bleached polycoated paperboard cartons normally recycled in curbside collection programs when not significantly contaminated.
- Recyclable plastics, metals (ferrous and non-ferrous), and glass were each less than 1%.
- The remaining 3.4% ± 1.2% of the total composition was formed by non-compostable and non-recyclable materials. Other plastic represented the largest portion of these contaminants at 1.9% ± 0.4%.
- No yard debris was found in the samples. This finding may be a result of a combination of factors such as:
    - Seasonality of yard waste generation (with little yard waste generation in early spring when the sampling occurred).
    - Business locations, such as strip malls or central business districts, with little or no green space present.
    - The random selection of businesses (with very little or no yard waste generation).
    - Businesses may have an alternative arrangement for their yard waste collection (e.g., commercial yard waste haulers or professional landscaping services).
- No homegrown fruits and vegetables were found in the samples. This seems logical because the samples were derived purely from commercial businesses (and not from residential households).

Though the timing of this sampling was intended to represent a typical week, for future studies, sampling over multiple seasons may better capture variations in commercial organics generation behavior throughout the year.

Table 2. Composition of Commercial Organic Materials

Material	% Ratio	+/-
Compostable Items	**87.9%**	**3.6%**
Fruits and Vegetables, Edible	11.2%	4.3%
Fruits and Vegetables, Non-edible	13.7%	2.6%
Homegrown Fruits and Vegetables	0.0%	0.0%
Meat, Edible	3.1%	1.2%
Meat, Non-edible	2.6%	1.8%
Mixed/Other Food Waste, Edible	19.1%	3.0%
Mixed/Other Food Waste, Non-edible	14.4%	3.9%
Single-use Food Service Compostable Paper	7.3%	1.9%
Other Compostable Paper	11.1%	1.9%
Yard Debris	0.0%	0.0%
Compostable Plastic Bags and Film	2.5%	0.4%
Compostable Plastic Food Packaging	0.8%	0.3%
Compostable Plastic Utensils and Straws	1.4%	0.3%
Other Compostables	0.7%	0.8%
Recyclable Items	**8.8%**	**3.1%**
Recyclable Paper	7.3%	3.0%
Recyclable Plastic	0.9%	0.2%
Recyclable Metal, Ferrous	0.1%	0.1%
Recyclable Metal, Non-Ferrous	0.2%	0.1%
Recyclable Glass	0.3%	0.2%
Other Materials	**3.4%**	**1.2%**
Other Plastic	1.9%	0.4%
Other Metal	0.1%	0.0%
Other Glass	0.1%	0.1%
Other Materials	1.3%	1.2%
TOTAL	**100.0%**	

The anonymized list showed variation in the size of organics containers of the businesses' subscriptions, ranging from 32-gallon toters up to 40-yard roll-off containers. Also, the number of containers in the subscriptions varied from a single container to multiple containers at a given business. We considered the container sizes as a proxy for the size of business, with smaller bins typically suggesting smaller businesses, while larger containers suggest larger commercial establishments. Accordingly, we believe that the sampling approach represented a variety of business sizes in King County.

In addition, we examined the locations of sampled businesses based on the cities in which they were located. We found that the business locations covered multiple areas around King County. The sampling appears to cover substantial geographic variation of businesses with organic materials collection service.

Appendix A. Material Definitions

Compostable Materials

1. **Fruits and Vegetables, Edible**—The edible portion of food that comes from a plant but does not appear to have grown on the customer's property. Examples include vegetables and fruits. Includes fruits and vegetables in the original or another container when the container weight is less than 10% of the total weight.
2. **Fruits and Vegetables, Non-edible**—The non-edible portions of food that comes from plants. Examples include fruit peels, vegetable peelings and potato skins, pits, cores, and juiced oranges.
3. **Homegrown Fruits and Vegetables**—Food that comes from a plant growing on or cleared from the customer's property. Examples include fruits and vegetables disposed of in the set-out because of falling or pruning from trees and gardens.
4. **Meat, Edible**—The edible portion of non-dairy food that comes from an animal. Examples include eggs and eggs in shell, fresh meat, cooked meat, and meat scraps. Does not include dairy products such as cheese and milk. Includes meat in the original or another container when the container weight is less than 10% of the total weight.
5. **Meat, Non-edible**—The non-edible portions of food that comes from an animal. Examples include egg shells, bones, gristle and meat trimmings, fish skins, and seafood shells.
6. **Mixed/Other Food Waste, Edible**—Any food that cannot be put in the above categories BUT deemed edible. Examples include food items that are a combination of the above categories, as well as unused tea packets, grains, crackers, bread, dairy, and cereal. Includes food in the original or another container when the container weight is less than 10% of the total weight.
7. **Mixed/Other Food Waste, Non-edible**—Any food that cannot be put in the above categories AND deemed non-edible. Examples include food items that are a combination of the above categories, as well as coffee grounds, used tea packets, and visibly non-edible grains, crackers, bread, dairy, and cereal.
8. **Single-use Food Service Compostable Paper**—Includes paper or paper packaging soiled with food that was used in a "single-use food service" capacity. Examples include paper plates, compostable paper cups (no plastic coating), pizza boxes, french-fry containers. Does not include napkins or paper towels.
9. **Other Compostable Paper**—Includes paper soiled with food that was not used in a "food service" capacity. Examples include napkins, paper towels, coffee filters, and tissue. Also includes shredded paper and newspapers used to contain food waste.
10. **Yard Debris**—Includes leaves, grass clippings, sod, garden wastes, brush, prunings, logs, and clumped soil and rocks associated with yard debris.
11. **Compostable Plastic Bags and Film**—Includes compostable plastic items, such as film "plastic" bags made of materials such as corn starch or soy designed to compost (e.g., BioBag, EcoSafe).
12. **Compostable Plastic Food Packaging**—Includes compostable food plastic containers and food packaging that are marked with the words "compostable" or "#7 PLA" in the plastic identifier. Includes materials from food service providers (e.g., restaurants, food trucks, food vendors), grocery stores, and other retailers. Examples include takeout containers, produce packaging, meat/produce trays IF compostable. Does not include utensils and straws.

13. **Compostable Plastic Utensils and Straws**—Includes utensils (e.g., cups/lids, bowls, clamshells, plates, trays, cutlery, and straws) marked with the words "compostable" or "#7 PLA" in the plastic identifier.
14. **Other Compostables**—Other compostable organic materials, not included above, such as hair, popsicle sticks, chopsticks, and toothpicks. Also includes other compostable plastic items.

Recyclable Materials

15. **Recyclable Paper**—Includes non-coated paper and bleached polycoated paperboard cartons normally recycled in curbside collection programs when not significantly contaminated**.** Examples include newspapers (not used to contain food waste), newspaper inserts, corrugated cardboard (waxed or unwaxed), magazines, phone books, junk mail, chipboard, boxboard, egg cartons, printing, writing paper, milk cartons, ice cream cartons, and paper cups with a plastic layer designed to be used for beverages or food (e.g., most to-go coffee cups and fast food soda cups).
16. **Recyclable Plastic**—Includes plastic normally recycled in curbside collection programs when not significantly contaminated. Examples include plastic tubs, bottles, jars, and non-compostable plastic cups usually marked with a #1 or #6 in the recycling code.
17. **Recyclable Metal, Ferrous**—Includes metal normally recycled in curbside collection programs. Includes materials made mainly of steel. These items will stick to a magnet and may be tin-coated. This subtype is used to store food, beverages, paint, and a variety of other household and consumer products. Examples include canned food and beverage containers, pet food cans, and bimetal containers with steel sides and aluminum ends.
18. **Recyclable Metal, Non-Ferrous**—Includes non-ferrous metal items, other than items described previously and may be made of aluminum, copper, brass, bronze. Examples include aluminum soda cans, pie pans and trays.
19. **Recyclable Glass**—Includes glass normally recycled in curbside collection programs when not significantly contaminated. Examples include glass bottles and jars.

Other Materials

20. **Other Plastic**—Any plastic material that does not fit into the above categories. Examples include plastic bags that are NOT made of materials that compost or biodegrade. Examples include plastic corks, expanded polystyrene (non-compostable foam packaging), packing peanuts, plastic gloves, and non-compostable, non-recyclable, single-use plastic food-serviceware.
21. **Other Metal**—Any metal material that does not fit into the above categories. Examples include aerosol cans, and metal tableware and utensils.
22. **Other Glass**—Any glass material that does not fit into the above categories. Examples include drinking glasses, Pyrex and other glass baking dishware.
23. **Other Materials**—Any material that does not fit into the above categories. Examples include grease, foil lined paper products, food service papers coated with plastic, gypsum waste, treated wood, ceramics, pottery, textiles, diapers, pet waste, loose soil and rocks, stumps, demolition debris, and hazardous wastes. Also includes organic items whose durability makes them hard to compost. Examples include wine corks, burlap sacks, pallets, wood crates, and rope.