Residential Curbside 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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FINAL

CASCADIA CONSULTING GROUP

Seattle | Oakland

www.cascadiaconsulting.com

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Table of Contents

Tables

Figures

1. Introduction and Summary

In 2017, the King County Solid Waste Division (SWD) contracted with Cascadia Consulting Group, Inc. (Cascadia) to complete a comprehensive characterization study of the single-family curbside collection program as part of the County's ongoing waste monitoring program. The study sought to understand residential composition and contamination, and generation rates, participation rates, and capture rates for the portion of the single-family population with curbside collection. The study design ensured that the organics results would be comparable to previous organics composition studies from 2009-2014 and provides additional metrics to track progress towards waste diversion goals.

The project team collected all garbage, recycling, and organics set out by nearly 800 randomly selected households. These households provided representative data for each of the County's four main organics service types:

- **Weekly/Embedded**: The resident's organics bins are collected weekly and the organics service is part of a packaged service; it is not chosen separately by the resident.
- **EOW/Embedded:** The resident's organics bins are collected every-other-week (EOW) and the organics service is part of a packaged service; it is not chosen separately by the resident.
- **Weekly/Subscription:** The resident's organics bins are collected weekly and the resident opts-in to organics service for an additional fee.
- **EOW/Subscription:** The residents' organics bins are collected every-other-week (EOW) and the resident opts-in to organics service for an additional fee.

Cascadia also collected data along the collection routes to assess utilization of the curbside collection services available. Households throughout the County can utilize the curbside collection services in four combinations:

- Garbage only
- Garbage and recycling
- Garbage and organics
- Garbage, recycling, and organics

Cascadia collected and hand-sorted samples of material over five field events (approximately every other month from February through October). Each field event lasted for one complete collection cycle, one or two weeks, depending on the service type for that household. Cascadia sorted samples into 15 material types, described in Appendix A: Material Type Definitions.

In 2017, the haulers delivered 220,215 tons of garbage, 106,269 tons of recycling, and 170,141 tons of organics from single-family residences in King County. The characterization results are summarized in this section.

A portion of residents in the county do not have curbside collection and these residents are excluded from the study. It is unknown what portion of residents exclusively self-haul, nor the composition of their waste.

Key Findings

There are over 40 pages of tables and figures summarizing the data collected during this study. Some of the key findings from the study are condensed below.

- **Quantities & Composition**
  - About half, 51%, of material in garbage carts is recoverable (Table 1) meaning it could be recycled or diverted through the available curbside programs.
  - All food material types combined account for 31% of the garbage stream (Table 1).
  - *Recyclable paper* is the most prevalent material in the recycling carts, (55%) (Table 1).
  - Approximately 85% of the organics cart is *yard debris,* 8% is food, and 2% is compostable paper (Table 1).
  - On average, food scraps participant households placed nearly 35 pounds of food scraps and compostable paper in their organics cart per month, an increase of 7% since 2014 (Table 2).
- **Set-outs & Food Scraps**
  - Approximately 74% of households set out a recycling cart each collection cycle (Figure 1).
  - Approximately 37% of households set out an organics cart each collection cycle (Figure 2).
  - About 25% of households placed food scraps and/or compostable paper in their organics cart (Figure 4), an increase of 15% since 2014.
- **Capture rates & Contamination**
  - About 79% of all recyclables were placed in a recycling cart (Figure 3).
  - The overall capture rate for food scraps and compostable paper was 17% (Figure 4), an increase of 27% since 2014.
  - More than half (53%) of recycling carts had a contamination rate less than 5% (Figure 5).
  - Nearly three fourths (74%) of organics carts had a contamination rate less than 1% (Figure 6).

Table 1. Detailed Composition, Single-family Generation

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**39.7%**		**87,443**	**3.7%**		**3,883**	**95.4%**		**162,381**	**51.1%**		**253,707**
Fruits and Vegetables, Edible	5.6%	0.6%	12,360	0.2%	0.1%	243	1.5%	0.4%	2,478	3.0%	0.3%	15,081
Fruits and Vegetables, Non-edible	7.3%	0.7%	16,119	0.1%	0.1%	103	3.6%	0.8%	6,116	4.5%	0.4%	22,338
Homegrown Fruits and Vegetables	0.0%	0.0%	88	0.0%	0.0%	7	0.2%	0.2%	405	0.1%	0.1%	500
Meat, Edible	2.2%	0.6%	4,911	0.1%	0.1%	87	0.4%	0.1%	726	1.2%	0.3%	5,723
Meat, Non-edible	1.8%	0.3%	4,042	0.0%	0.0%	50	0.4%	0.1%	658	1.0%	0.2%	4,750
Mixed/Other Food Waste	13.5%	1.1%	29,690	1.2%	0.4%	1,313	2.3%	0.7%	3,908	7.0%	0.6%	34,912
Compostable Paper	7.0%	0.4%	15,318	1.5%	0.2%	1,622	2.1%	0.4%	3,545	4.1%	0.2%	20,485
Compostable Plastic	0.1%	0.0%	136	0.0%	0.0%	45	0.1%	0.0%	227	0.1%	0.0%	408
Other Compostables	0.6%	0.3%	1,235	0.1%	0.1%	102	0.3%	0.4%	572	0.4%	0.2%	1,910
Yard Debris	1.6%	0.7%	3,543	0.3%	0.4%	312	84.5%	3.2%	143,746	29.7%	1.1%	147,600
Recyclable	**11.0%**		**24,333**	**87.3%**		**92,792**	**0.6%**		**968**	**23.8%**		**118,093**
Recyclable Paper	4.3%	0.5%	9,419	54.9%	2.2%	58,350	0.4%	0.2%	683	13.8%	0.5%	68,452
Recyclable Plastic	3.0%	0.2%	6,696	10.3%	0.9%	10,969	0.1%	0.1%	144	3.6%	0.2%	17,809
Recyclable Metal	1.9%	0.2%	4,233	4.0%	0.4%	4,302	0.0%	0.0%	38	1.7%	0.1%	8,574
Recyclable Glass	1.8%	0.4%	3,985	18.0%	1.5%	19,171	0.1%	0.1%	103	4.7%	0.4%	23,258
Other Materials	**49.2%**		**108,439**	**9.0%**		**9,594**	**4.0%**		**6,793**	**25.1%**		**124,826**
Other Materials	49.2%	2.3%	108,439	9.0%	1.7%	9,594	4.0%	2.4%	6,793	25.1%	1.3%	124,826
Totals	**100%**		**220,215**	**100%**		**106,269**	**100%**		**170,141**	**100%**		**496,626**
Sample Count			762			629			418			1,809

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 2. Key Organics Metrics

	Number of Organics Samples	Avg. Lbs Organics per Month*	Avg. Lbs FSCP per Month*
Overall	**418**	**214**	**35**

* Average for organics or FSCP participants only.

Figure 1. Recycling Set-out Rate by Service Schedule

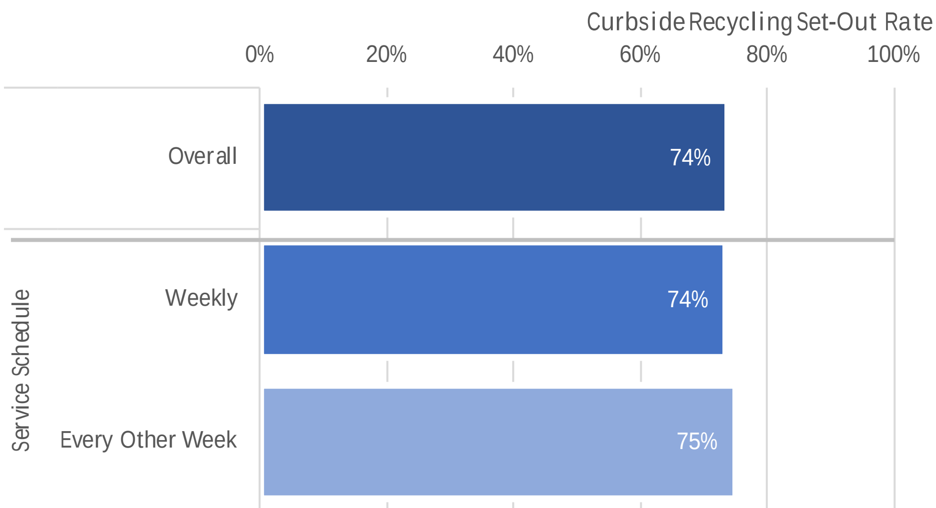


Figure 2. Organics Set-out Rate by Service Schedule and Service Type

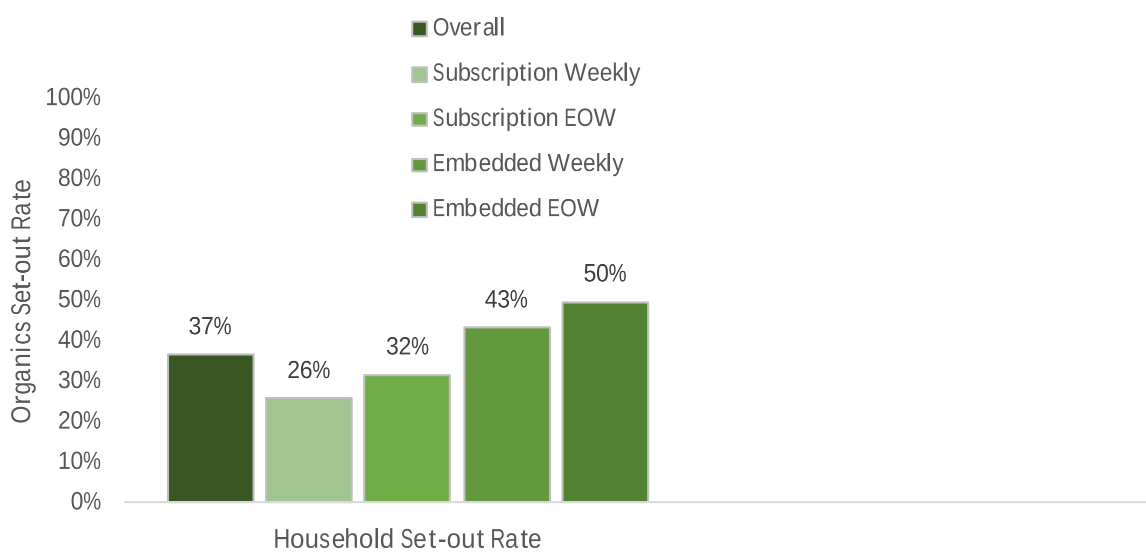


Figure 3. Recyclables Capture Rate by Service Schedule

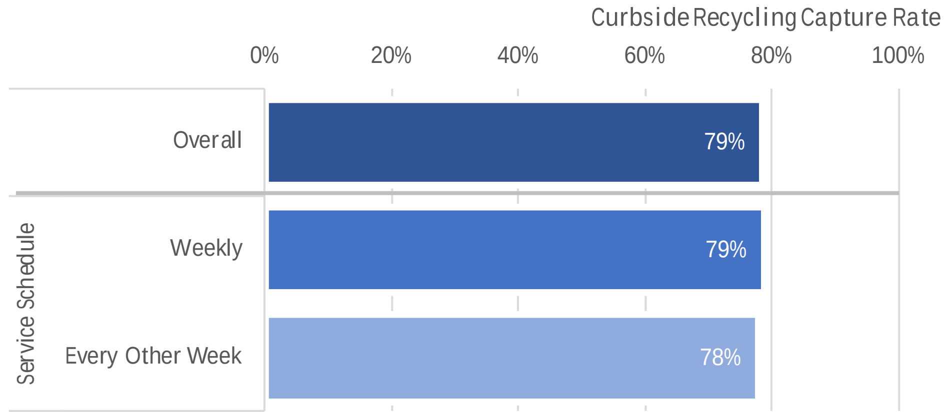


Figure 4. Household Food Scraps and Compostable Paper Capture Rate Over Time

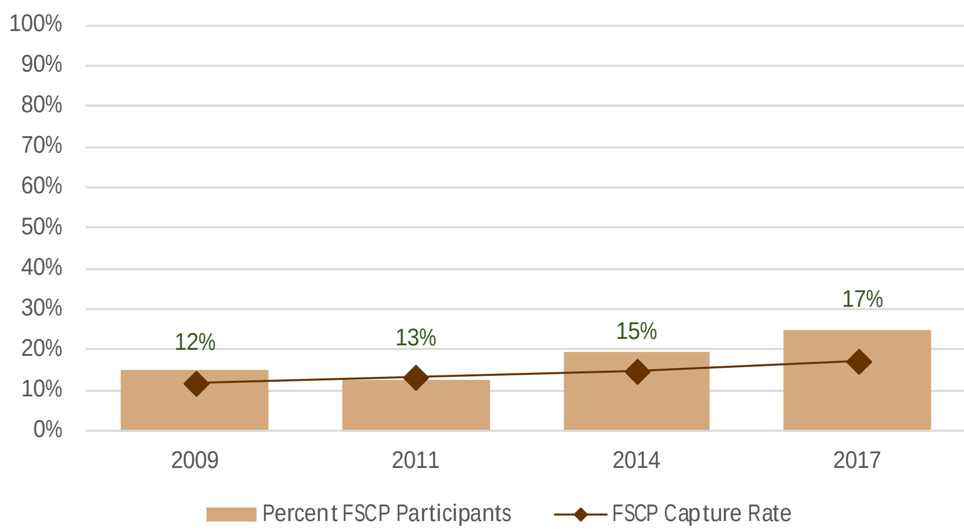


Figure 5. Recycling Contamination Rate Distribution

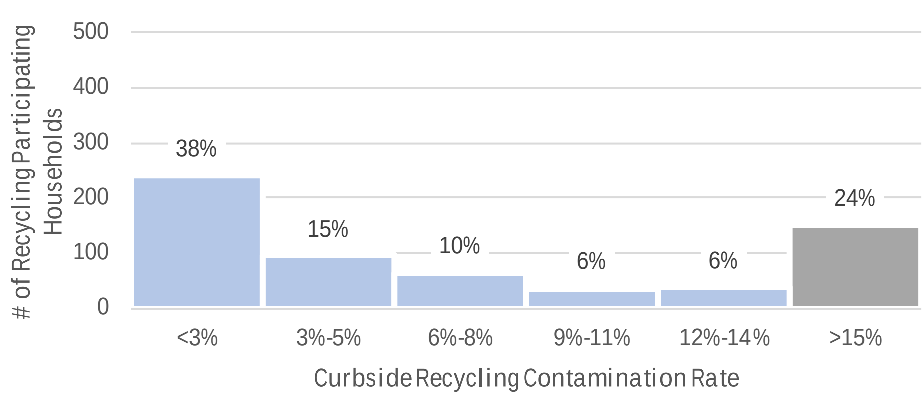
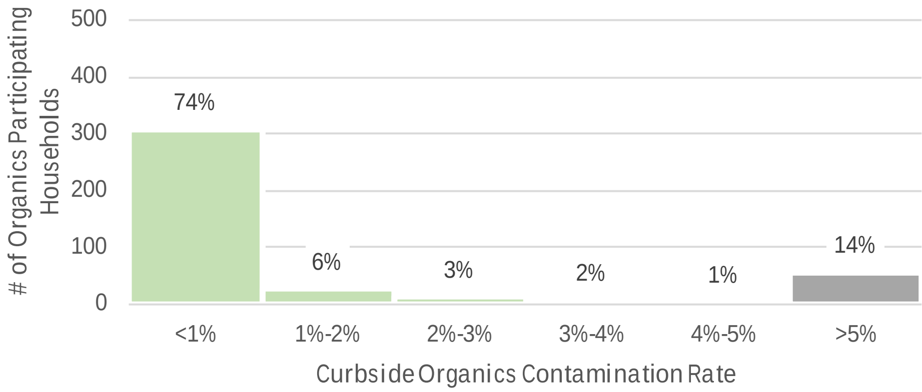


Figure 6. Organics Contamination Rate Distribution



The remainder of this report describes the study methodology and findings, and is organized as follows:

- **Section 2. Summary of Methodology** explains the methodology used to design and implement the data collection portion of this study.
- **Section 3. Findings** presents the study findings.
- **Appendices** follow the main body of the report. They define all material types, provide a complete explanation of the methodology and formulas used in the characterization calculations, and include copies of field forms.

2. Summary of Methodology

This section summarizes the three main steps of the study methodology and highlights the revisions in the methodology from previous studies.

Commonly Used Terms

This study includes several unique terms and definitions. Definitions for these terms are below.

- **King County.** Refers to King County, excluding Seattle.
- **Household or Resident:** For this study, a *household* or *resident* is defined as a single-family residence in King County, excluding the City of Seattle, with curbside garbage collection.
- **Generation:** In this report, *generation* refers to the sum of all curbside collected material: garbage, recycling, and organics. *Generation* does not include self-hauled materials to disposal, recycling, or composting facilities, and it does not include organic material composted or otherwise managed on the residents' property.
- **Recycling Service.** For this study, *recycling service* only includes commercially collected curbside/alley programs.
- **Organics Service.** For this study, *organics service* only includes commercially collected curbside/alley programs where residents may combine food waste, compostable paper, and yard waste in a single cart.
- **Service Schedule**: The *service schedule* refers to the frequency of the collection. Weekly service means the carts are collected one time per week. Every other week (EOW), means the carts are collected every other week. A household may have a different service schedule for each stream (garbage, recycling, and organics).
- **Service Type:** The *service type* refers to the method by which a household signs up for organics service, either an opt-in *subscription* method or an opt-out *embedded* method.
- **Subscribe, Subscription, Subscriber:** These terms refer to the universe of *households* that must opt-in to *organics service* as an add-on service.
- **Embedded:** This term refers to the universe of households with *organics service* as part of a package with garbage and recycling service; it is not chosen separately by the resident. If desired, a resident may opt-out of the *embedded* service, which is why the number of customers in an embedded jurisdiction may be less than the number of households.
- **Organics Customer.** An *organics customer* is a King County household that either receives *embedded* organics service or has opted-in to a *subscription* organics service.
- **Set-Out.** A *set-out* is a *garbage, recycling, or organics service* container placed on the curb/alley for pick up by the collection company. It is important to distinguish between a customer (meaning a household that has *recycling* or *organics service*) and a *set-out* (where the resident uses the service and physically sets out the container for collection).
- **FSCP Participant.** A *FSCP participant* is a household that places at least some food scraps or compostable paper (FSCP) in the *organics service* container.

- **Data Collection Area.** A *data collection area* is the area inside the boundaries of a single organics route and includes the sections of garbage and recycling routes that fall into the boundaries of the organics route.
- **Sample.** A *sample* includes all material set out for collection from a household from a single stream (either garbage, recycling, or organics), including bagged material set next to the cart. Each household may have as many as three samples (one sample from each stream) or as few as one (a household that has only a garbage set-out, for example).

The consultant team also worked with SWD staff to identify material types and definitions for this study. The 15 material types are grouped into three material classes: **Compostable**, **Recyclable**, and **Other Materials**. See Appendix A: Material Type Definitions for a complete list of the material types and detailed definitions.

Study Design

Before scheduling the fieldwork, the consultant team met with key staff at the SWD to define the study universe, schedule field seasons, develop field protocols, and discuss sort location logistics.

The study "universe" included all King County cities and unincorporated areas (excluding Seattle) where combined FSCP and yard debris collection service is offered. The list of cities, their service type and service schedule for each stream (garbage, recycling, and organics) is included in Appendix B: Study Design. The universe includes only routes primarily serving single-family residences.

Four organics routes per day were randomly selected for sampling. Each sampling event consisted of one collection cycle for the households along the selected routes. Some households have every other week (EOW) recycling or organics service, for those households, sampling occurred across two weeks to capture both recycling and organics samples. For each of the selected routes, the haulers provided the subscriber count and a map showing the route boundaries. Jurisdictions with selected routes are summarized in Table 3.

Table 3. Jurisdiction Service Schedule and Service Type

Jurisdiction	Service Schedule	Service Type
Auburn	Weekly	Subscription
Bellevue	Weekly	Embedded
Bothell	Weekly	Embedded
Carnation	Weekly	Subscription
Des Moines	EOW	Subscription
Federal Way	Weekly	Subscription
Issaquah	Weekly	Embedded
Kent	EOW	Embedded
Kirkland	Weekly	Embedded
Lake Forest Park	EOW	Embedded
Maple Valley	EOW	Subscription
Mercer Island	EOW	Embedded
Redmond	Weekly	Embedded
Renton	Weekly	Embedded
Sammamish	Weekly	Subscription
Seatac	EOW	Embedded
Shoreline	Weekly	Embedded
Unincorporated	EOW	Subscription

Collect Data

For each day of the study, Cascadia route surveyors used route maps provided by the haulers to travel the selected routes ahead of the regular collection vehicles to count the number of set-outs on each route and to collect samples. The route surveyors counted over 70,000 set-outs (more than 144,000 carts) during five seasons and collected 1,809 samples. In areas with subscription organics service, the route surveyors also counted the total number of households on the route where the hauler could not provide a household count. After traveling each route, the route surveyors brought the collected samples to the Bow Lake transfer station for hand sorting.

The average garbage set-out weighed approximately 23 pounds, the average recycling set-out weighed approximately 23 pounds, and the average organics set-out weighed approximately 56 pounds. The field crew sorted each sample into 15 material types; each material type was weighed independently. The crew leader recorded the weight for each sorted material type on the sampling form, reviewed the form, and later entered the data into a custom database for analysis. A full description of the hand-sort procedure is included in Appendix B: Study Design.

Changes to the Methodology from the Previous Study

By design, the current study collected and characterized organics samples in much the same way as previous studies, allowing for comparisons over time. However, this study included samples from more streams (garbage and recycling), included more field days, and simplified the material list. These bullets detail the key differences between the 2014 and 2017 studies.

- In 2014, sampling was completed over eight field periods of two days each for 16 sampling days. In 2017, the sampling was completed over five field periods each lasting a full collection cycle (one week for most households, two weeks for some households). Collecting samples for the full collection cycle was required to sample all streams from a household with EOW service.

- The 2014 study only collected organics samples from selected households. The current study collected samples of garbage and recycling (when set out) from the selected households in addition to the organics set-out. Including the garbage and recycling streams paints a fuller picture of the average household composition and allows for unique insights into residential solid waste patterns.

- The material list for 2017 was streamlined to better align with SWD's other data collection efforts and materials management initiatives.

3. Findings

Interpreting the Composition Results

How Data Is Presented

For each stream, composition data are presented in three ways throughout this report:

1. An overview of composition, by **Material Class,** is presented as a bar chart.
2. A table lists the five most prevalent material types.
3. A detailed table lists the full composition and quantity results for the 15 *material types*. Please refer to Appendix A: Material Type Definitions for a detailed list of definitions for material types used in the study.

Throughout the report, there are also tables and figures that communicate information about participation rates, material capture rates, and the distribution of certain behaviors among households.

Material Designations

Throughout this report the **Material Classes** (**Compostable**, **Recyclable**, and **Other Materials**) are bolded and capitalized, while specific material types such as *recyclable paper* and *meat, edible* are italicized.

Means and Error Ranges

The data from the sorting process were treated with a statistical procedure that provides two kinds of composition information for each of the *material types*:

- Estimates of composition by weight.
- The precision of the composition estimates.

All estimates of precision were calculated at the 90% confidence level. The equations used in these calculations appear in Appendix D: Calculations.

The example below illustrates how the results can be interpreted. In this example, the best estimate of the amount of *yard debris* present is 30.3%. The +/-1.2% figure reflects the precision of the estimate. When calculations are performed at the 90% confidence level, we are 90% certain that the true amount of *yard debris* is between 30.3% plus 1.2% and 30.3% minus 1.2%. We are 90% certain that the mean lies between 31.5% and 29.1%.

Material Type	Est. Pct.	+ / -
Yard Debris	30.3%	1.2%

Rounding

To keep composition tables and figures readable, estimated tonnages are rounded to the nearest ton, and estimated percentages are rounded to the nearest tenth of a percent. Due to this rounding, the tonnages in the report, when added together, may not exactly match the subtotals and totals shown. Similarly, the percentages, when added together, may not exactly match the subtotals or totals shown. Percentages less than 0.05% are shown as 0.0%.

It is important to recognize that the tons in the report were calculated using the more precise (not rounded) percentages. Using the rounded percentages to calculate tonnages yields quantities that differ from the rounded numbers in the report.

For example, the rounded percentage for *yard debris* in the organics stream in Table 5 is shown as 84.5%, while the more precise number, 84.4860987507027%, was used in calculations. If the rounded numbers (84.5%) had been used in the calculations, *yard debris* would be 143,770 tons. Using the more precise numbers, *yard debris* is calculated to be 143,746 tons as shown in Table 5—a difference of 24 tons.

Results

This section describes the single-family residential curbside characterization results in nine subsections:

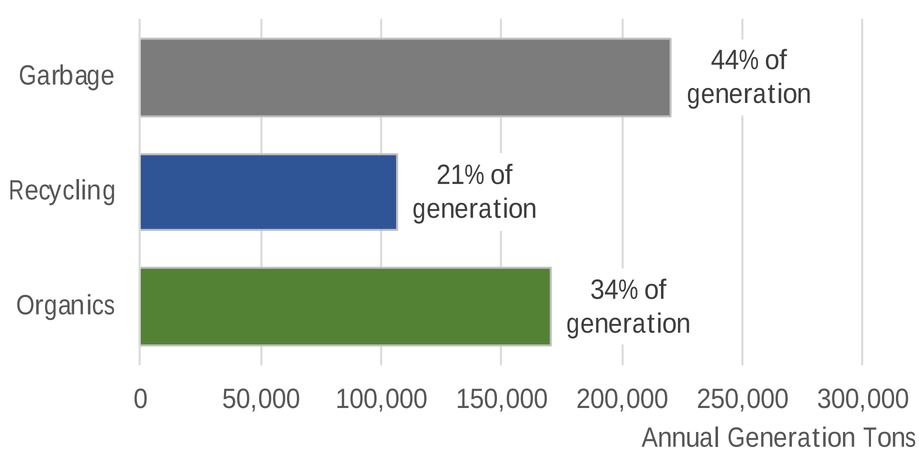
1. Composition of single-family generation.
2. Composition of material set out in garbage service carts.
3. Composition of material set out in recycling service carts.
4. Recycling set-outs and participation rates.
5. Composition of material set out in organics service carts.
6. Organics set-outs and food scrap participation rates.
7. Capture rates for key recyclable materials.
8. Capture rates for food scrap and compostable paper.
9. Patterns of contamination behavior.

Single-family Generation

Material Streams

In calendar year 2017, single-family residents in King County set out over 496,600 tons of material in their garbage, recycling, and organics service carts. Figure 7 illustrates the tons by stream.

Figure 7. Annual Tons by Material Stream



Composition

Figure 8 summarizes composition by recoverability for all materials collected from single-family generators in King County. Table 4 summarizes the five most prevalent materials generated by these residents (by weight). Table 5 presents the detailed composition of materials collected from single-family generators in King County.

Key Findings

- Of all the material generated by King County single-family households, 51% (253,707 tons) is **Compostable** and 24% (118,093 tons) is **Recyclable.**
- The four most prevalent divertible material types (*yard debris, recyclable paper, mixed/other food waste, and recyclable glass)* account for over 55% of total generation.
- *Yard debris* (30%, 147,600 tons) is the most prevalent material generated by single-family households in King County.

Figure 8. Composition by Material Class, Single-family Generation

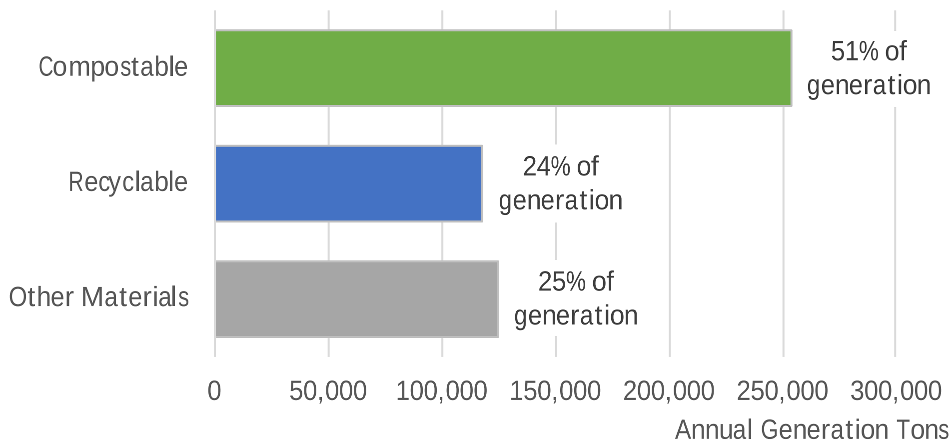


Table 4. Top Five Material Types, Single-family Generation

Material	Est. Percent	Est. Tons
Yard Debris	29.7%	147,600
Other Materials	25.1%	124,826
Recyclable Paper	13.8%	68,452
Mixed/Other Food Waste	7.0%	34,912
Recyclable Glass	4.7%	23,258
Total	**80.4%**	**399,048**

Table 5. Detailed Composition, Single-family Generation

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**39.7%**		**87,443**	**3.7%**		**3,883**	**95.4%**		**162,381**	**51.1%**		**253,707**
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Sample Count			762			629			418			1,809

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

The material type *other materials* includes all materials not defined elsewhere. Examples of *other materials* include: animal waste, kitty litter, treated wood, construction materials, Styrofoam, and plastic trash bags.

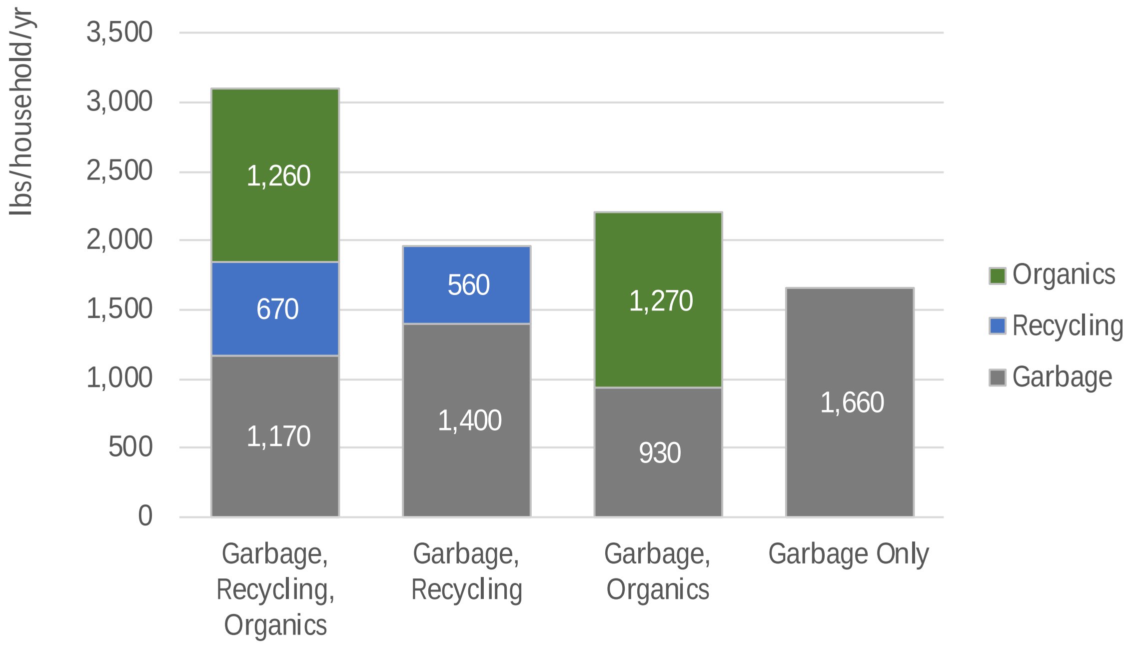
Collection Services Utilized

Households throughout the County can utilize the curbside collection services available to them in four combinations:

- Garbage only,
- Garbage and recycling,
- Garbage and organics,
- Garbage, recycling, and organics.

During the sampling events, the field crew noted which carts were set out at the randomly selected households and weighed each sample. This data is then used to estimate the annual material generation by services utilized. As shown in Figure 9, total generation was lowest at houses that utilized garbage only service, and highest at houses that utilized all three, garbage, recycling, and organics. Generation, as defined by this study, is the sum all material, regardless of stream, collected curbside from single-family residents. It is possible that households with only garbage carts dispose of their organics and recyclables in some other way, perhaps by composting on-site or self-hauling to a compost or recycling facility which may contribute to their low total generation.

Figure 9. Annual Generated Pounds per Household by Services Utilized



Single-family Garbage Service Composition

In calendar year 2017, single-family residents in King County set out over 220,200 tons of material in their garbage service carts. Figure 10 summarizes composition by recoverability for the garbage collected from single-family households in King County. Table 6 summarizes the five most prevalent materials (by weight) in single-family garbage carts. Table 7 presents the detailed composition of single-family garbage carts.

Key Findings

- About half of the single-family garbage stream could be diverted from landfill. This consists of 40% **Compostable** items (87,443 tons), and 11% **Recyclable** items (24,333) tons. Together, this represents over 111,000 tons per year of additional material that could be diverted from landfill.
- Of the materials in the garbage that could be composted or recycled, the three most prevalent are *mixed/other food waste* (14%, 29,690 tons), *fruits and vegetables, non-edible* (7%, 16,119 tons), and *compostable paper* (7%, 15,318 tons).
- All food material types combined account for 31% of the garbage stream (67,211 tons).
- The edible food material types account for approximately 8% of the garbage stream.

Figure 10. Composition by Material Class, Single-family Garbage

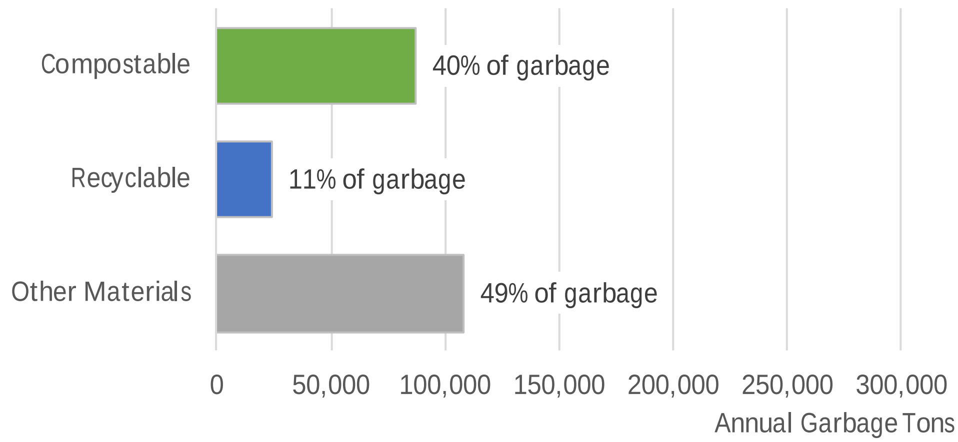


Table 6. Top Five Material Types, Single-family Garbage

Material	Est. Percent	Est. Tons
Other Materials	49.2%	108,439
Mixed/Other Food Waste	13.5%	29,690
Fruits and Vegetables, Non-edible	7.3%	16,119
Compostable Paper	7.0%	15,318
Fruits and Vegetables, Edible	5.6%	12,360
Total	**82.6%**	**181,926**

Table 7. Detailed Composition, Single-family Garbage

	Garbage		
Material	Est. %	+ / -	Est Tons
Compostable	**39.7%**		**87,443**
Fruits and Vegetables, Edible	5.6%	0.6%	12,360
Fruits and Vegetables, Non-edible	7.3%	0.7%	16,119
Homegrown Fruits and Vegetables	0.0%	0.0%	88
Meat, Edible	2.2%	0.6%	4,911
Meat, Non-edible	1.8%	0.3%	4,042
Mixed/Other Food Waste	13.5%	1.1%	29,690
Compostable Paper	7.0%	0.4%	15,318
Compostable Plastic	0.1%	0.0%	136
Other Compostables	0.6%	0.3%	1,235
Yard Debris	1.6%	0.7%	3,543
Recyclable	**11.0%**		**24,333**
Recyclable Paper	4.3%	0.5%	9,419
Recyclable Plastic	3.0%	0.2%	6,696
Recyclable Metal	1.9%	0.2%	4,233
Recyclable Glass	1.8%	0.4%	3,985
Other Materials	**49.2%**		**108,439**
Other Materials	49.2%	2.3%	108,439
Totals	**100%**		**220,215**
Sample Count			762

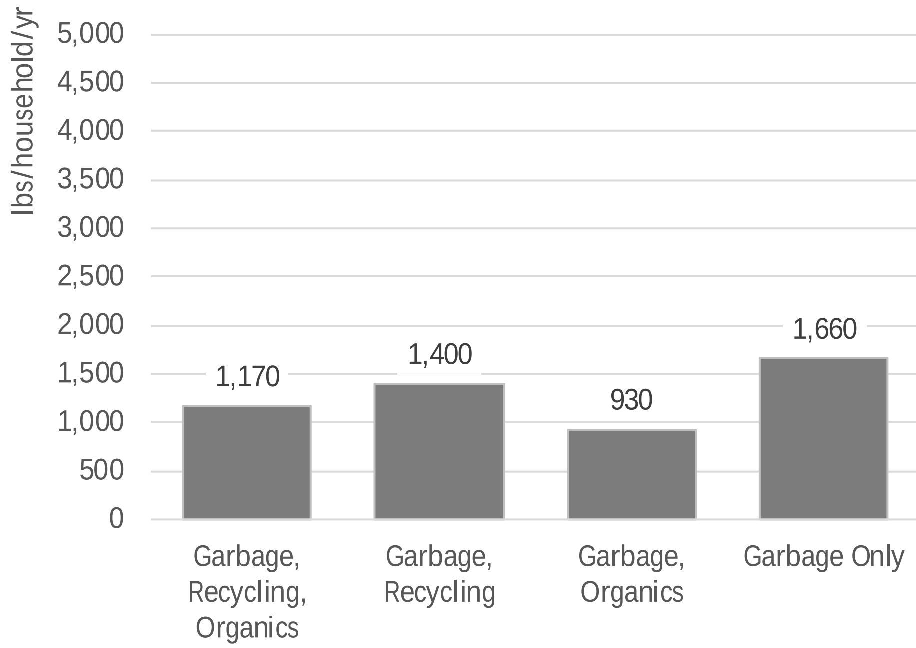
Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

The material type *other materials* includes all materials not defined elsewhere. Examples of *other materials* include: animal waste, kitty litter, treated wood, construction materials, Styrofoam, and plastic trash bags.

Collection Services Utilized

During the sampling events, the field crew noted which carts were set out at the randomly selected households and weighed each sample. This data is then used to estimate the annual garbage pounds per household by services utilized. As shown in Figure 11, annual garbage pounds per household was lowest at houses that utilized garbage and composting carts, followed by houses that use garbage, recycling and organics carts. Logically, the pounds of garbage per household per year is highest for residents that only use garbage service.

Figure 11. Annual Garbage Pounds per Household Rates by Services Utilized



Single-family Recycling Service Composition

In calendar year 2017, single-family residents in King County set out 106,269 tons of material in their recycling service carts. Figure 12 summarizes composition by recoverability for recycling collected from households in King County. Table 8 summarizes the five most prevalent materials (by weight) in single-family recycling carts. Table 9 presents the detailed composition of single-family recycling carts.

Key Findings

- In the recycling stream, contaminants (**Other Materials** and **Compostable)** accounted for 13% (13,477 tons) of the material placed in the recycling cart.
- By far the largest component of the recycling stream is *recyclable paper* (55%, 58,350 tons), followed by *recyclable glass* (18%, 19,171 tons).

Figure 12. Composition by Material Class, Single-family Recycling

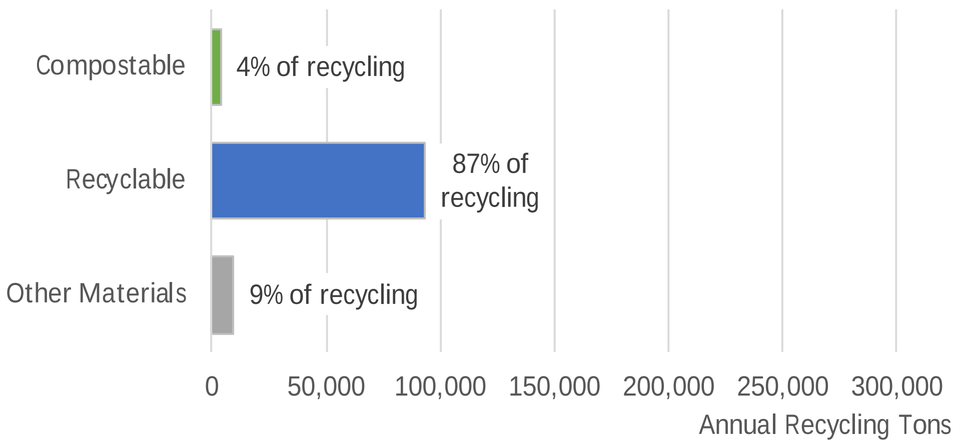


Table 8. Top Five Material Types, Single-family Recycling

Material	Est. Percent	Est. Tons
Recyclable Paper	54.9%	58,350
Recyclable Glass	18.0%	19,171
Recyclable Plastic	10.3%	10,969
Other Materials	9.0%	9,594
Recyclable Metal	4.0%	4,302
Total	**96.3%**	**102,386**

Table 9. Detailed Composition, Single-family Recycling

	Recycling		
Material	Est. %	+ / -	Est Tons
Compostable	**3.7%**		**3,883**
Fruits and Vegetables, Edible	0.2%	0.1%	243
Fruits and Vegetables, Non-edible	0.1%	0.1%	103
Homegrown Fruits and Vegetables	0.0%	0.0%	7
Meat, Edible	0.1%	0.1%	87
Meat, Non-edible	0.0%	0.0%	50
Mixed/Other Food Waste	1.2%	0.4%	1,313
Compostable Paper	1.5%	0.2%	1,622
Compostable Plastic	0.0%	0.0%	45
Other Compostables	0.1%	0.1%	102
Yard Debris	0.3%	0.4%	312
Recyclable	**87.3%**		**92,792**
Recyclable Paper	54.9%	2.2%	58,350
Recyclable Plastic	10.3%	0.9%	10,969
Recyclable Metal	4.0%	0.4%	4,302
Recyclable Glass	18.0%	1.5%	19,171
Other Materials	**9.0%**		**9,594**
Other Materials	9.0%	1.7%	9,594
Totals	**100%**		**106,269**
Sample Count			629

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

The material type *other materials* includes all materials not defined elsewhere. Examples of *other materials* include: animal waste, kitty litter, treated wood, construction materials, Styrofoam, and plastic trash bags.

Collection Services Utilized

During the sampling events, the field crew noted which carts were set out at the randomly selected households and weighed each sample. This data is then used to estimate the annual recycling pounds per household by services utilized. As shown in Figure 13, recycling cart pounds per household is higher at households that utilize their garbage, recycling, and organics service (670 pounds per household per year) than at households that use garbage and recycling service (560 pounds per household per year).

Figure 13. Annual Recycling Pounds per Household by Services Utilized

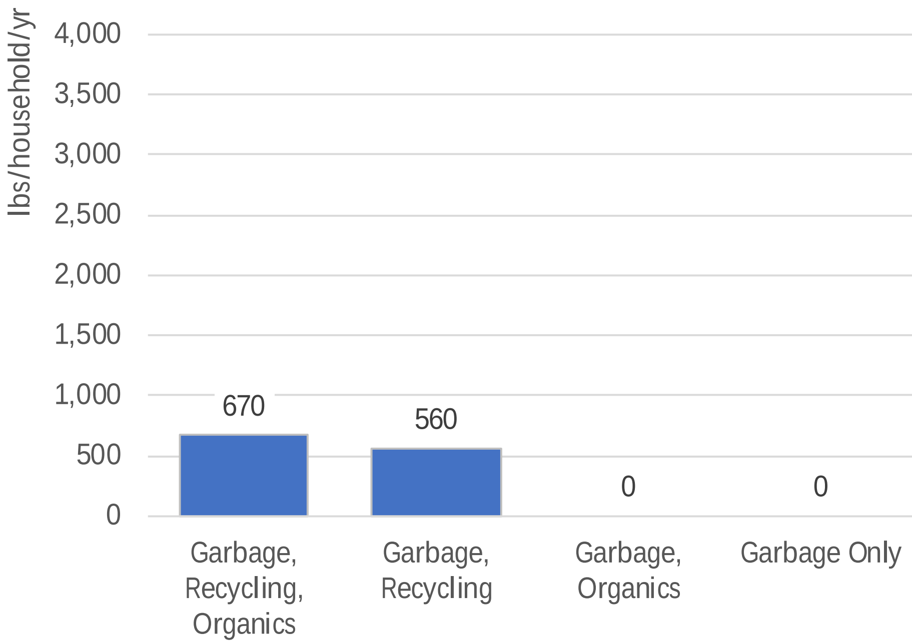
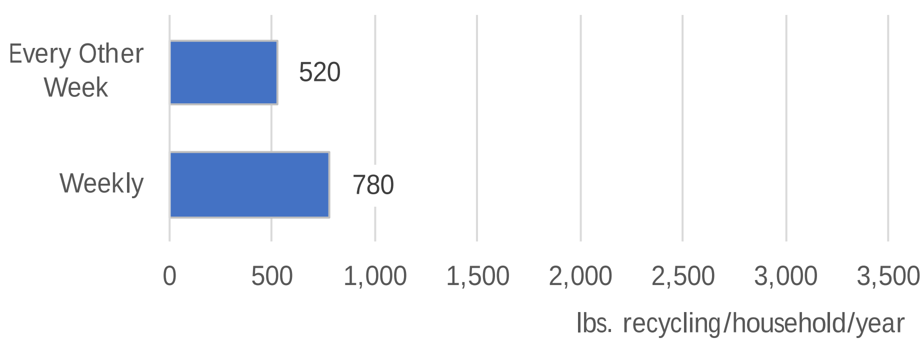


Figure 14 illustrates the annual pounds of recycling set out per household per year based on the recycling service schedule. As shown, when the set-out weight data is annualized, households with weekly recycling service place more material in their recyclables carts than households with every other week service.

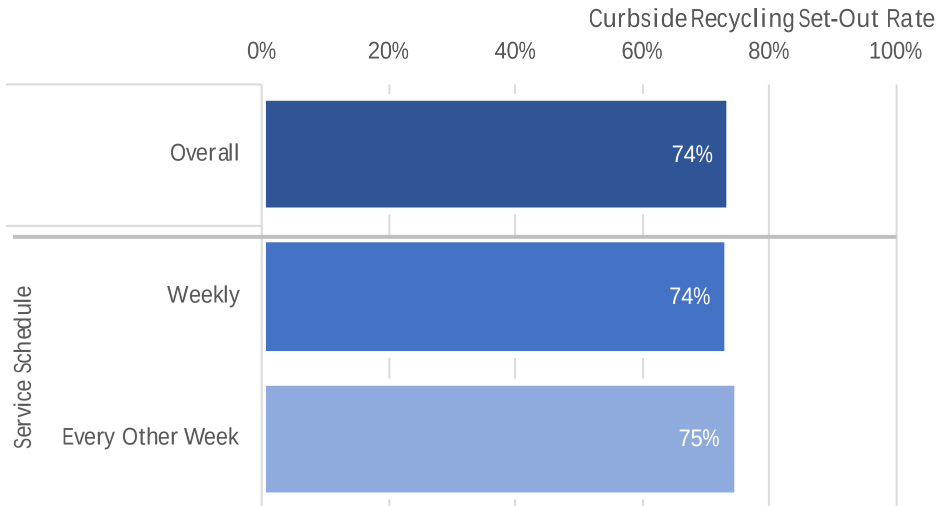
Figure 14. Annual Recycling Pounds per Household by Service Schedule



Recycling Set-out Rate

During a collection cycle, not all recycling customers set-out their cart for collection. Using the data collected by surveyors along the route and household count data provided by haulers, Cascadia calculated the recycling set-out rate. The set-out rate is the proportion of households that physically place their recycling cart out for collection. Overall, almost three-quarters (74%) of households put their cart out for collection. The recycling set-out rate is about the same for households with EOW service (75%) as households with weekly service (74%). These findings are summarized in Figure 15.

Figure 15. Recycling Set-out Rate by Service Schedule



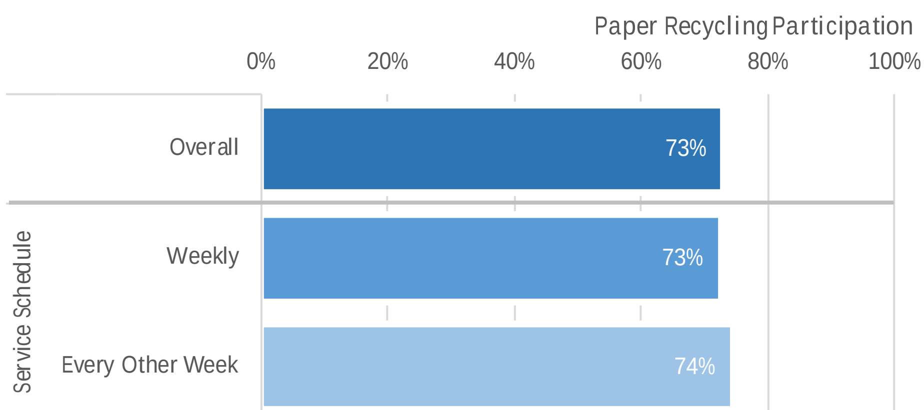
Recycling Participation Rate

The participation rate for a particular recyclable material is calculated using set-out data collected by the route surveyors, household count data provided by the haulers, and recycling steam composition results from the sample sorting activities.

Recyclable Paper Participation Rate

The recyclable paper participation rate is the proportion of all households that set-out a recycling cart containing recyclable paper. As shown in Figure 16, overall, 73% of households set out a recycling cart containing recyclable paper. The recyclable paper participation rate was about the same for households with EOW service (74%) as for households with weekly service (73%).

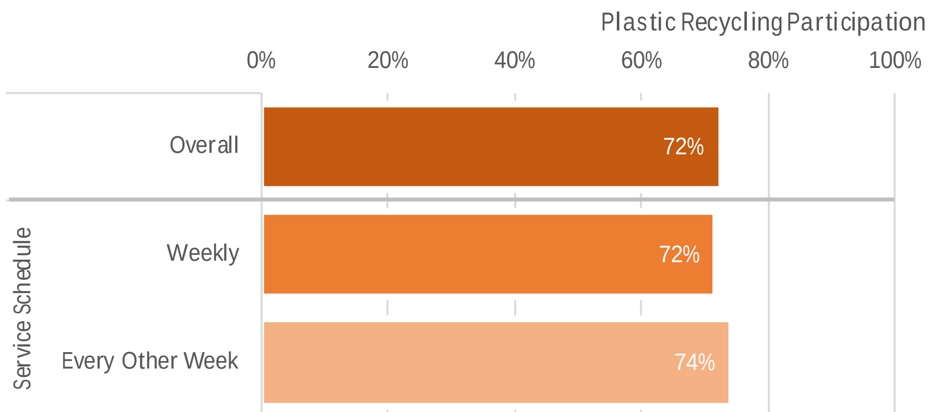
Figure 16. Recyclable Paper Participation Rate by Service Schedule



Recyclable Plastic Participation Rate

The recyclable plastic participation rate is the proportion of all households that set-out a recycling cart containing recyclable plastic. As shown in Figure 17, overall, 72% of all households set-out a recycling cart containing recyclable plastic. The recyclable plastic participation rate was slightly higher for households with EOW service (74%) than for households with weekly service (72%).

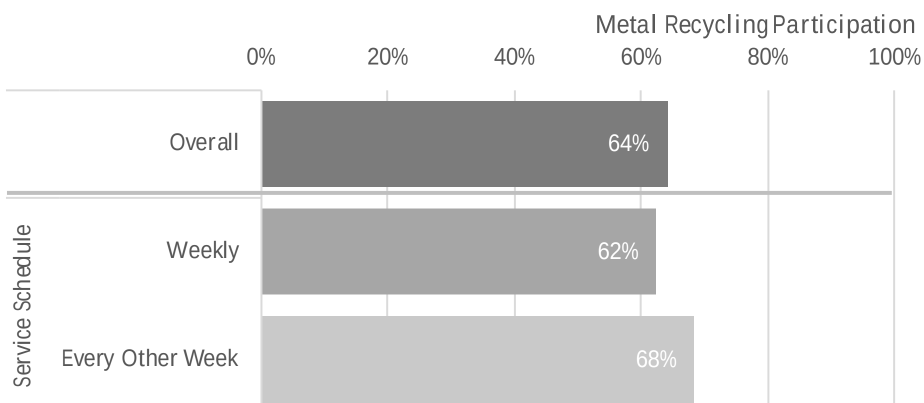
Figure 17. Recyclable Plastic Participation Rate by Service Schedule



Recyclable Metal Participation Rate

The recyclable metal participation rate indicates the percentage households with a set-out that contained recyclable metal in the cart. As shown in Figure 18, overall, 64% of all households set-out a recycling cart containing recyclable metal. The recyclable metal participation rate was higher for households with EOW service (68%) than for households with weekly service (62%).

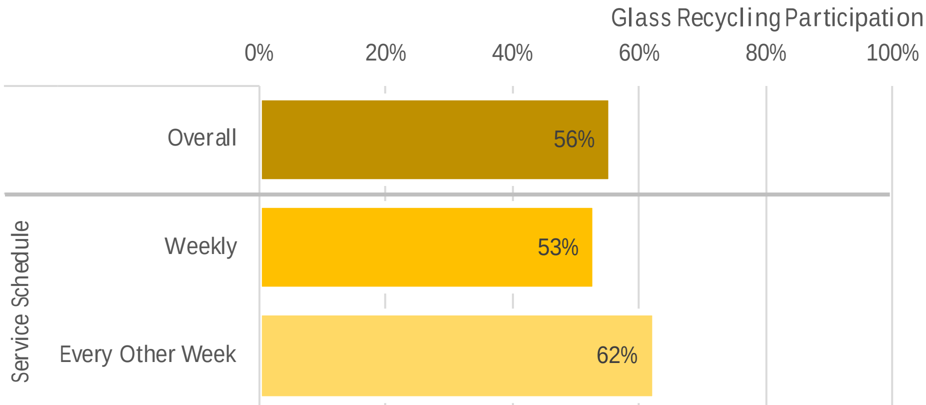
Figure 18. Recyclable Metal Participation Rate by Service Schedule



Recyclable Glass Participation Rate

The recyclable glass participation rate is the proportion of all households that set-out a recycling cart containing recyclable glass. As shown in Figure 19, overall more than half, (56%) of households set-out a cart containing recyclable glass. EOW service carts had a higher participation rate (62%) compared to weekly service (53%). Though the recyclable glass participation rate is the lowest among the recyclable materials, recyclable glass is the second most prevalent recyclable material in the recycling carts. This illustrates the much higher per-item weight of a glass containers compared to plastic or metal containers.

Figure 19. Recyclable Glass Participation Rate by Service Schedule



Single-family Organics Service Composition

In 2017, single-family organics customers in King County set out 170,141 tons of material in their organics service carts. Figure 20 summarizes composition by recoverability for organics collected from single-family organics customers in King County. Table 10 summarizes the five most prevalent materials (by weight) in single-family organics carts. Table 11 presents the detailed composition of single-family organics carts.

Key Findings

- By far the largest proportion of material in the organics bins is *yard debris,* accounting for 85% (143,746 tons).
- In the organics bins, contaminants consisted of **Recyclable** items (less than 1%, 968 tons) and **Other Materials** (4% and 6,793 tons).
- *Fruits and vegetables, non-edible* is the most prevalent food type.
- The edible food types account for approximately 2% of the organics stream.

Figure 20. Composition by Material Class, Single-family Organics

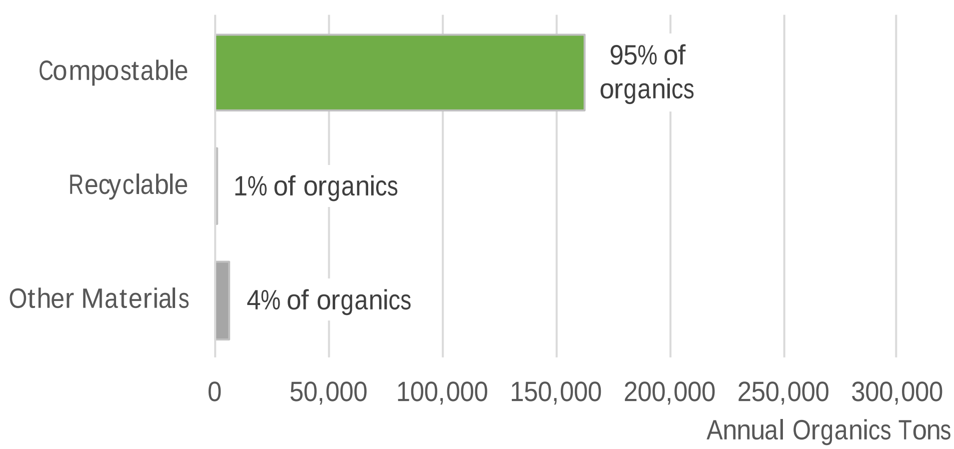


Table 10. Top Five Material Types, Single-family Organics

Material	Est. Percent	Est. Tons
Yard Debris	84.5%	143,746
Other Materials	4.0%	6,793
Fruits and Vegetables, Non-edible	3.6%	6,116
Mixed/Other Food Waste	2.3%	3,908
Compostable Paper	2.1%	3,545
Total	**96.5%**	**164,108**

Table 11. Detailed Composition, Single-family Organics

	Organics		
Material	Est. %	+ / -	Est Tons
Compostable	**95.4%**		**162,381**
Fruits and Vegetables, Edible	1.5%	0.4%	2,478
Fruits and Vegetables, Non-edible	3.6%	0.8%	6,116
Homegrown Fruits and Vegetables	0.2%	0.2%	405
Meat, Edible	0.4%	0.1%	726
Meat, Non-edible	0.4%	0.1%	658
Mixed/Other Food Waste	2.3%	0.7%	3,908
Compostable Paper	2.1%	0.4%	3,545
Compostable Plastic	0.1%	0.0%	227
Other Compostables	0.3%	0.4%	572
Yard Debris	84.5%	3.2%	143,746
Recyclable	**0.6%**		**968**
Recyclable Paper	0.4%	0.2%	683
Recyclable Plastic	0.1%	0.1%	144
Recyclable Metal	0.0%	0.0%	38
Recyclable Glass	0.1%	0.1%	103
Other Materials	**4.0%**		**6,793**
Other Materials	4.0%	2.4%	6,793
Totals	**100%**		**170,141**
Sample Count			418

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

The material type *other materials* includes all materials not defined elsewhere. Examples of *other materials* include: animal waste, kitty litter, treated wood, construction materials, Styrofoam, and plastic trash bags.

Collection Services Utilized

As shown in Figure 21, the quantity of organic material collected is about the same for households that utilized only garbage and organics bins (1,270 pounds per household per year) as for households that utilized all three carts (1,260 pounds per household per year).

Figure 21. Annual Organics Pounds per Household by Services Utilized

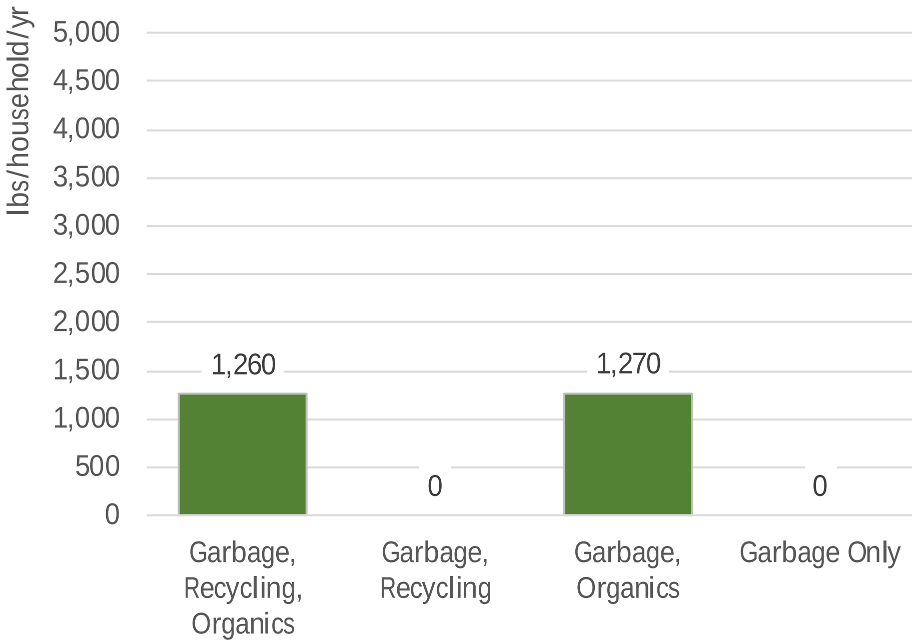
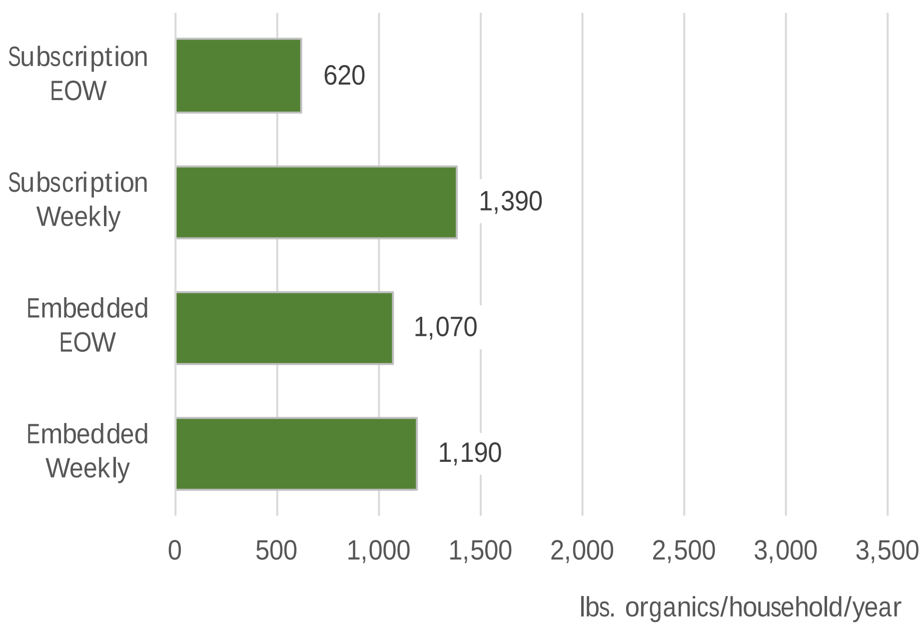


Figure 22 illustrates the annual pounds of organics set out per organics customer, based on the service type and service schedule. As shown, organics customers with weekly service place more material in their organics carts (1,390 pounds per year for subscription, 1,190 pounds for embedded) than organics customers with EOW service (620 pounds per year for subscription, 1,070 pounds for embedded). Weekly service appears to encourage organics customers to set-out more material than EOW service.

Figure 22. Annual Organics Pounds per Household by Service Schedule and Service Type



Organics Set-out Rate

On collection day, not all residents with service available to them set-out their cart for pick up. Cascadia calculated the organics set-out rate using the data collected by surveyors along the route and household count data provided by haulers. The set-out rate is the proportion of households that physically place their organics cart out for collection. The organics set-out rate is calculated and presented two ways, with all households as the denominator, and with organics customers as the denominator. The organics customer set-out rate is greater than the household set-out rate because there are fewer organics customers than households (the denominator is smaller).

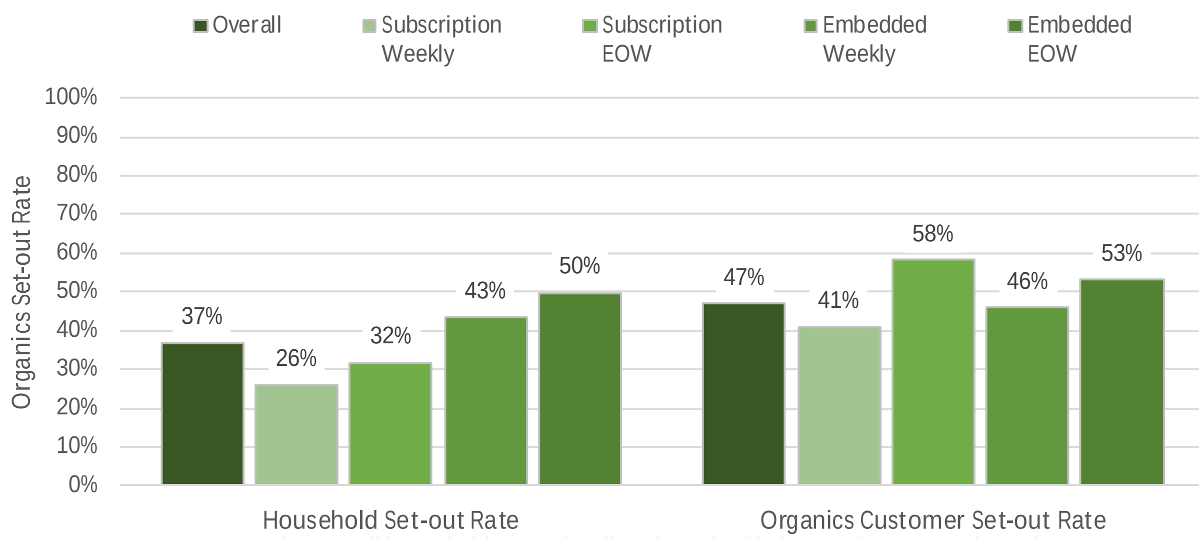
The set-out rate is highest for households with embedded EOW service (50%) followed by households with embedded weekly service (43%). For organics customers, the set-out rate is highest for subscription EOW service (58%), followed by embedded EOW service (53%). These findings are summarized in Table 12 and Figure 23. Overall, 37% of households and slightly less than half (47%) of organics customers set-out their cart each collection cycle.

Table 12. Organics Set-out Rate by Service Schedule and Customer Type

	Subscription Weekly	Subscription EOW	Embedded Weekly*	Embedded EOW*	Overall
Household Set-out Rate	26%	32%	43%	50%	37%
Organics Customer Set-out Rate	41%	58%	46%	53%	47%

* In practice, not all households are subscribers in embedded areas due to organic service opt-out thus the household rate is lower than the customer rate even though households and customers should be synonymous.

Figure 23. Organics Set-out Rate by Service Schedule and Service Type



* In practice, not all households are subscribers in embedded areas due to organic service opt-out consequently the rates for households and customers are slightly different.

Organics Participation Rate

The participation rate for compostable material is calculated using set-out data collected by the route surveyors, household and customer count data provided by the haulers, and organics stream composition results from the sample sorting activities.

Food Scraps and Compostable Paper (FSCP) Participation Rates

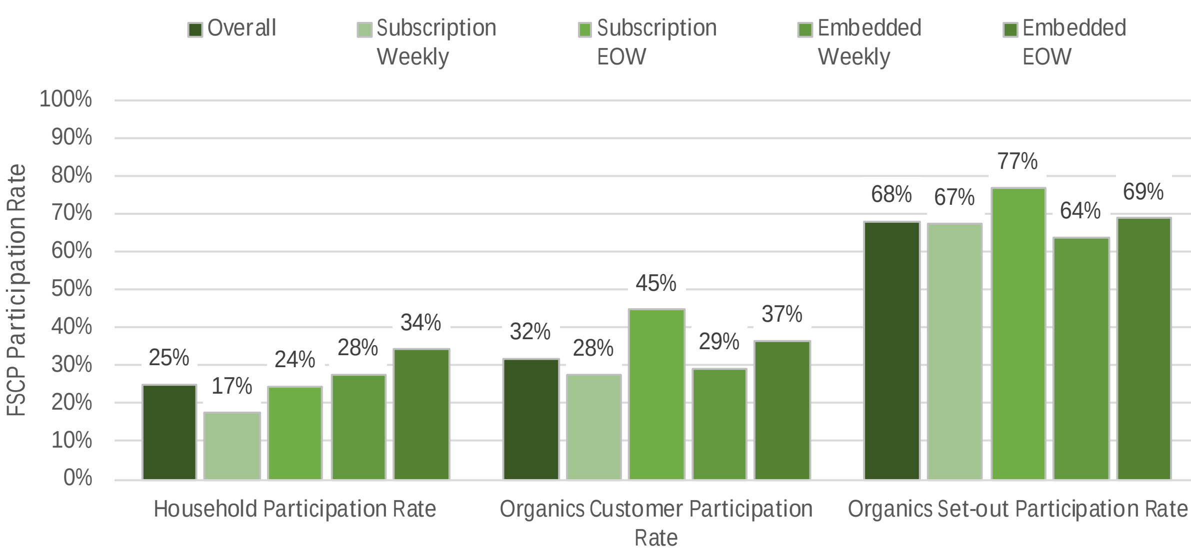
The FSCP participation rate is calculated three ways:

1. The proportion of all households that included FSCP in the cart.
2. The proportion of organics customers that included FSCP in the cart.
3. The proportion of organics set-outs that included FSCP in the cart.

The organics set-out participation rate is greater than organics customer participation rate which is greater than the household participation rate because the denominator is smallest for the set-out participation rate and largest for the household participation rate.

As shown in Figure 24, overall, over two thirds (68%) of set-outs contained FSCP. The rate was highest for set-outs with subscription EOW service (77%). Overall, just 25% of households set-out a cart containing FSCP during a collection cycle.

Figure 24. Food Scrap and Compostable Paper Participation Rate



* In practice, not all households are subscribers in embedded areas due to organic service opt-out consequently the rates for households and customers are slightly different.

Organics Data Comparisons between Service Schedules and Subscription Types

Table 13 compares key metrics between organics customer types, embedded versus subscription. The set-out rate is similar for both types of customers (48% for embedded, 46% for subscription). The FSCP participation rate is also similar for both types of customers (32% for embedded and 33% for subscription). The averaged pounds of organics per month is slightly higher for subscribers (236 pounds per month) than for those with embedded service (202 pounds per month).

Table 13. Comparison of Key Organics Metrics by Service Type

	Number of Sampled Households	Organic Customers Set-out Rate	FSCP Participation Rate
Embedded	468	48%	32%
Subscription	328	46%	33%
Overall	**796**	**47%**	**32%**

Table 14. Comparison of Key Organics Metrics by Service Type

	Number of Organics Samples	Avg. Lbs Organics per Month*	Avg. Lbs FSCP per Month*
Embedded	277	202	40
Subscription	141	236	26
Overall	**418**	**214**	**35**

* Average for organics or FSCP participants only.

Table 15 compares key metrics between organics collection schedules. The organics set-out rate and FSCP participation rate is highest for EOW service (55% and 39%, respectively). However, the average pounds of organics per month and averaged FSCP per month is higher for weekly service (233 and 39, respectively). This compares to 169 pounds of organics per month and 26 pounds of FSCP per month for EOW service. These data are shown in Table 16.

Table 15. Comparison of Key Organics Metrics by Service Schedule

	Number of Sampled Households	Organic Customers Set-out Rate	FSCP Participation Rate
Weekly	432	44%	29%
EOW	364	55%	39%
Overall	**796**	**47%**	**32%**

Table 16. Comparison of Key Organics Metrics by Service Schedule

	Number of Organics Samples	Avg. Lbs Organics per Month*	Avg. Lbs FSCP per Month*
Weekly	208	233	39
EOW	210	169	26
Overall	**418**	**214**	**35**

* Average for organics or FSCP participants only.

Recycling Capture Rate and Diversion Efficiency

Capture rate refers to the proportion (as a percentage) of a targeted material collected for diversion (recycling or composting), relative to the total quantity of that material generated. In the context of this study, it is important to note that generated is not all material created by single-family residents. In this report, the quantity generated refers to the sum of all curbside collected material: garbage, recycling, and organics. Generation does not include self-hauled materials to disposal, recycling or composting facilities, and it does not include organic material composted or otherwise managed on the residents' property.

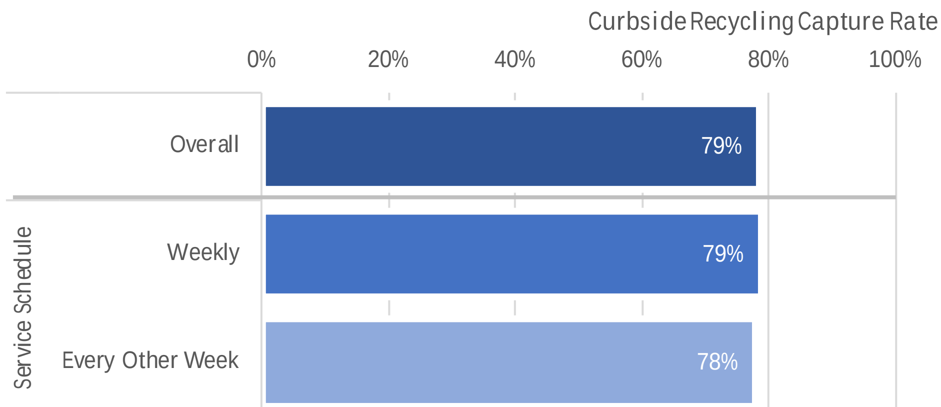
Even with these caveats and distinctions, capture rates are useful to help SWD staff direct education and outreach efforts where additional quantities of recyclable and compostable material could be diverted from landfill. Two main factors can increase the capture rate:

1. **Increase Set-outs:** It is possible to in increase the capture rate by increasing the number of recycling or organics carts set-out each collection cycle.
2. **Improve Diversion Efficiency:** It is possible to increase the capture rate by decreasing the amount of recoverable material a customer places in the garbage cart either by moving that material to a diversion cart or by not generating the material.

Recyclables Capture Rate

As illustrated in Figure 25 the recyclables capture rate at households with weekly recycling available to them is nearly the same as at households with EOW service (79% and 78%, respectively). This appears to indicate that the service schedule does not affect whether residents place their recyclable materials in the recycling cart or garbage cart.

Figure 25. Recyclables Capture Rate by Service Schedule



This study found that overall recyclables capture rate did not follow a normal distribution pattern throughout the population but rather a bimodal ("all or nothing") distribution, as illustrated in the distribution of individual household capture rates in Figure 26. This figure shows the proportion of households that fall within a specified range of capture rates (each range is called a cohort). Of the households sampled for this study, the majority, 56%, place at least 80% of their recyclable materials in the recycling cart. Approximately 20% of sampled households place none of their recyclable materials in the recycling cart.

Figure 26. Recyclables Capture Rate

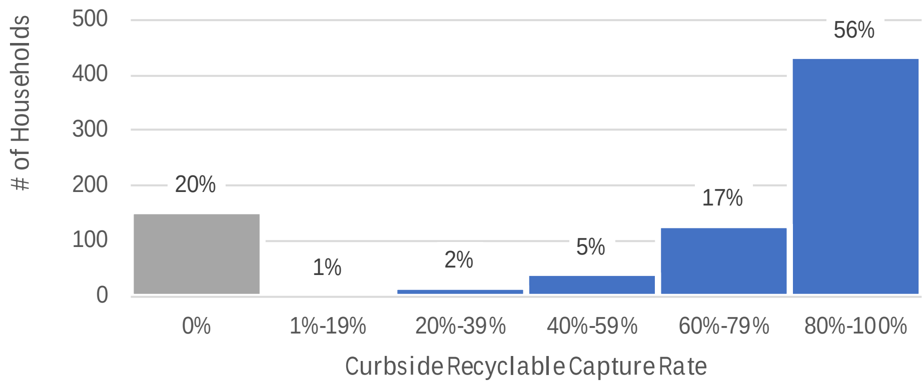


Figure 27 and Figure 28 summarize the recycling capture rate behavior at households with weekly and EOW recycling service. For both service types, most households capture at least 80% of their recyclables. However, there is a noticeable difference in the number of households that capture none of their recyclables between the two service types. Seven percent of the sampled households with weekly service did not recycle at all, compared to 25% of EOW service customers.

Figure 27. Recyclables Capture Rate Weekly Service

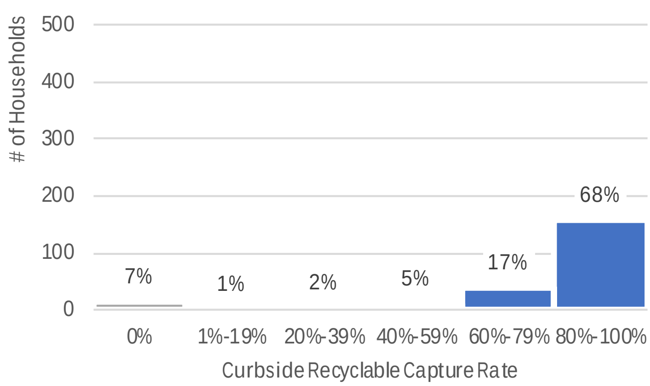
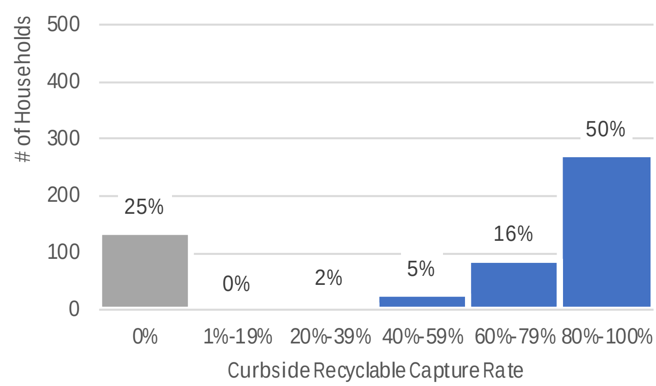


Figure 28. Recyclables Capture Rate Every Other Week Service



The next several figures illustrate the capture rates for individual materials. Recyclable paper and recyclable glass have the highest capture rates and the fewest households with a zero percent capture rate. Recyclable metal has the lowest capture rate and the highest proportion of households with a zero percent capture rate.

Recyclable Paper Capture Rates

Figure 29 shows the capture rate for recyclable paper (the proportion of recyclable paper set out for curbside collection that ends up in a recycling cart) for weekly and EOW service schedules. As shown, it is about the same, 86% and 84%, respectively.

Figure 29. Recyclable Paper Capture Rate by Service Schedule

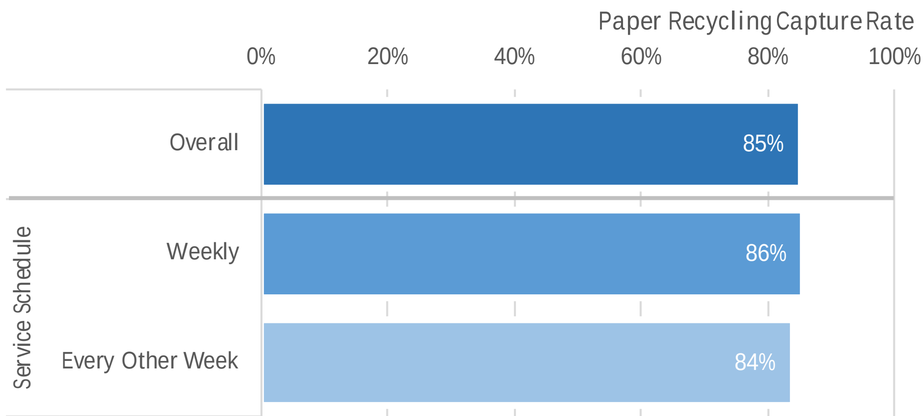


Figure 30 shows the number and proportion of sampled households that recycle paper by cohort. As shown, most, 64% of the sampled households recycle 80-100% of their recyclable paper. However, about a fifth, 19% of the sampled households recycle none of the recyclable paper they generate. Figure 31 and Figure 32 show the paper recycling behavior of households by service schedule. More households with EOW service do not recycle their paper (23%) than households with weekly service (7%).

Figure 30. Recyclable Paper Capture Rate

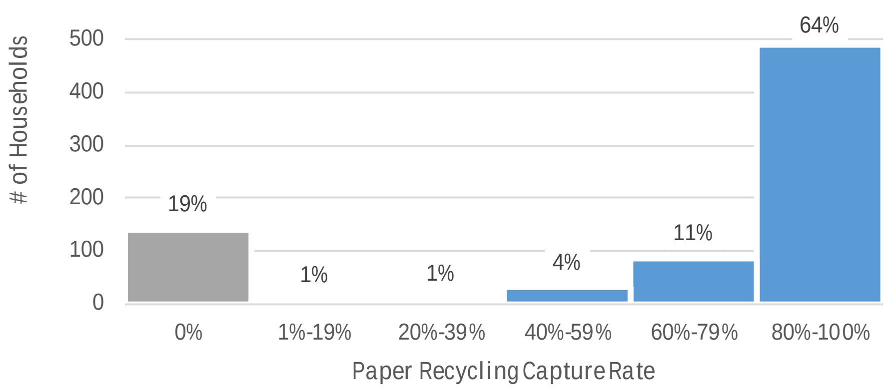


Figure 31. Recyclable Paper Capture Rate, Weekly Service

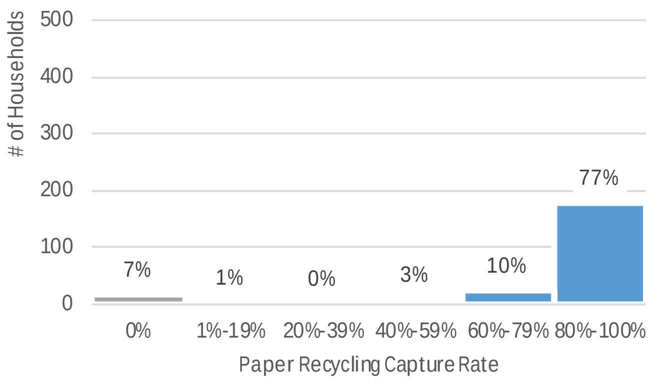
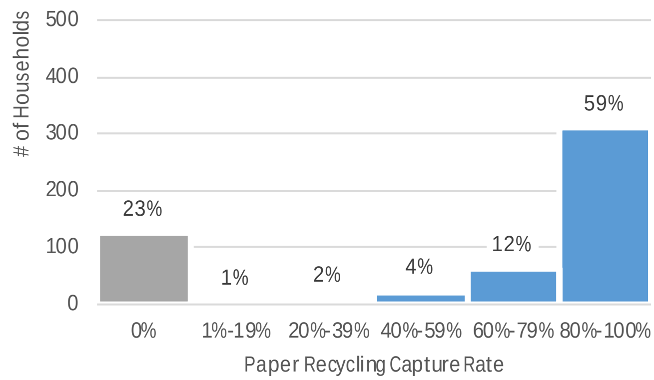


Figure 32. Recyclable Paper Capture Rate EOW Service



Recyclable Plastic Capture Rates

Figure 33 shows the capture rate for recyclable plastic (the proportion of recyclable plastic set out for curbside collection that ends up in a recycling cart) for weekly and EOW service schedules. As shown, it is similar, 62% and 60%, respectively.

Figure 33. Recyclable Plastic Capture Rate by Service Schedule

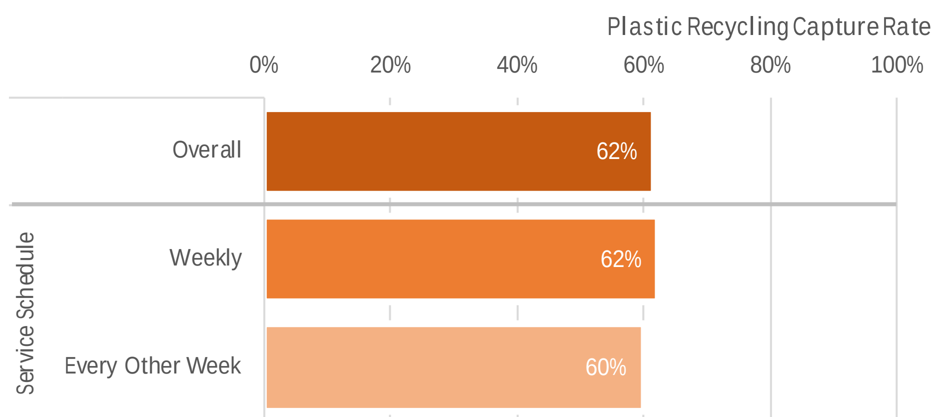


Figure 34 shows the number and proportion of sampled households that recycle plastic by cohort. As shown, only a third, 32%, of the sampled households recycle 80-100% of their recyclable plastic (much smaller than the size of this cohort for recyclable paper). About a fifth, (18%) of the sampled households recycle none of their recyclable plastic. Figure 35 and Figure 36 show the plastic recycling behavior of households by service schedule. More households with EOW service do not recycle their plastic (23%), compared to households with weekly service (7%).

Figure 34. Recyclable Plastic Capture Rate

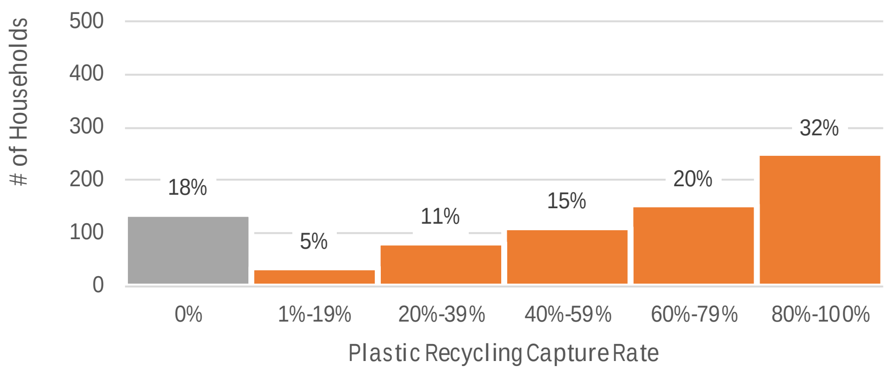


Figure 35. Recyclable Plastic Capture Rate Weekly Service

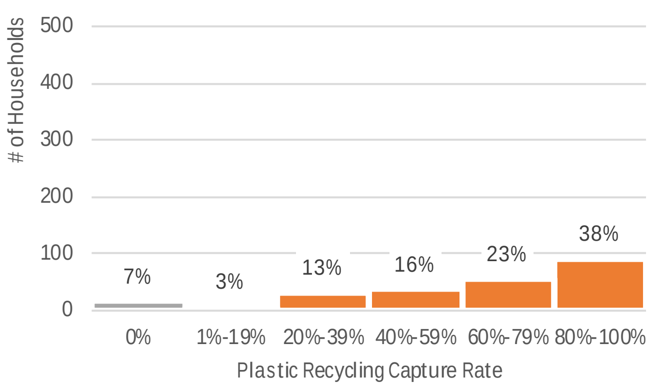
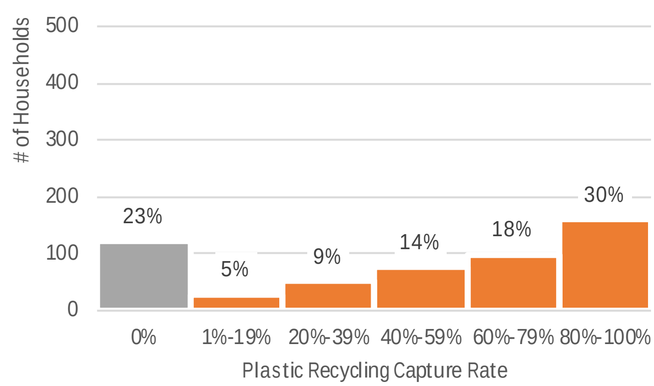


Figure 36. Recyclable Plastic Capture Rate EOW Service



Recyclable Metal Capture Rates

Figure 37 shows the capture rate for recyclable metal (the proportion of recyclable metal set out for curbside collection that ends up in a recycling cart) for weekly and EOW service schedules. Slightly more metal is captured from households with EOW service (52%) as compared to weekly service (49%).

Figure 37. Recyclable Metal Capture Rate by Service Schedule

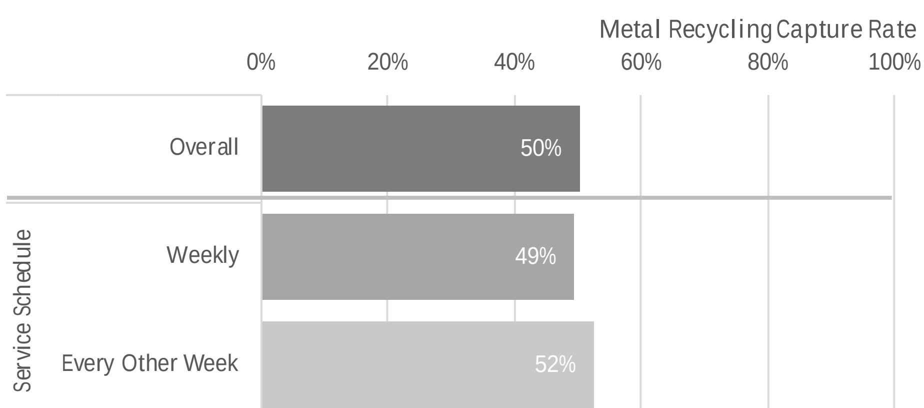


Figure 38 shows the number and proportion of sampled households that recycle metal by cohort. As shown, only a third, 32%, of the sampled households recycle 80-100% of their recyclable metal. More than a fifth, 22% of the sampled households recycle none of the recyclable metal they generate. Figure 39 and Figure 40 show the metal recycling behavior of households by service schedule. More households with EOW service do not recycle their metal (25%), compared to households with weekly service (15%).

Figure 38. Recyclable Metal Capture Rate

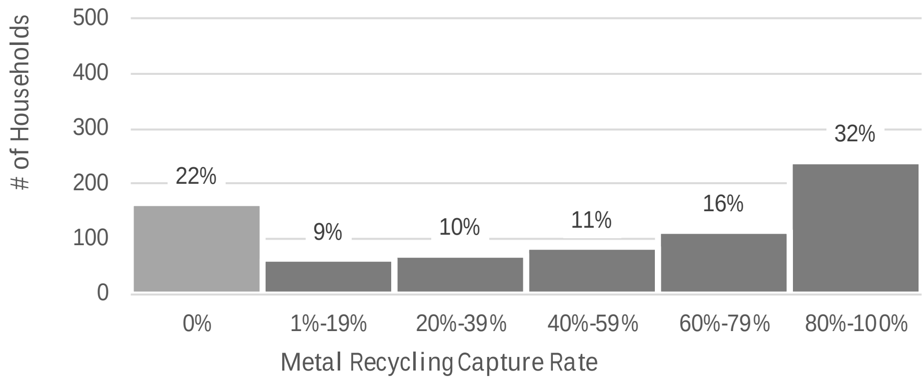


Figure 39. Recyclable Metal Capture Rate Weekly Service

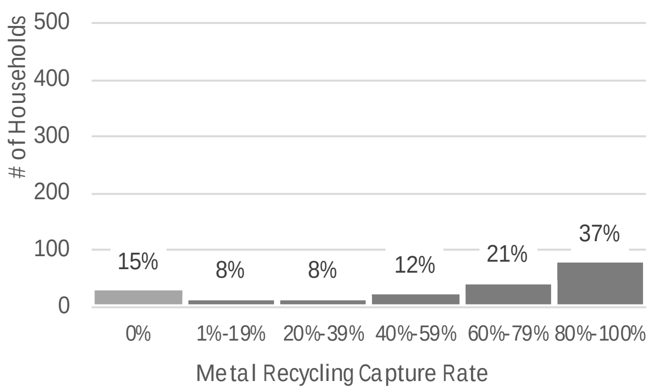
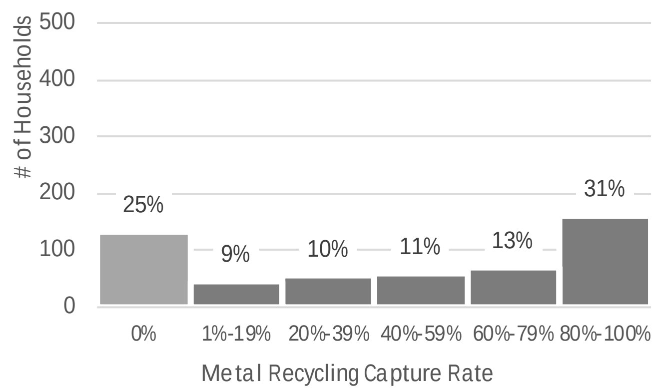


Figure 40. Recyclable Metal Capture Rate EOW Service



Recyclable Glass Capture Rates

Figure 41 shows the capture rate for recyclable glass (the proportion of recyclable glass set out for curbside collection that ends up in a recycling cart) for weekly and EOW service schedules. More glass is captured from households with EOW service (85%) as compared to weekly service (81%).

Figure 41. Recyclable Glass Capture Rate by Service Schedule

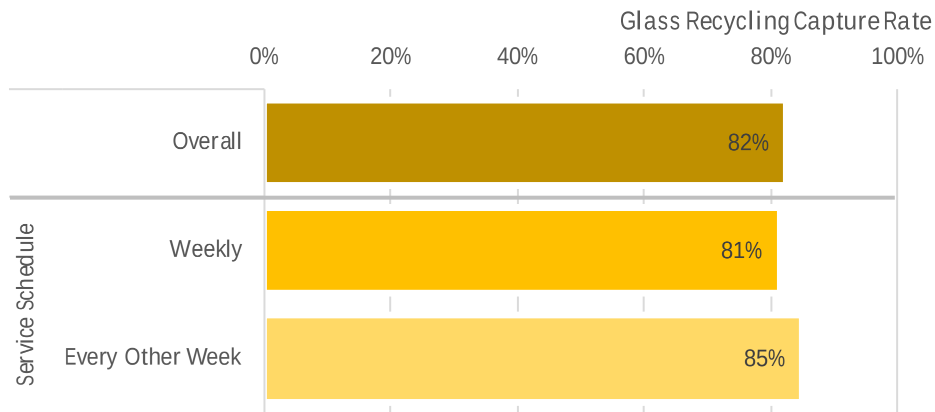


Figure 42 shows the number and proportion of sampled households that recycle glass by cohort. As shown, the majority, 72%, of the sampled households recycle 80-100% of their recyclable glass. Meanwhile, 13% of the sampled households recycle none of the recyclable glass they generate. Figure 43 and Figure 44 show the glass recycling behavior of households by service schedule. About the same proportion of households with EOW service (13%) as weekly service (11%) do not recycle their glass.

Figure 42. Recyclable Glass Capture Rate

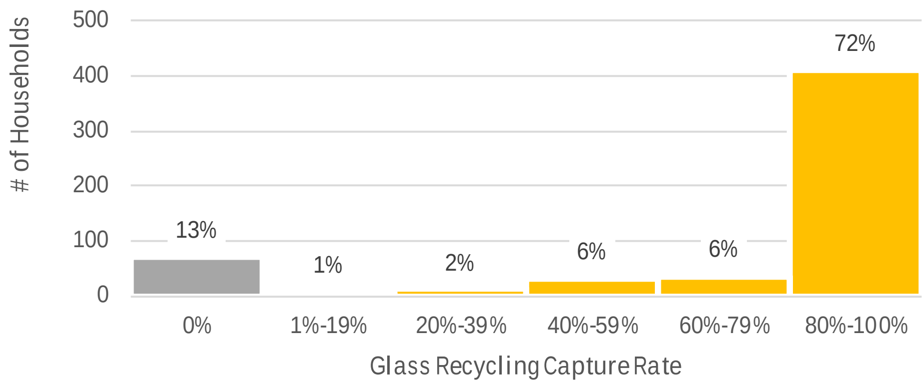


Figure 43. Recyclable Glass Capture Rate Weekly Service

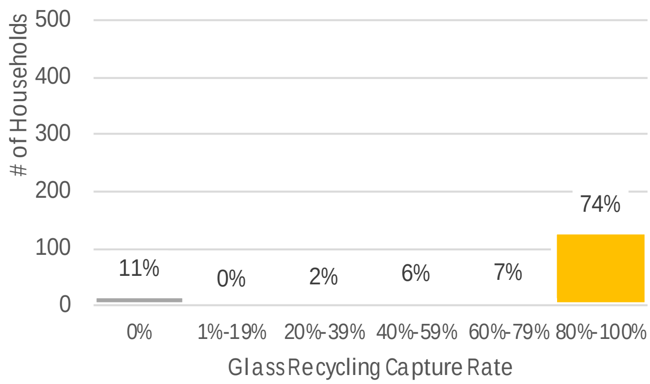
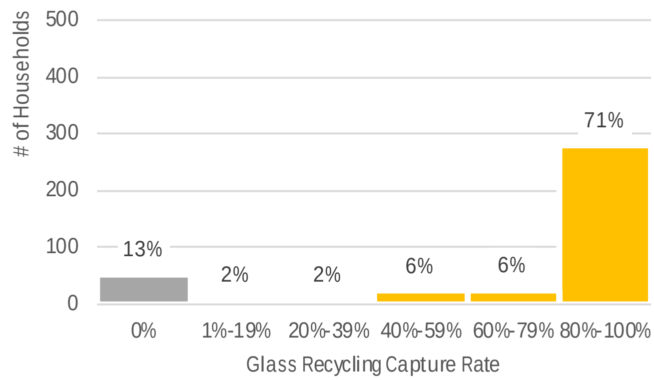


Figure 44. Recyclable Glass Capture Rate EOW Service

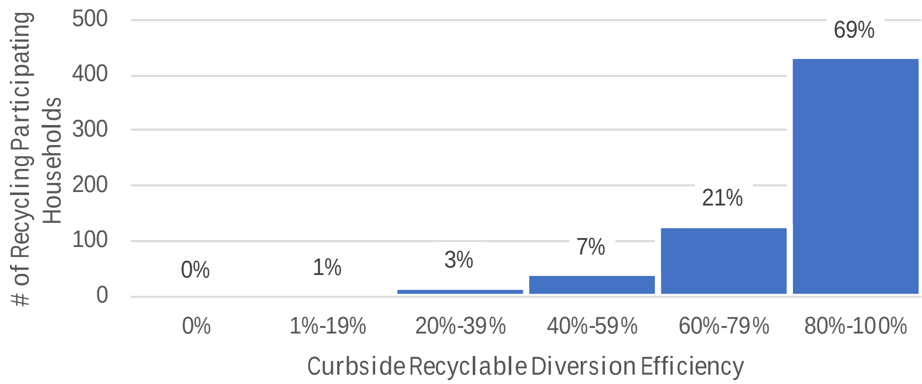


Recyclables Diversion Efficiency

Diversion efficiency is the rate at which households that set-out curbside recycling carts put recyclables into the appropriate diversion cart. Whereas the capture rate examines recycling as a proportion of generation at <u>all households</u>, diversion efficiency looks at recycling as a proportion of generation at <u>only the households with a set-out</u>. Increasing diversion efficiency is one of the two key pathways to increasing the capture rate, but relatively little information about diversion efficiency was available prior to this study because previous studies did not sample all carts (garbage, recycling and organics) from single-family households.

This study found that overall recyclables diversion efficiency did not follow a normal distribution pattern throughout the population but rather a bimodal ("all or nothing") distribution, as illustrated in the histograms of household diversion efficiency in Figure 45. This figure shows the proportion of households that fall within a specified range of diversion efficiency. As shown, over two-thirds (69%) of households with a set-out placed at least 80% of their recyclables in the recycling cart. At the other end of the behavior distribution, no households set out a recycling cart with zero recycling in it (zero percent of households had a zero percent diversion efficiency). This isn't surprising since only households with a set out are included in this calculation and while it is theoretically possible to have a zero percent diversion efficiency, for example setting out a recycling cart with only non-recyclable materials (contaminants), it is unlikely.

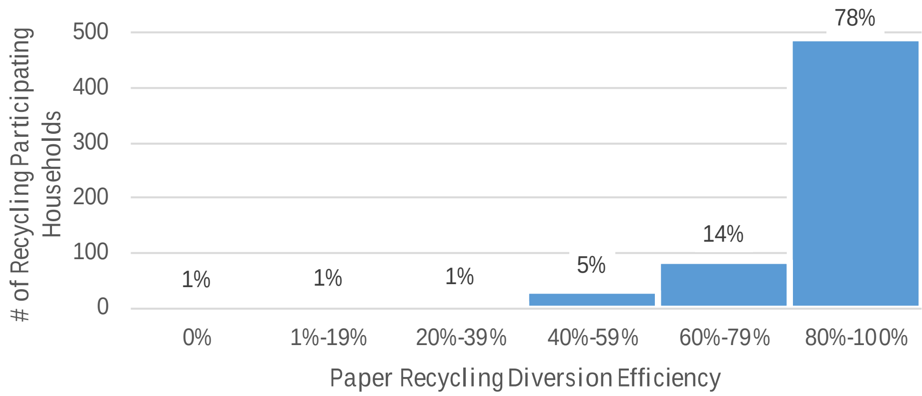
Figure 45. Recyclables Diversion Efficiency



Recyclable Paper Diversion Efficiency

As shown in Figure 46, over three-fourths (78%) of households with a recycling set-out placed at least 80% of their recyclable paper in the recycling cart. At the other end of the behavior distribution, one percent of households set out a recycling cart with zero recyclable paper in it (one percent of households had a zero percent paper diversion efficiency). This means that 1% of households with a recycling set-out placed all off their recyclable paper in either the garbage cart or the organics cart.

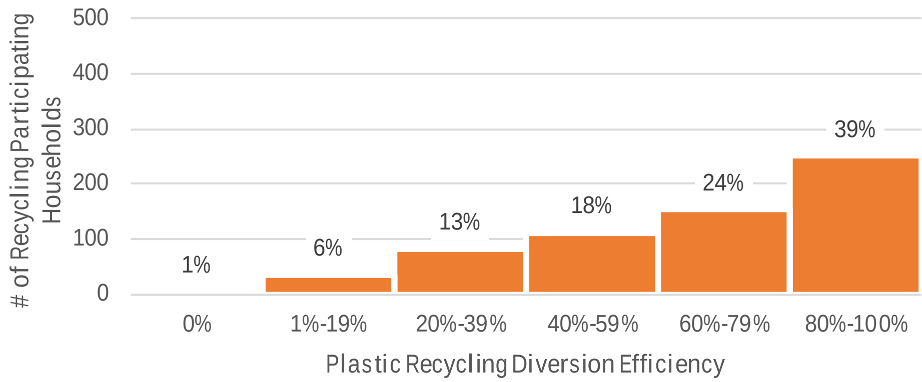
Figure 46. Recyclable Paper Diversion Efficiency



Recyclable Plastic Diversion Efficiency

For recyclable plastic, as shown in Figure 47, 39% of households with a recycling set-out placed at least 80% of their recyclable plastic in the recycling cart. One percent of households with a recycling set-out placed all off their recyclable plastic in either the garbage cart or the organics cart.

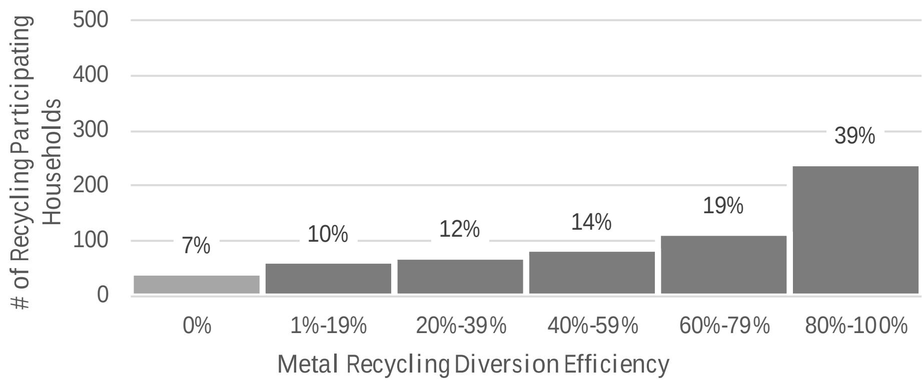
Figure 47. Recyclable Plastic Diversion Efficiency



Recyclable Metal Diversion Efficiency

As shown in Figure 48, 39% of households placed at least 80% of their recyclable metal in the recycling cart. At the other end of the behavior distribution, 7% of households with a recycling set-out placed all off their recyclable metal in either the garbage cart or the organics cart.

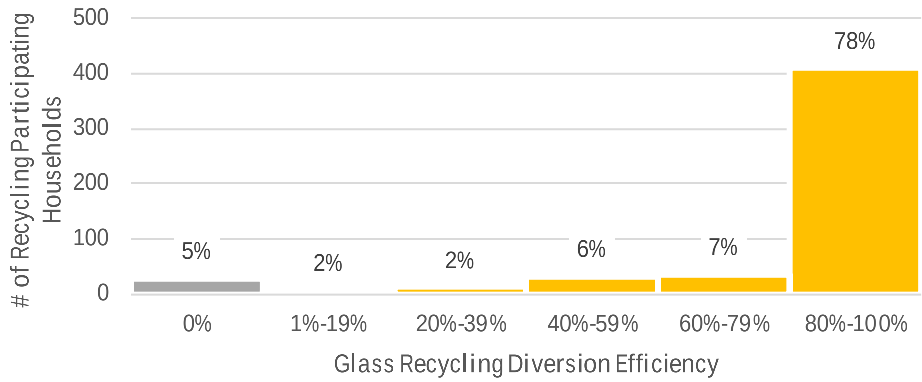
Figure 48. Recyclable Metal Diversion Efficiency



Recyclable Glass Diversion Efficiency

Figure 49 shows the diversion efficiency for glass. As shown, over three-quarters (78%) of households with a recycling set-out placed at least 80% of their recyclable glass in the recycling cart. At the other end of the behavior distribution, 5% of households with a recycling set-out placed all their recyclable glass in either the garbage cart or the organics cart.

Figure 49. Recyclable Glass Diversion Efficiency

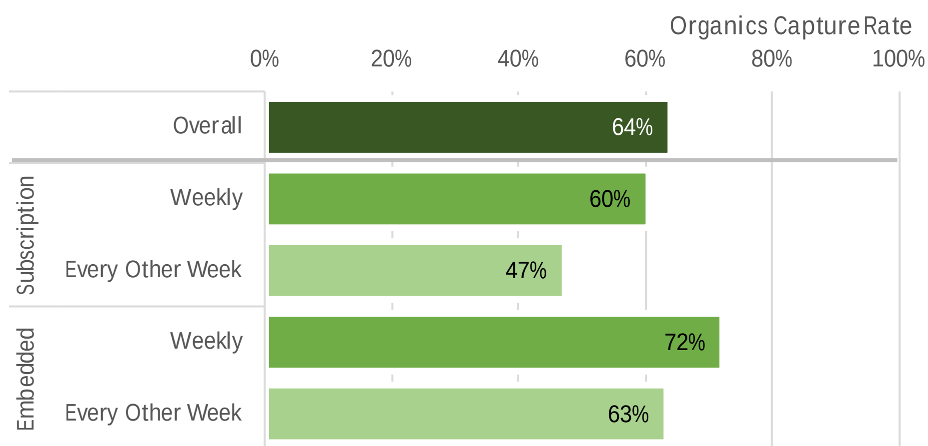


Compostables Capture Rates and Diversion Efficiency

Similar to the previous sections where we looked at capture rates and diversion efficiency for recyclables, this section of the report examines the capture rate and diversion efficiency for compostable materials.

Figure 50 illustrates the household compostables capture rates (the proportion of compostables set out for curbside collection that ends up in an organics cart) for the four service type and service schedule combinations. As shown, households in areas with weekly embedded service have the highest compostables capture rate; 72% of the compostable material set out is collected in an organics cart. This is followed by EOW embedded (63%) and weekly subscription (60%). EOW subscription has the lowest organics capture rate, at 47%.

Figure 50. All Compostables Capture Rate by Service Schedule and Service Type



Across all households, approximately a third, (32%) place at least 80% of their compostable materials generated. However, almost half, 47% of all households place none of the compostable materials they generate in their curbside organics bin. Figure 51 summarizes the organics capture rate behavior for individual households.

Figure 51. All Compostables Capture Rate

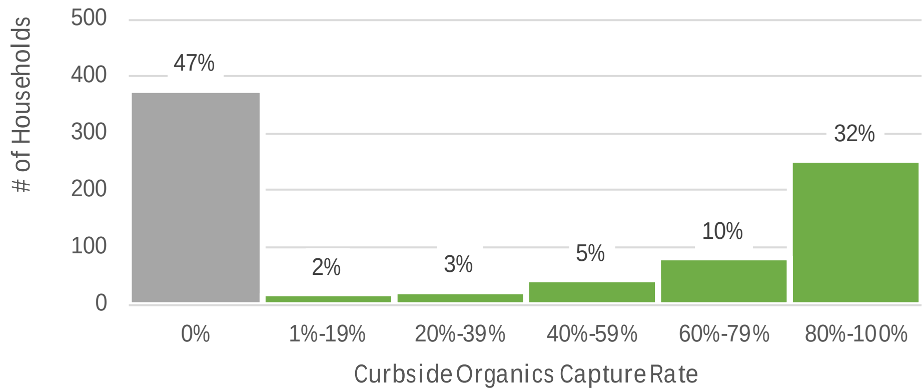


Figure 52 through Figure 55 summarize the organics capture rate behavior at households with embedded weekly, embedded EOW, subscription weekly, and subscription EOW service. Households with embedded EOW organics available to them were the most likely to capture at least 80% of their organics; households with subscription EOW service available to them were the least likely (36% and 18%, respectively). Fifty seven percent of households with subscription service (either weekly or EWO) available to them placed none of their compostables in an organics cart, measurably higher than the embedded customers.

Figure 52. All Compostables Capture Rate Embedded Weekly

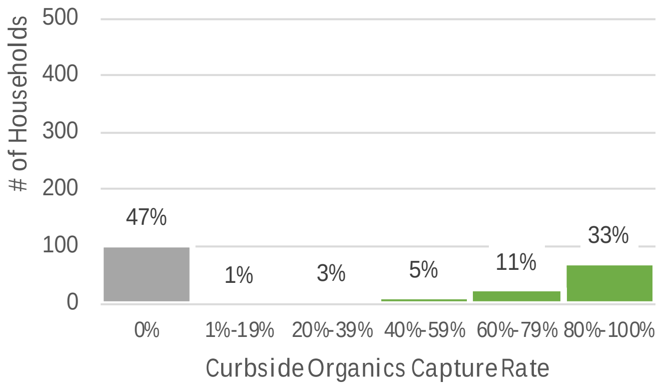


Figure 53. All Compostables Capture Rate Embedded Every Other Week

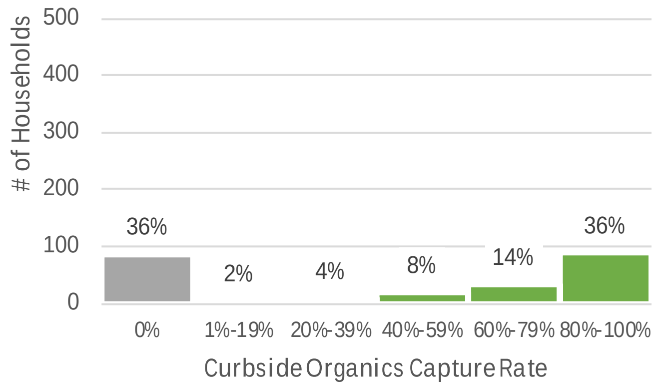


Figure 54. All Compostables Capture Rate Subscription Weekly

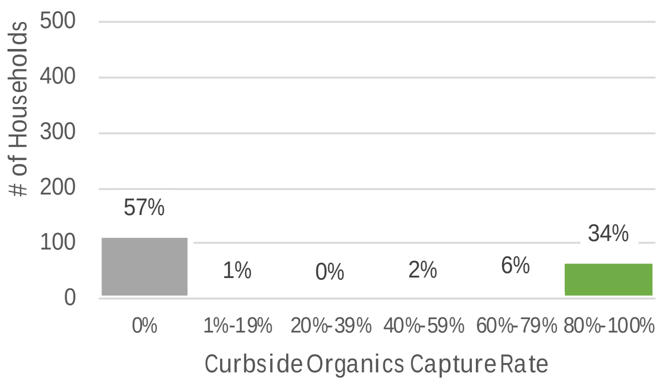
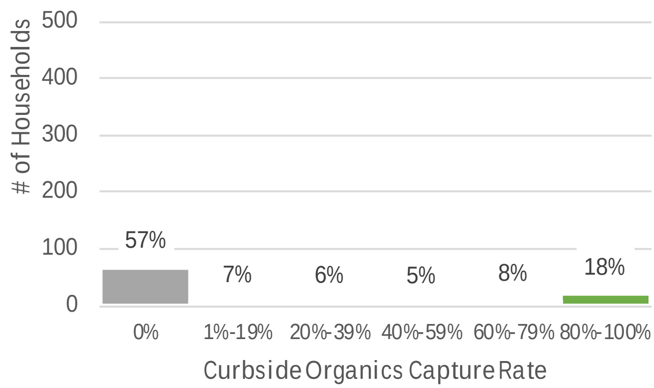


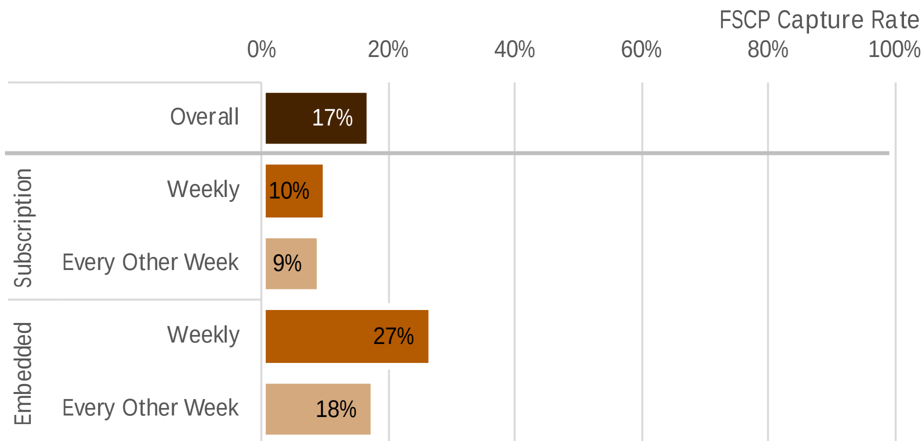
Figure 55. All Compostables Capture Rate Subscription Every Other Week



Food Scraps and Compostable Paper (FSCP) Capture Rates

Figure 56 shows the FSCP capture rate by service schedule and type. As shown, the capture rate for FSCP is highest, at 27% for weekly embedded households, followed by EOW embedded customers (18%). The capture rate for FSCP is lowest amongst households with EOW subscription service (9%).

Figure 56. Food Scraps and Compostable Paper Capture Rate, by Service Schedule and Service Type



Unlike the recyclable materials or compostables overall, most households, 63%, divert none of their FSCP. Just 12% of sampled households divert 80-100% of their FSCP.

Figure 57. Food Scraps and Compostable Paper Capture Rate

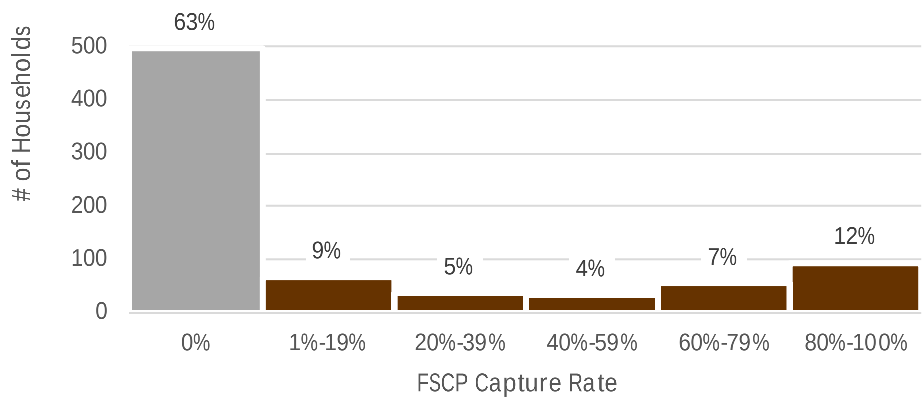


Figure 58 through Figure 61 showcase the FSCP capture rate behavior at households with embedded weekly, embedded EOW, subscription weekly, and subscription EOW service. At 15% and 13%, the embedded EOW and embedded weekly organics customers had the largest proportion of sampled households that placed at least 80% of their FSCP in an organics cart. Customers with subscription weekly service were proportionally the largest group (at 70%) of households to not divert any FSCP.

Figure 58. FSCP Capture Rate
Embedded Weekly Service

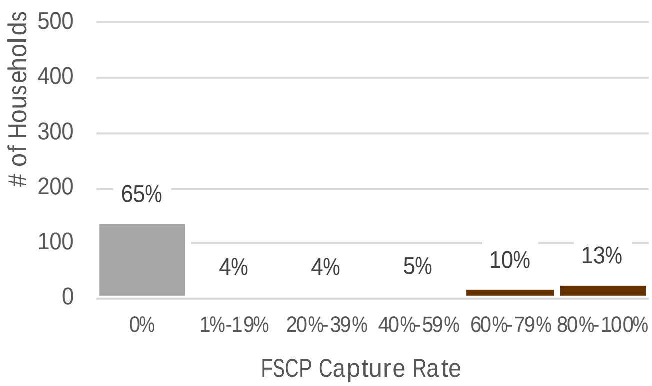


Figure 59. FSCP Capture Rate
Embedded Every Other Week Service

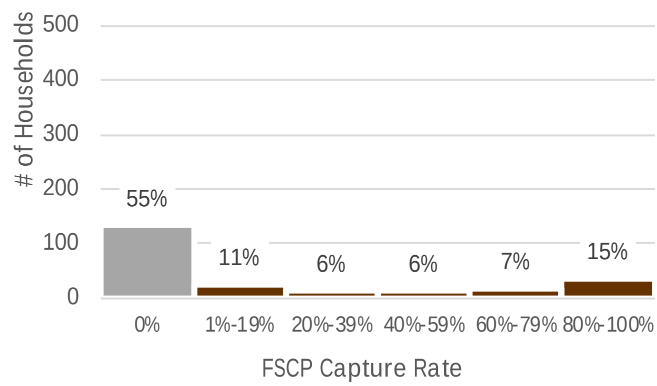


Figure 60. FSCP Capture Rate
Subscription Weekly Service

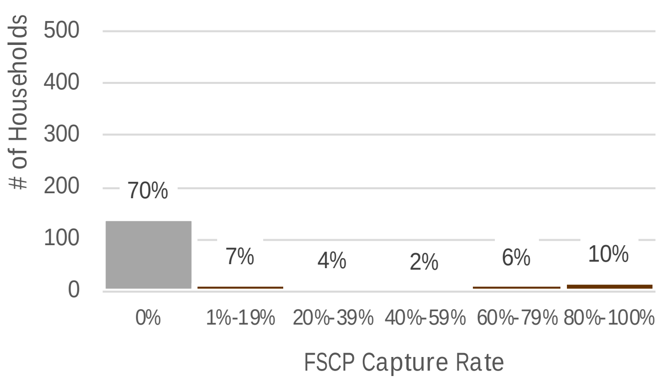
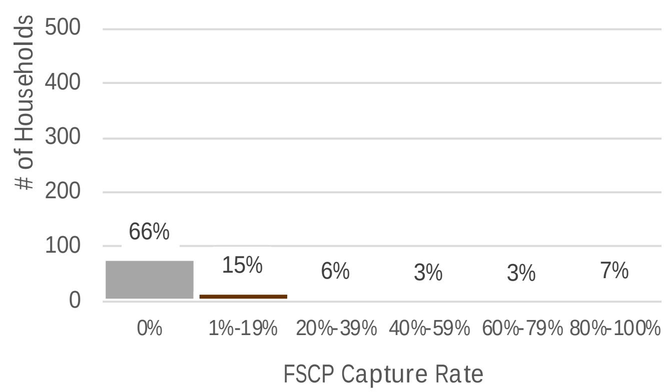


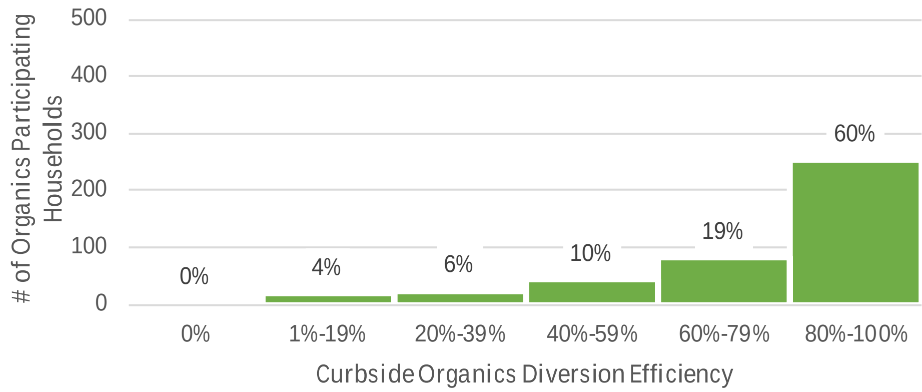
Figure 61. FSCP Capture Rate
Subscription Every Other Week Service



Compostables Diversion Efficiency

Improving diversion efficiency (increasing the quantity of organics collected by the households that are already setting out a cart) is a key strategy to raising the capture rate. Similar to the recycling diversion efficiency, this study found that overall compostable diversion efficiency did not follow a normal distribution pattern throughout the population but rather a bimodal ("all or nothing") distribution. This is illustrated in the histograms of household diversion efficiency in Figure 62. As shown, less than two-thirds (60%) of organics customers with a set-out placed at least 80% of their compostables in the organics cart. Another 19% of organics customers with a set-out placed 60-79% of the organics they generate in the cart. This shows an opportunity for additional diversion of material from landfill if residents already willing to participate in curbside organics collection modified their behavior slightly to capture even more of the organic material generated at home.

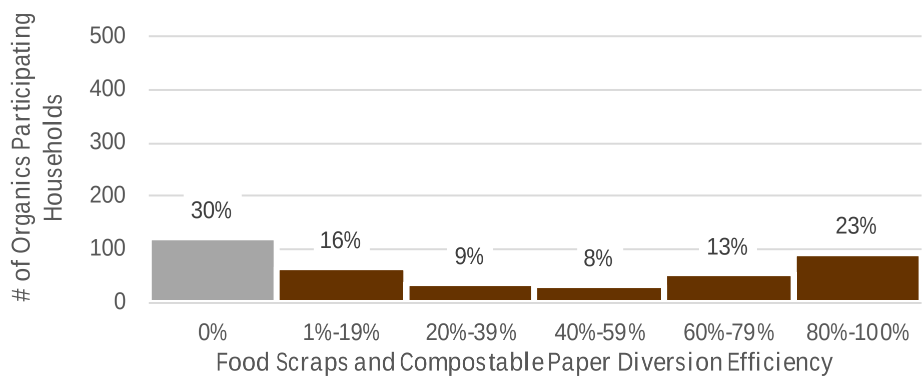
Figure 62. All Compostables Diversion Efficiency



Food Scraps and Compostable Paper (FSCP) Diversion Efficiency

As shown in Figure 63, less than a quarter (23%) of organics customers with a set-out put 80-100% of their FSCP in the organics bin. About a third (30%) composted no FSCP via curbside collection, while another 16% of organics customers with a set-out placed a small amount (1-19%) of their FSCP in their organics cart.

Figure 63. Food Scraps and Compostable Paper Diversion Efficiency



Contamination Rate Patterns

One key objective for this study is to better understand the level of contamination in the recycling and organics collection carts. Of the 106,269 tons that King County single-family residents set out for recycling, 13,477 tons (13%) is comprised of non-recyclable material. Meanwhile, of the 170,141 tons of organics collected curbside from residents, 7,761 tons, 5% is contamination (non-compostable material). These sections present additional detail on recycling and organics contamination in King County's curbside collection programs.

Recycling Contamination Rates

Figure 64 shows the distribution of contamination among households with a recycling set-out. As shown, the majority (53%) of recycling set-outs have less than 5% contamination. The bulk of this cohort have less than 3% contamination. However, nearly a quarter (24%) of recycling set-outs have over 15% contamination. The cohort represents an opportunity for additional outreach and education.

Figure 64. Recycling Contamination Rate Distribution

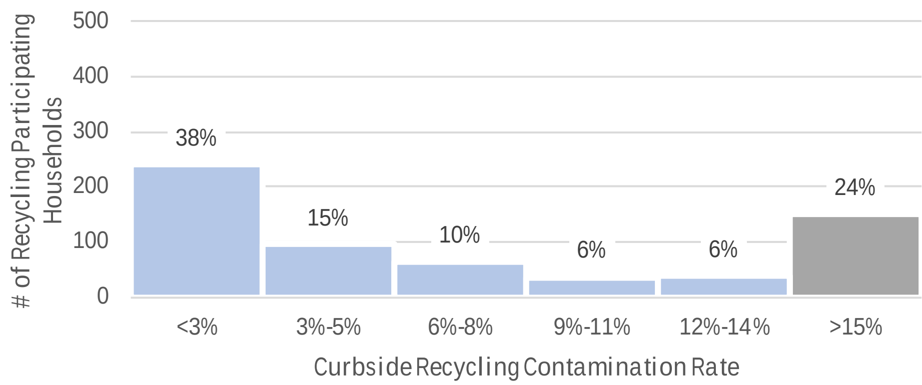


Figure 65 and Figure 66 examine recycling contamination data by service schedule, weekly and EOW, respectively. The proportion of recycling set-outs with greater than 15% contamination is about the same, 26% and 23%, respectively for each service schedule. On the other end of the spectrum, 36% of set-outs in areas with EOW service had less than 3% contamination in their cart, compared to 42% in areas with weekly service.

Figure 65. Recycling Contamination Rate Distribution Weekly Service

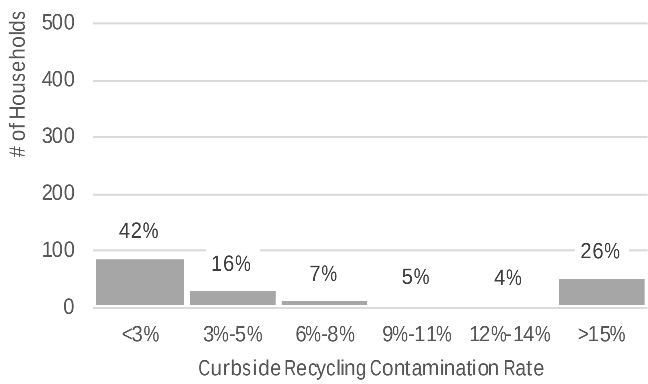
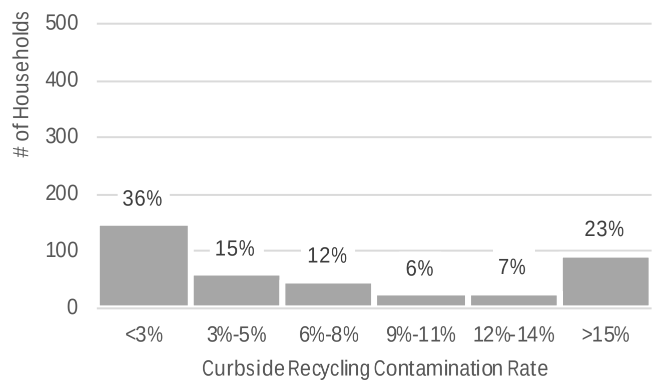


Figure 66. Recycling Contamination Rate Distribution Every Other Week Service



Organics Contamination Rates

Figure 67 shows the distribution of contamination among organics cart set-outs. As shown, almost three quarters (74%) of organics set-outs have carts with less than 1% contamination. Fourteen percent (14%) of organics participants have organics collection carts with over 5% contamination. This cohort represents an opportunity for additional outreach and education.

Figure 67. Organics Contamination Rate Distribution

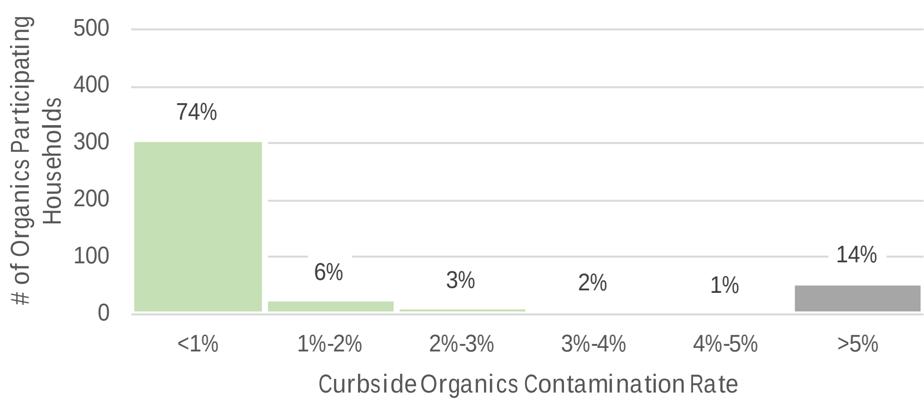


Figure 68 through Figure 71 show the contamination rate distribution for the different organics service type and service schedule combinations. The distribution is about the same for each subpopulation of organics set-outs. Most set-outs in each service combination have less than 1% contamination. Meanwhile, 18% of set-outs in areas with embedded weekly service were over 5% contaminants. Organics set-outs in areas with embedded EOW service had the smallest greater than 5% contamination cohort.

Figure 68. Organics Contamination Rate Distribution Embedded Weekly Service

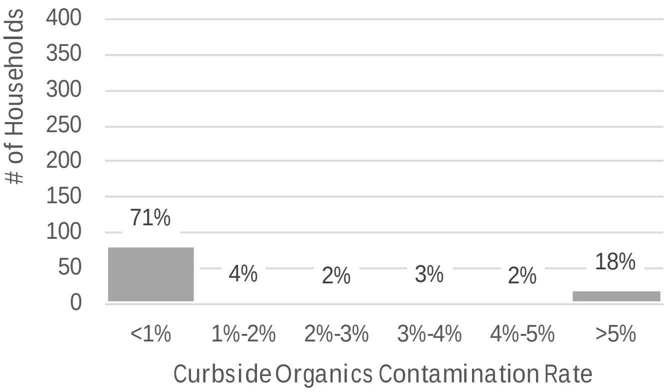


Figure 69. Organics Contamination Rate Distribution Embedded Every Other Week Service

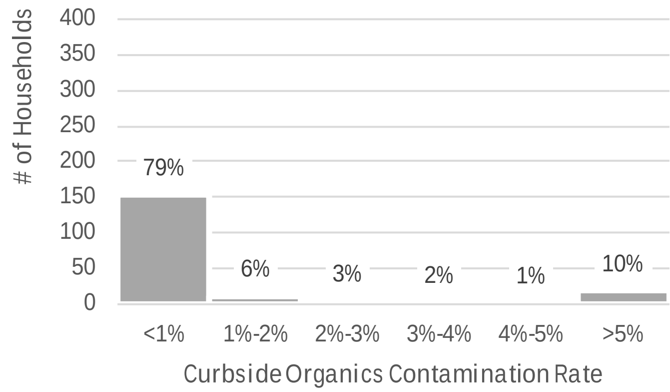


Figure 70. Organics Contamination Rate Distribution Subscription Weekly Service

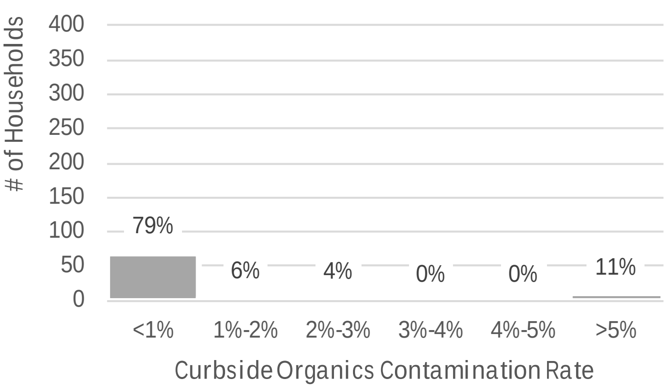
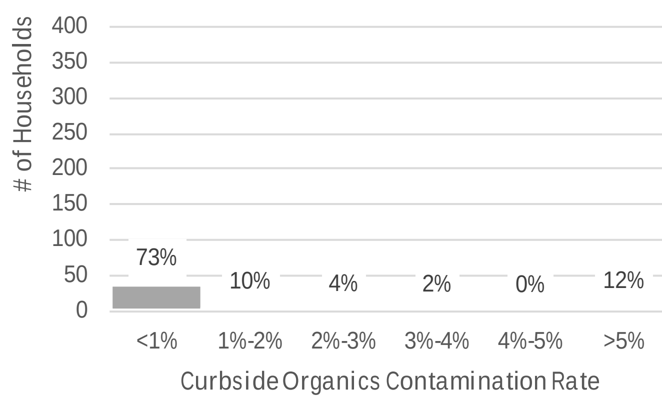


Figure 71. Organics Contamination Rate Distribution Subscription Every Other Week Service



Comparisons to Previous Organics Studies

There have been marked changes to curbside organics service throughout King County since the first organics study in 2007. Residents in nearly every jurisdiction within the county can now include food scraps in their carts (99% of households in 2017 compared to 57% in 2007). Programs have also had many years to mature and attract new users. Methodological changes between the 2007 and 2017 studies are significant, including a switch from collecting samples from route trucks as they complete their route to collecting samples directly from carts at the curbside, and an increase from a single sampling season to five seasons. For these reasons, direct comparisons of the results between 2007 and the four subsequent studies (2009, 2011, 2014, and 2017) are difficult; however, the methodology changes from 2009 to 2017 are smaller so the results are more comparable.

For comparison, where the methodology allows, the same metrics from each study are summarized in this section. Some differences are methodological, some are programmatic, and some are due to behavior changes by King County residents.

Organics Rate Comparisons

Table 17 presents several key measures from the 2007 through 2017 studies. Each of the measure is discussed in more detail following the table.

Table 17: Comparison of Key Data between 2011 and 2017

	2007	2009	2011	2014	2017
Organics					
Percent Organic Customers	68%	63%	67%	72%	78%
Organic Customers Set-out Rate	38%	49%	38%	52%	47%
FSCP Capture Rate	*	12%	13%	15%	17%
Food Scraps & Compostable Paper Participants					
Organics Customer Participation Rate	*	24%	19%	27%	32%
Set-out Participation Rate	*	50%	49%	52%	68%
Diversion Efficiency Rate	*	77%	86%	67%	56%

*Methodology changes from 2007 prevent comparisons between years for this measure.

Organics Customer Rate

The decrease in the proportion of organics customers from 2007 to 2009 may be due to an increase in jurisdictions implementing paid, subscription-based—rather than embedded—organics service programs. King County residents with organics service available to them increased faster than the number of residents who subscribe to the service, therefore the organics customer rate decreased. Between 2009 and 2014, the trend appears to have reversed and the organics customer rate increased.

Set-Out Rate

Besides changes in the utilization of organics service carts by households, the changes in the set-out rate may be influence by external factors such as:

- **General weather patterns-**A late spring or an early winter may influence the frequency of set-outs.

- **Weather in the week immediately preceding the sample collection-**If the weather is good then the set-out rate may increase due to an increase in the time spent doing yard work by organics customers. Conversely, if the weather is bad the set-out rate may decrease.
- **Holidays-**If sampling occurs during a holiday week the set-out rate may decrease. The study intentionally avoids all major holidays. Summer season sampling when families go on summer vacation may influence the summer set-out rate.

As shown in Table 18 the set-out rate is highly variable from season to season as households set their carts out more frequently when the weather is conducive to gardening. The correlation between set-out and weather is reinforced when considering the intra-seasonal set-out rate across study years. The spring season set out rate varies from a low of 26% in 2011 to a high of 63% in 2017, likely driven by fair gardening weather the weekend preceding field work.

Table 18. Set-out Rate by Field Season

	Spring			Summer			Fall			Winter			Overall
	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
2009		54%				44%							**49%**
2011	26%			50%					37%				**38%**
2014			57%		53%			54%		43%			**52%**
2017			63%	49%		43%		43%				35%	**47%**

Food Scraps and Compostable Paper Participation Rate

The food scraps and compostable paper (FSCP) participation rate for set-outs (68%) and all organics customers (32%) has been consistently increasing since 2011. This indicates that more organics customers are putting FSCP in their organics carts.

Food Scraps and Compostable Paper Capture Rate

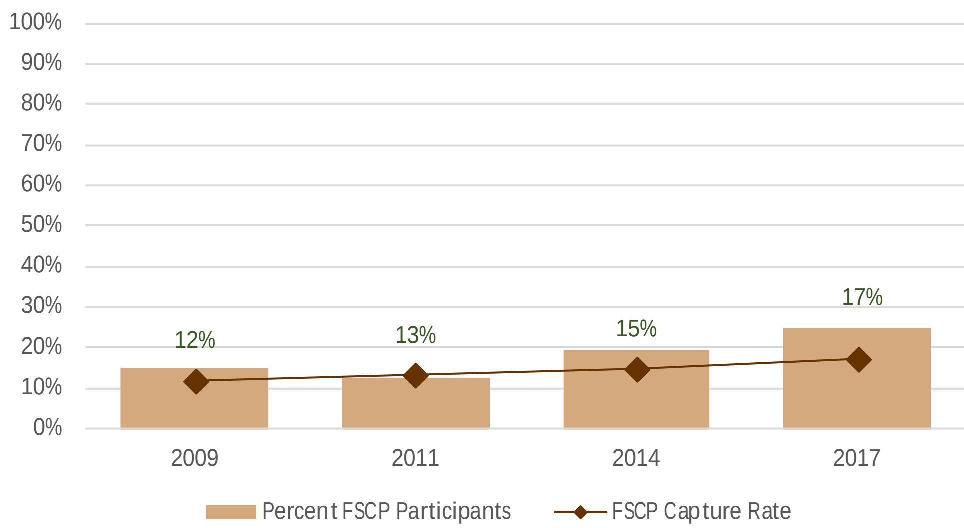
In previous iterations of this study the food scraps and compostable paper (FSCP) household capture rate was calculated based on several inputs: subscription rate, set-out rate, participation rate, and composition data from this and other studies. The methodology changes implemented in 2017 (collecting all three carts at the curb) permit a much simpler calculation of the FSCP household capture rate. The FSCP capture rate is now simply the quantity of FSCP in organics carts divided by the total quantity of FSCP set-out. The household capture rate has steadily increased to 17% since it was first calculated in 2009 (Table 19). The household capture rate is best estimate of what proportion of the FSCP generated by single family residents in King County is going to Cedar Grove; it is the metric least susceptible to measurement error.

Since the SWD has commissioned studies at intervals, we can compare the FSCP capture rate and the participation rate over time. As shown in Table 19 and Figure 72, both rates are increasing modestly.

Table 19. Household Food Scraps and Compostable Paper Capture Rates

	2009	2011	2014	2017
Household FSCP Capture Rate	12%	13%	15%	17%
Household FSCP Participation Rate	15%	13%	19%	25%

Figure 72. Household Food Scraps and Compostable Paper Capture Rate Over Time



Composition Comparisons

Because of the similarity in methods between the 2014 and 2017 studies, a t-test can check for statistically significant changes in composition data since 2014. This statistical calculation was used to test the null hypothesis "There is no statistically significant difference, between the 2014 and 2017 study periods, in the percentage of food scraps composted." The same null hypothesis was also tested for each of the other material classes. The t-test results are summarized in Table 20; none of the material classes exhibited a statistically significant change in composition since 2014 (the increase in the proportion of food is on the cusp of being significant). The calculations and a discussion of the t-test are included in Appendix D: Calculations

Table 20. T-test Results

Material Class	Change in Composition	t-Statistic	p-Value	Statistically Significant Change*
Food	1.9% ⬆	2.1734	0.0299	No
Compostable Paper	0.0% ⬌	0.0125	0.9900	No
Other Compostable	-2.6% ⬇	1.5826	0.1137	No
Contaminants	0.7% ⬆	0.6179	0.5367	No
Total Number of Samples				

**(Cut-off for statistically significant difference = 0.025)*

Appendix A: Material Type Definitions

Compostable Items

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, juiced oranges.
3. **Homegrown Fruits and Vegetables—**food that comes from a plant growing on or cleared from the customer's property. Examples will 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—**any food that cannot be put in the above categories. Examples include food items that are a combination of the above categories, as well as coffee grounds, 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. **Compostable Paper—**any food-soiled and other compostable paper items without a plastic lining/coating, such as paper towels, napkins, tissues, uncoated paper bags and wrapping, and other papers that were soiled with food during use; uncoated paper food service packaging (e.g. cups, plates, bowls); compostable paper cups; pizza boxes; waxed cardboard boxes; coffee filters; newspaper (if used to contain food waste); and shredded paper.
8. **Yard Debris—**includes leaves, grass clippings, sod, garden wastes, brush, prunings, logs, and clumped soil and rocks associated with yard debris.
9. **Compostable Plastic—**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) and compostable plastic ("PLA") containers and packaging (e.g. cups/lids, bowls, clamshells, plates, trays, cutlery, straws). Compostable plastic containers and packaging are marked with the words "compostable" or "#7 PLA" in the plastic identifier.
10. **Other Compostables—**other compostable organic materials, not included above, such as hair, popsicle sticks, chopsticks, and toothpicks.

Recyclable Items

11. **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, 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).

12. **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.
13. **Recyclable Metal—**includes metal normally recycled in curbside collection programs when not significantly contaminated. Examples include aluminum cans, tin cans, and items made mostly of ferrous or non-ferrous metal.
14. **Recyclable Glass—**includes glass normally recycled in curbside collection programs when not significantly contaminated. Examples include glass bottles and jars.

Other Materials

15. **Other Materials—**any material that does not fit into the above categories. Examples include plastic bags that are NOT made of materials that compost or biodegrade, textiles, grease, foil lined paper products, food service papers coated with plastic, Styrofoam, gypsum waste, treated wood, pet waste, loose soil and rocks, stumps, demolition debris, hazardous wastes, and non-recyclable metals, glass, and plastics. Also includes organic items whose durability makes them hard to compost. Examples include wine corks, burlap sacks, pallets, wood crates, and rope.

Appendix B: Study Design

Objectives

The objective of the residential curbside generation study was to develop a complete set of metrics around residential composition, generation rates, participation rates, and organics and recycling capture rates. Cascadia collected data for each of the basic service types in King County:

- Weekly embedded organics service,
- Every-other-week (EOW) embedded organics service,
- Weekly subscription organics service, and
- Every-other-week (EOW) subscription organics service.

The study produced results comparable to the 2009-2014 residential organics studies and provided a set of whole new metrics—recycling and organics capture rates and participation level distributions—that are valuable when tracking progress towards diversion goals and designing outreach and education programs.

Summary

Composition, set-out, and participation data were collected over five field events each lasting for one week (approximately every other month from February through October). During each event, samples were collected from 20 routes (four routes per day for five days). Routes were randomly selected from around the county. Cascadia anticipated to collect and sort carts from approximately 800 households during the study.

Table 21 shows the planned sampling schedule for the 2017 study.

Table 21. 2017 Sampling Schedule

Field Event	Month	Start Date	End Date
1	February	2/27/17	3/3/17
2	April	4/24/17	4/28/17
3	June	6/19/17	6/23/17
4	August	8/14/17	8/18/17
5	October	10/9/17	10/13/17

The second round of field work was originally scheduled for late April. The field work was rescheduled to mid-May to accommodate other logistical concerns at the transfer station where samples were to be sorted.

Each sampling event's field work can be broken into two broad elements—sample collection and sample sorting. The plan was for the hauler to provide Cascadia with a list of residential organics routes by day of the week. From this list, we randomly selected four organics routes per day (one from each service type) from each weekday, for a total of 20 routes for each field event. During each event, the route surveyors were instructed to traverse the selected routes recording set-out information for the route and to collect material from eight set-outs for hand sorting. For each selected set-out, a sample included all material from a single stream (garbage, recycling, or organics) set out for collection, including bagged material set next to the cart. The goal was for samples from eight set-outs to be collected per route on 20 routes per field event for a total of 160 set-outs per field event.

The route surveyors sorted the samples at the Shoreline and Bow Lake transfer stations (depending on which station was closer to where we collected samples). Following the sorts, the project team analyzed the data to determine the composition of garbage, recycling, and organics set out by residents, the number of households that set out carts for collection that include food waste, how participation varies by service type, and how contamination varies by service type.

This document describes the proposed study methodology. The sampling plan is organized into five sections.

- **Section 1: Study Terms and Definitions—**a list of several unique terms used throughout this document.
- **Section 2: Route Selection—**a description of the method used to define the universe of routes and the random selection process.
- **Section 3: Route Data and Sample Collection—** a description of the method in which data were collected along each of the selected routes and the method used to collect random, representative samples.
- **Section 4: Sorting Procedures—**a description of the method used to characterize samples.
- **Section 5: Material Definitions—**the complete list of materials, definitions, and examples of acceptable and unacceptable items in each category.

Study Terms and Definitions

- **King County.** Refers to King County, excluding Seattle.
- **Household:** For the purposes of this study, a *household* is defined as a single-family residence in King County, excluding the City of Seattle.
- **Generation:** In this report, *generation* refers to the sum of all curbside collected material: garbage, recycling, and organics. *Generation* would not include self-hauled materials to disposal, recycling or composting facilities, and it would not include organic material composted or otherwise managed on the residents' property.
- **Recycling Service.** For the purposes of this study, *recycling service* only includes commercially collected curbside/alley programs.
- **Organics Service.** For the purposes of this study, *organics service* only includes commercially collected curbside/alley programs where residents may combine food waste and yard waste in a single cart.
- **Service Schedule**: The *service schedule* refers to the frequency of the collection. Weekly service means the carts are collected one time per week. Every other week (EOW), means the carts are collected every other week. A household may have a different service schedule for each stream (garbage, recycling, and organics).

- **Service Type:** The *service type* refers to the method by which a household signs up for organics service, either an opt-in *subscription* method or an opt-out *embedded* method.
- **Subscribe, Subscription, Subscriber:** These terms refer to the universe of *households* that must opt-in to *organics service* as an add-on service.
- **Embedded:** This term refers to the universe of households with *organics service* as part of a package with garbage and recycling service; it is not chosen separately by the resident.
- **Organics Customer.** An *organics customer* is a King County household that either receives *embedded* organics service or has opted-in to a *subscription* organics service.
- **Set-Out.** A *set-out* is a *garbage, recycling, or organics service* container placed on the curb/alley for pick up by the collection company. It is important to distinguish between a *customer* (a household with *collection service*) and a *set-out* (where the resident uses the service and physically sets out the container for collection).
- **Food Waste Participant.** A *food waste participant* is a household that places at least some food waste or compostable paper in the *organics service* container.
- **Data Collection Area.** A *data collection area* is the area inside the boundaries of a single organics route and includes the sections of garbage and recycling routes that fall into the boundaries of the organics route.
- **Sample.** A *sample* includes all material set out for collection from a household from a single stream (either garbage, recycling, or organics), including bagged material set next to the cart. Each household may have as many as three samples (one sample from each stream) or as few as one (a household that has only a garbage set-out, for example).

The service schedule and service type for each jurisdiction in King County is listed in Table 22.

Table 22. Service Types and Service Schedules by City

Jurisdiction	Hauler	Organics Service Schedule	Organics Service Type
Algona	WM - South Sound	EOW	Subscription
Auburn	WM - South Sound	Weekly	Subscription
Beaux Arts	Republic of Bellevue	Weekly	Subscription
Bellevue	Republic of Bellevue	Weekly	Embedded
Black Diamond	Republic of Kent	EOW	Subscription
Bothell	WM - Northwest	Weekly	Embedded
Burien	Recology	Weekly	Embedded
Carnation	Recology	Weekly	Subscription
Clyde Hill	Republic of Bellevue	Weekly	Embedded
Covington	Republic of Kent	EOW	Subscription
Des Moines	Recology	EOW	Subscription
Duvall	WM - Northwest	Weekly	Subscription
Enumclaw	Enumclaw	EOW	Subscription
Federal Way	WM - South Sound	Weekly	Subscription
Hunts Point	Republic of Bellevue	Weekly	Subscription
Issaquah	Recology	Weekly	Embedded
Kenmore	Republic of Bellevue	Weekly	Subscription
Kent	Republic of Kent	EOW	Embedded
Kirkland	WM - Northwest	Weekly	Embedded
Lake Forest Park	Republic of Bellevue	EOW	Embedded
Maple Valley	Recology	EOW	Subscription
Medina	Republic of Bellevue	Weekly	Subscription
Mercer Island	Republic of Bellevue	EOW	Embedded
Newcastle	WM - Seattle	Weekly	Subscription
Normandy Park	Republic of Kent	EOW	Embedded
North Bend	Republic of Bellevue	EOW	Subscription
Pacific	WM - South Sound	EOW	Subscription
Redmond	WM - Northwest	Weekly	Embedded
Renton	Republic Services	Weekly	Embedded
Sammamish	WM - Northwest	Weekly	Subscription
Sammamish Klahanie	Recology	Weekly	Embedded
SeaTac	Recology	EOW	Embedded
Shoreline	Recology	Weekly	Embedded
Snoqualmie	WM - Northwest	Weekly	Embedded
Tukwila	WM - Seattle	EOW	Subscription
Unincorporated - North	WM - Northwest	Weekly	Subscription
Unincorporated - North	Republic of Bellevue	Weekly	Subscription
Unincorporated - South	WM - South Sound	Weekly	Subscription
Unincorporated - South	WM - Seattle	Weekly	Subscription
Unincorporated - South	Republic of Kent	EOW	Subscription
Unincorporated - Vashon	Vashon	N/A	N/A
Woodinville	WM - Northwest	Weekly	Subscription
Yarrow Point	Republic of Bellevue	Weekly	Subscription

Route Selection

Cascadia obtained a list of residential organics routes by day of the week from each hauler. We organized the routes by day of the week and service type. From this list, we randomly selected four organics routes per day (one from each service type and service schedule combination), for a total of 20 routes for each field event using the *=rand()* function in Microsoft Excel. Through random selection, we ensured that the selected routes provided a representative mix of jurisdictions throughout the county and service types and service schedules. The same routes were eligible to be used each field event. We did not sample routes that had participated in cart tagging pilot studies recently completed by the haulers around King County because those households have received educational information on cart tags, which may influence the materials placed in their carts and the resulting data. The routes selected for sampling are listed in Table 23.

Table 23: Jurisdictions with Routes Randomly Selected for Sampling in 2017

	Winter-February			
Monday	Bothell	Federal Way	Maple Valley	Shoreline
Tuesday	Kent	Kirkland	Lake Forest Park	Redmond
Wednesday	Bellevue	Federal Way	Lake Forest Park	Shoreline
Thursday	Kirkland	Mercer Island	Sammamish	Unincorporated
Friday	Auburn	Des Moines	Issaquah	Kent

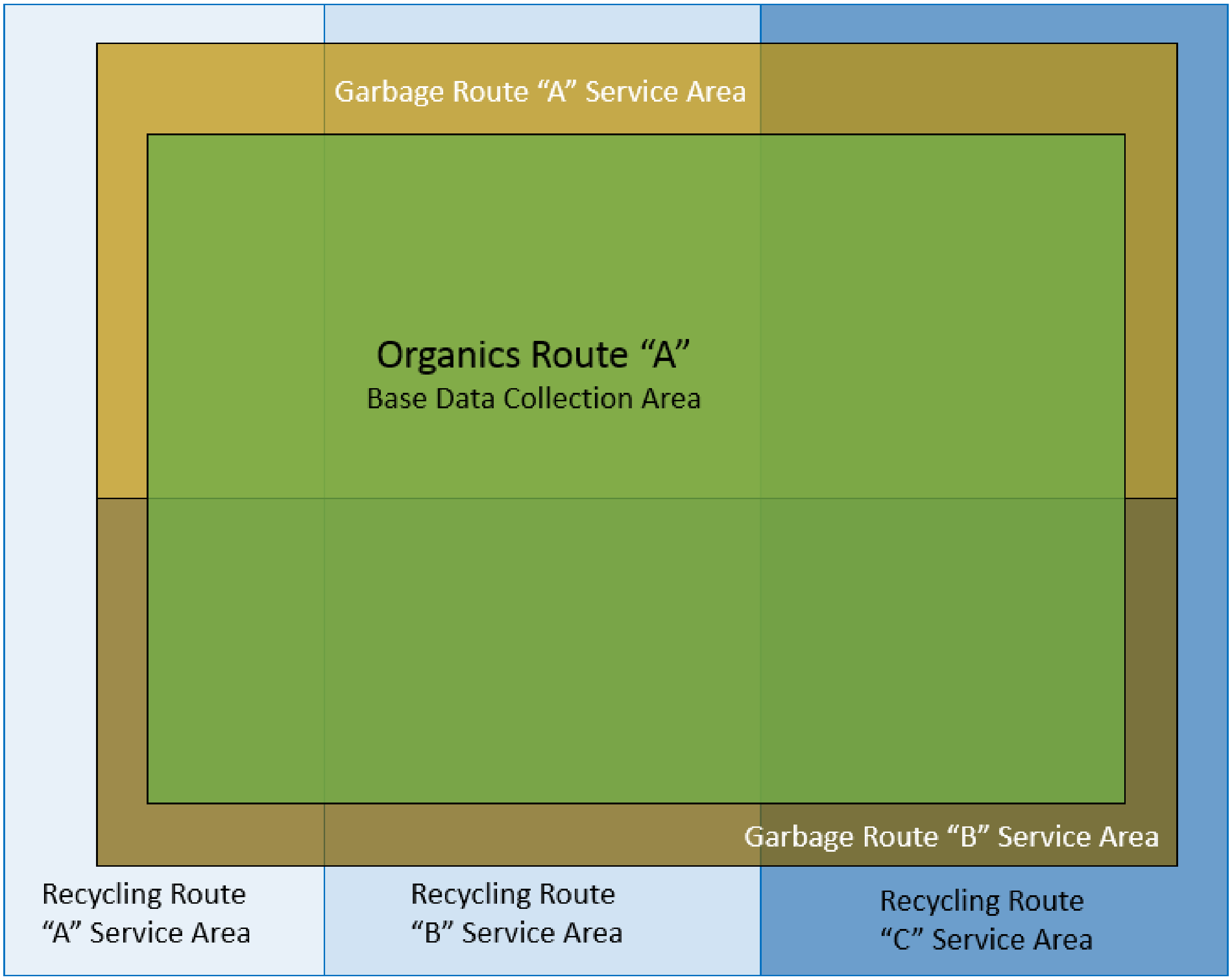
	Spring-May			
Monday	Bothell	Federal Way	Maple Valley	Shoreline
Tuesday	Kent	Kirkland	Lake Forest Park	Redmond
Wednesday	Bellevue	Federal Way	Lake Forest Park	Shoreline
Thursday	Kirkland	Mercer Island	Sammamish	Unincorporated
Friday	Auburn	Des Moines	Issaquah	Kent

	Summer-June			
Monday	Bothell	Federal Way	Maple Valley	Mercer Island
Tuesday	Carnation	Kent	Lake Forest Park	Redmond
Wednesday	Bellevue	Federal Way	Lake Forest Park	Seatac
Thursday	Auburn	Mercer Island	Sammamish	Unincorporated
Friday	Auburn	Des Moines	Issaquah	Kent

	Summer-August			
Monday	Bothell	Federal Way	Maple Valley	Mercer Island
Tuesday	Carnation	Kent	Lake Forest Park	Redmond
Wednesday	Federal Way	Lake Forest Park	Renton	Seatac
Thursday	Auburn	Mercer Island	Sammamish	Unincorporated
Friday	Auburn	Des Moines	Issaquah	Kent

	Fall-October			
Monday	Bothell	Federal Way	Maple Valley	Mercer Island
Tuesday	Carnation	Kent	Lake Forest Park	Redmond
Wednesday	Federal Way	Lake Forest Park	Renton	Seatac
Thursday	Auburn	Mercer Island	Sammamish	Unincorporated
Friday	Auburn	Des Moines	Issaquah	Kent

Figure 73. Organics Route Data Collection Area Illustration



The organic route boundaries were the data collection area (DCA) boundaries. We assumed that every household in the DCA boundary had garbage and recycling service (since over 99% of households in the county have embedded garbage and recycling service). We then calculated set-out rates for households within the DCA boundaries because we knew the total number of households within the boundaries from the hauler provided data.

Route Data and Sample Collection

Each day, two route surveyors working as a team were assigned to each of the four base data collection areas (DCA). At the start of every sampling day, each route surveyor received a DCA map, driving directions, data collection sheets, the count of organics subscribers in the DCA, and the count of households in the in the DCA. Each route surveyor wore a name tag with the hauler's logo on it. Additionally, each truck had a banner with the SWD logo and "study in progress" displayed on the side, should any customers along the route have questions about the study. The teams travelled their assigned DCA, recording the number of garbage, recycling, and organics set-outs on an electronic set-out count form. Paper field forms were available as a back-up to the electronic entry forms. An example of the set-out count form is included in Appendix E: Example Field Forms.

The route surveyors traversed the DCA 30 minutes before the hauler begins collection. This ensured that the sampler was sufficiently ahead of the hauler to prevent any disruptions to collection operations while allowing residents the maximum time to set out their carts for counting and collection.

Cascadia informed both the haulers and local police in the areas we were collecting samples of our sampling and collection plan the week prior to the start of sampling to ensure that all channels were properly informed should resident questions or interactions come up. We also had handouts with information about the study to provide to customers with questions about the study. Cascadia also tracked the number and type of customer interactions that occurred during the study, including recording the addresses of any customers who opt out of the study so they could be excluded from future rounds of sample collection. Examples of a customer handout and interaction tracking form are included in Appendix E: Example Field Forms.

The route survey teams were also responsible for selecting set-outs for sampling. Using a predetermined sampling interval, each route survey team collected all material from eight set-outs each day. The sampling interval was determined using the following procedure:

1. For each sampling day and DCA, the expected number of set-outs, *L*, was estimated using organics route data provided by the haulers. The number *L* was then reduced by one-fifth (producing 0.8 x *L*). This was done to ensure that the targeted number of set-outs were selected on each sampling day, even if there were fewer set-outs than expected.
2. Next, the interval *n* was determined to ensure systematic sampling of set-outs. If *r* represented the number of samples needed, and .8 x *L* represented the number of expected set-outs, then $n = (.8 \times L) \div r$; every n^{th} set-out were selected for sampling. To help facilitate this process, the sampling interval was noted on the set-out count form.

All the material from a single stream from each set-out constituted a sample. Each sample was stored and labeled separately. An example sample label is included in Appendix E: Example Field Forms. After the route survey team completed their DCA they transported the samples to the sorting facility.

Sorting Procedures

The goal was for all material set out from approximately 32 households were sorted each day for each sampling event, approximately 160 households total for each field event. The sorting procedure included the following four steps.

Step 1: Review methodology and sorting categories with the crew. To provide consistent sorting, Cascadia used highly trained crewmembers throughout the project. Before the sorting began, all crewmembers reviewed the procedures, forms, and material definitions. The material definitions are included in Appendix A: Material Type Definitions.

Step 2: Sort Sample. Once the sample was placed on the sorting table, two- to three-person sorting crews sorted material by hand into the prescribed material categories. The sorting crew manager monitored the accuracy of sorting, rejecting materials improperly classified.

Step 3: Weigh the Sample. The field crew manager verified the purity of each material as it was weighed using a pre-tared scale and recorded the data on the sample tally sheet. An example of a sample tally sheet is included in Appendix E: Example Field Forms.

Step 4: Review Data. At the conclusion of each sorting day, the field crew manager conducted a quality control review of the data recorded.

The sample selection, collection, and sorting process is summarized in Figure 74.

Figure 74. Overview of the Sample Selection and Sorting Process

Appendix C. Greenhouse Gas Impacts

Cities and counties around Puget Sound have implemented organics service for many reasons including reductions in greenhouse gas (GHG) emissions and costs. This appendix quantifies current and potential GHG reductions from increased diversion of typical curbside recyclable and compostable materials. It is divided into two sections, the first covering emissions from current conditions and the second covering estimated emissions from increased diversion of recyclables and organics from the disposed waste stream. The GHG emissions calculations were performed using the U.S. EPA's Waste Reduction Model (WARM), a streamlined model that estimates the GHG emissions associated with different materials management options.

The EPA has developed emissions factors for many materials based on the environmental footprint of each material associated with production and collection through final disposition of each discarded material.[1] Not every one of the WARM materials has a direct analogue with the material list used in this study, so Cascadia aggregated the 14 divertible study material types into 10 WARM material types. The study material type *other materials* is assumed to include no readily divertible materials and is excluded from the WARM modeling. For this analysis, Cascadia matched materials in the waste composition study to the materials included in WARM as shown in Table 24 and noted whether they are considered recyclable or compostable.

Table 24. Material types Included in the GHG Analysis

Study Material Type	WARM Material Type	Recovery Method
Fruits and Vegetables, Edible	Fruits and Vegetables	Compost
Fruits and Vegetables, Non-edible	Fruits and Vegetables	Compost
Homegrown Fruits and Vegetables	Fruits and Vegetables	Compost
Meat, Edible	Food Waste (meat only)	Compost
Meat, Non-edible	Food Waste (meat only)	Compost
Mixed/Other Food Waste	Food Waste (non-meat)	Compost
Compostable Paper	Mixed Organics	Compost
Compostable Plastic	PLA	Compost
Other Compostables	Mixed Organics	Compost
Yard Debris	Yard Trimmings	Compost
Recyclable Paper	Mixed Paper (primarily residen	Recycle
Recyclable Plastic	Mixed Plastics	Recycle
Recyclable Metal	Mixed Metals	Recycle
Recyclable Glass	Glass	Recycle

The results from the model depend not only on the composition of materials included in the analysis, but also on the characteristics of the landfill and transportation methods. For the analysis, we have assumed:

- An emissions factor for electricity based on the average Pacific-region grid; this factor is used to calculate the avoided emissions associated with power production from landfill gas (LFG)

[1] Detailed documentation about the development of lifecycle GHG emissions factors for materials can be found at the following location: https://www.epa.gov/warm/documentation-waste-reduction-model-warm

capture and recovery. WARM likely overestimates the benefits of LFG capture in Washington State due to the high level of hydroelectric power and low levels of coal power in the grid.

- A landfill gas collection efficiency based on landfill management standards that meet California regulatory requirements.
- A decomposition rate of materials in the landfill based on wet conditions, greater than 40 inches of precipitation per year.
- Transportation distances for materials from the curb to its end-of-life management facility as shown in Table 25. WARM assumes that diesel fuel vehicles are used and calculates emissions factors. WARM is likely overestimating the impacts of transporting materials in King County since many of our collection vehicles are CNG-fueled. WARM also does not account for the emissions from shipping recyclables to markets overseas.

Table 25: Modeled Transportation Distances

Materials Management Facility	Distance (miles)
Landfill	24.51
Combustion	29.55
Recycling	21.64
Composting	31.46

The GHG emissions reduction analysis also considered:

- Carbon storage in landfills and increase in soil carbon storage from application of compost to soils.[2]
- Forest carbon storage from the recycling of paper products, which cause annual tree harvests to drop below otherwise anticipated levels.
- Fugitive emissions from composting.

Most of the emissions and factors listed above support increased diversion (recycling requires less electricity than production using virgin materials, for instance) but some support landfilling (sending organics to landfill, for example).

Current Diversion Emissions

In 2017, recycling and organics service programs collected about 92,792 tons of recyclables and 162,381 tons of compostables. Compared to landfilling the material, curbside recycling and organics service programs reduced emissions by over 206,000 MtCO2e (see Table 26). For perspective, this is equivalent to the emissions from electricity generation for 30,910 homes or the emissions from driving over 505

[2] EPA determined that neither literature review nor discussion with experts would yield a sufficient basis for quantitative soil carbon estimates for WARM. EPA therefore used Century, a soil organic matter model, to simulate and calculate soil carbon storage from various composting scenarios.

million miles.[3] For the emissions reductions under the current system negative values indicate that the current system is reducing emissions, and positive values indicate that current system is increasing emissions. In other words, negative values are "good" and positive values are "bad." Currently, recycling mixed paper is providing the greatest reduction in GHG emissions whereas composting yard trimmings increases GHG emissions (compared to landfilling the yard trimmings).

Table 26. Estimated GHG Reductions from Recycling and Organics Service

WARM Material Types	Change in GHG Tons (MtCO2e) Under Current Diverison Scenario
Fruits and Vegetables	-4,346
Food Waste (meat only)	-706
Food Waste (non-meat)	-2,426
PLA	406
Mixed Organics	-1,028
Yard Trimmings	22,396
Mixed Paper (primarily residential)	-184,272
Mixed Plastics	-11,598
Mixed Metals	-18,930
Glass	-5,729
Total	**-206,234**

Future Potential

In 2017, King County single family households landfilled about 111,776 tons of recyclable and compostable material. If customers, set-out rates, or participation rates increase, the quantity of these materials captured in curbside programs will likely increase as well and hopefully provided a reduction in GHG emissions.

Tons Recovered

We used WARM to model the potential changes in GHG emissions when 25%, 50%, and 75% of a currently disposed material was diverted to composting or recycling (as appropriate per material). Table 27 lists in the "Disposed" column how many tons of each material type single-family households disposed in 2017. The next three columns, "Recovered at 25% Diversion," "Recovered at 50% Diversion," and "Recovered at 75% Diversion," specify the tonnages included in the WARM model at each modeled diversion level. The diversion level specifies the quantity of the remaining disposed material that gets diverted. For example, 28,568 tons of fruits and vegetables are disposed annually. If an additional 25% of that fruits and vegetables were recovered, that would be an additional 7,142 tons of fruits and vegetables recovered.

[3] Equivalencies calculated using the U.S. EPA *Greenhouse Gas Equivalencies Calculator* available at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator and the equivalencies built into the WARM model.

Table 27. Recovered Tons at Each Modeled Diversion Level

WARM Material Types	Tons Disposed	Recovered at 25% Diversion	Recovered at 50% Diversion	Recovered at 75% Diversion
Fruits and Vegetables	28,568	7,142	14,284	21,426
Food Waste (meat only)	8,953	2,238	4,476	6,715
Food Waste (non-meat)	29,690	7,423	14,845	22,268
Mixed Organics	16,553	4,138	8,277	12,415
PLA	136	34	68	102
Yard Trimmings	3,543	886	1,771	2,657
Mixed Paper (primarily residential)	9,419	2,355	4,710	7,065
Mixed Plastics	6,696	1,674	3,348	5,022
Mixed Metals	4,233	1,058	2,117	3,175
Glass	3,985	996	1,992	2,989
Total	**111,776**	**27,944**	**55,888**	**83,832**

Estimated Changes in GHG Emissions

The change in GHG emissions for each material is measured in metric tons of CO_2 equivalent (MtCO2e) and noted in Table 26. For the emissions associated with the baseline tons, negative values indicate that landfilling is a net carbon sink, and positive values indicate that landfilling is a net carbon source for that materials. In other words, negative values are "good" and positive values are "bad." For example, the negative baseline numbers associated with yard trimmings and increasingly positive values with increased diversion indicate that increased diversion of this material increases GHG emissions. Possible reasons for this may include:

- An increase in the fuel used by equipment to handle yard trimmings at a compost facility compared to a landfill.
- A high LFG potential for yard trimmings.
- Growing trees remove carbon from the atmosphere, so landfilling trees sequesters the carbon while composting releases the carbon.

The magnitude of the reduction (or increase) in GHG emissions per material depends on both the quantity of the material diverted and the material itself. Each material has a different GHG emission reduction potential based on how readily it degrades in the landfill, how far it travels to market, and other factors. Mixed paper recycling offers the greatest reduction potential (11,203MtCO2e at 25% diversion).

Diverting 25% of each material in Table 26 from disposal reduces GHG emissions by over 7,500 MtCO2e per year; diverting additional quantities from the landfill reduces GHG emissions even further. Diverting 75% of the currently disposed organics would cause an estimated GHG reduction of nearly 52,300 MTCO2e per year. These reductions are on top of the reductions already achieved through current diversion levels.

Table 28. Change in MtCO2e at Each Modeled Diversion Level

WARM Material Types	Baseline GHG Tons (MtCO2e) Under Current Waste Management Practices*	GHG Tons (MtCO2e) from Alternative Scenarios		
		at 25% Diversion	at 50% Diversion	at 75% Diversion
Fruits and Vegetables	8,248	4,929	1,610	-1,709
Food Waste (meat only)	2,585	1,545	505	-536
Food Waste (non-meat)	8,572	5,123	1,673	-1,776
PLA	-224	-173	-122	-71
Mixed Organics	236	-493	-1,221	-1,949
Yard Trimmings	-1,069	-931	-794	-656
Mixed Paper (primarily residential)	-3,853	-11,203	-18,554	-25,905
Mixed Plastics	141	-1,606	-3,353	-5,100
Mixed Metals	89	-4,526	-9,142	-13,757
Glass	84	-212	-509	-805
Total	**14,808**	**-7,549**	**-29,906**	**-52,264**

** For the emissions associated with the baseline tons, negative values indicate that landfilling is a net carbon sink and positive values indicate that landfilling is a net carbon source for that material. Negative values are "good" and positive values are "bad".*

Appendix D: Calculations

Estimating Composition

Composition estimates were calculated using a method that gave equal weighting or "importance" to each sample. Confidence intervals (error ranges) were calculated based on assumptions of normality in the composition estimates.

In the descriptions of calculation methods, the following variables are used frequently:

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

Estimating the Composition

For a given sampling stratum, the composition estimate denoted by r_j represents the ratio of the component's weight to the total weight of all the samples in the stratum. This estimate was derived by summing each component's weight across all the selected samples belonging to a given stratum and dividing by the sum of the total weight for all the samples in that stratum, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i}$$

where:

- c = weight of particular component
- w = sum of all component weights
- for $i = 1$ to n, where n = number of selected samples
- for $j = 1$ to m, where m = number of components

For example, the following simplified scenario involves three samples. For the purposes of this example, only the weights of the material type *dairy* are shown.

	Sample 1	Sample 2	Sample 3
Weight (c) of *dairy* (in lbs.)	5	3	4
Total Sample Weight (w) (in lbs.)	80	70	90

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

To find the composition estimate for the component *meat*, the weights for that material are added for all selected samples and divided by the total sample weights of those samples. The resulting composition is 0.05, or 5%. In other words, 5% of the sampled material, by weight, is *dairy*. This finding is then projected onto the stratum being examined in this step of the analysis.

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:

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

where:

$$\bar{w} = \frac{\sum_i w_i}{n}$$

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

Second, precision levels at the 90% confidence level were calculated for a component's mean as follows:

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

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

Composition results for strata were then combined, using a weighted averaging method, to estimate the composition of larger portions of the waste stream. For example, the organics, recycling, and garbage samples were combined to estimate the composition for the County's curbside single-family residential generation. The relative tonnages associated with each stratum served as the weighting factors. The calculation was performed as follows:

$$O_j = \left(p_1 * r_{j1}\right) + (p_2 * r_{j2}) + (p_3 * r_{j3}) + \ldots$$

where:

- *p* = the proportion of tonnage contributed by the noted waste stratum (the weighting factor);
- *r* = ratio of component weight to total waste weight in the noted waste stratum (the composition percent for the given material component); and
- for *j* = 1 to *m*, where *m* = number of material components.

For example, the above equation is illustrated here using three waste strata.

	Stratum 1	**Stratum 2**	**Stratum 3**
Ratio (r) of *dairy*	5%	10%	10%
Tonnage	25,000	100,000	50,000
Proportion of tonnage (*p*)	14.3%	57.1%	28.6%

To estimate the larger portions of the waste stream, the composition results for the three strata are combined as follows.

$$O_{Carpet} = (0.143 * 0.05) + (0.571 * 0.10) + (0.286 * 0.10) = 0.093 = 9.3\%$$

Therefore, 9.3% of this examined portion of the waste stream is *dairy*.

The variance of the weighted average was calculated as follows:

$$\text{Var}\ (O_j) = \left(p_1^2\ \text{Var}(r_{j1})\right) + \left(p_2^2\ \text{Var}(r_{j2})\right) + \left(p_3^2\ \text{Var}(r_{j3})\right) + \ldots$$

Subscription Rate

The subscription rate is calculated by dividing the monthly average number of organics or recycling service customers in the County by the monthly average number of garbage service customers. The King County Solid Waste Division (SWD) provided customer number data for the period from January 2017 through December 2017.

$$ave.monthly\ organics\ or\ recycling\ customers \div\ ave.monthly\ garbage\ customers = subscription\ rate$$

Set-out Rate

The set-out rate is calculated by dividing the total number of carts set out from each stream for along surveyed routes by the total number of customers for each stream along surveyed routes. For the purposes of this study all households were assumed to be garbage customers and recycling customers. In jurisdictions with embedded organics service all households were assumed to be organics customers. In jurisdictions with subscription organics service the haulers provided the number of organics customers on the surveyed organics routes.

$$number\ of\ set\ outs\ on\ routes \div number\ of\ customers\ on\ routes = set\ out\ rate$$

Participation Rate

The customer participation rate for any material is a measure of the people who have signed up for a service (not all households organics service even if it's available) that place the material of interest in the correct cart (recyclables in the recycling cart and organics in the organics cart). Placing recyclables in an organics cart does not count when calculating the participation rate. The set-out participation rate is a measure of the number of carts set out for collection that contain the material of interest.

For example, the set-out food scraps participation rate is calculated by dividing the number of samples that contained food scraps by the total number of samples collected.

$$\begin{aligned}&(samples\ with\ food\ scraps) \div (total\ samples)\\&= set\ out\ food\ scraps\ participation\ rate\end{aligned}$$

The customer food scraps participation rate is calculated by multiplying the set-out food scraps participation rate by the set-out rate. The premise is that we know what percent of set-outs have food scraps and we know what percent of customers set their carts out, so the percent of customers who participate is the product of those two numbers.

$$\begin{aligned}&(set\ out\ rate) \times (set\ out\ food\ scraps\ participaton\ rate)\\&\quad = customer\ food\ scraps\ participation\ rate\end{aligned}$$

Evaluating Changes in the Composition Between Studies

Comparisons examined the changes in the composition percentages for each of four material groups. To control for population changes and other factors that may influence the total amount of material composted from year to year, the tests described in this appendix measure material proportions, not actual tonnage. For example, say that **Food** accounts for 10% of composted material each year, and that a total of 1,000 tons of material was composted in one year and 2,000 tons composted in the next. While the amount of **Food** increased from 1,000 to 2,000 tons, the percentage remained the same. Therefore, the tests would indicate that there had been no change.

The purpose of conducting these comparisons is to identify trends within the organics stream in the percentage of selected types of waste disposed over time. One specific example is stated as follows:

Hypothesis: "There is no statistically significant difference, between the 2014 and 2017 study periods, in the percentage of **Food** composted."

Statistics are then employed to look for evidence disproving the hypothesis. A "significant" result means that there is enough evidence to disprove the hypothesis and it can be concluded that there is a true difference across years. "Insignificant" results indicate that either a) there is no true difference, or b) even though there may be a difference, there is not enough evidence to prove it.[4]

The purpose of these tests is to identify changes across years; however, the study did not attempt to investigate *why* or *how* these changes occurred. The changes may be due to a variety of. Future studies could be designed to test the influence of various potential sources of the increase/decrease of specific materials in the disposed waste stream.

Statistical Considerations

The analyses were based on the component percentages, by weight. As described in Appendix D: Calculations, these percentages are calculated by dividing the sum of the selected component weights by the sum of the corresponding sample weights. T-tests (modified for ratio estimation) were used to examine the variations from year to year.

Normality

The distributions of some of the material types may be skewed and may not follow a normal distribution. Although t-tests assume a normal distribution, they are very robust to departures from this assumption, particularly with large sample sizes. In addition, the material classes are sums of the material types, which improve our ability to meet the assumptions of normality.

Dependence

There may be dependence between material types (i.e., if a person disposes of material A, they always dispose of material B at the same time).

There is certainly a degree of dependence between the calculated percentages. Because the percentages sum to 100 (in the case of year-to-year comparisons), if the percentage of material A increases, the percentage of some other material must decrease.

Multiple T-Tests

In all statistical tests, there is a chance of incorrectly concluding that a result is significant. The year-to-year comparison required conducting several t-tests (one for each material class), **each** of which carries that risk. However, we were willing to accept only a 10% chance, **overall**, of making an incorrect conclusion. Therefore, each test was adjusted by setting the significance threshold to $\frac{0.10}{w}$ (*w* = the number of t-tests).

The adjustment can be explained as follows:

[4] Please see the "Power Analysis" discussion on page 69.

For each test, we set a $1 - \frac{0.10}{w}$ chance of not making a mistake, which results in a $\left(1 - \frac{0.10}{w}\right)^w$ chance of not making a mistake during all *w* tests.

Since one minus the chance of not making a mistake equals the chance of making a mistake, by making this adjustment, we have set the overall risk of making a wrong conclusion during any one of the tests at

$$\left(1 - \left(1 - \frac{0.10}{w}\right)^w\right) = 0.10.$$

The chance of a "false positive" for the year-to-year comparisons made in this study is restricted to 10% overall, or 2.5% for each test (10% divided by the four tests equals 2.5%).

For more detail regarding this issue, please refer to Section 11.2 "The Multiplicity Problem and the Bonferroni Inequality" of *An Introduction to Contemporary Statistics* by L.H. Koopmans (Duxbury Press, 1981).

Power Analysis

As the number of samples is increased, so is the ability to detect differences. In the future, an a *priori* power analysis might benefit this research by determining how many samples would be required to detect a particular minimum difference of interest.

Interpreting the Calculation Results

For the purposes of this study, only those calculation results with a p-value of less than 2.5% are considered to be statistically significant. As described above, the threshold for determining statistically significant results (the "alpha-level") is conservative, accounting for the fact that so many individual tests were calculated.

The t-statistic is calculated from the data. According to statistical theory, the larger the absolute value of the t-statistic, the less likely the two populations are to have the same mean. The p-value describes the probability of observing the calculated t-statistic if there were no true difference between the population means.

Appendix E: Example Field Forms

This appendix contains examples of the field forms used throughout the study, including:

- Set Out Count Form
- Sample Label
- Sample Tally Sheet
- Customer Hand Out
- Customer Interaction Tracking Form

Figure 75. Set Out Count Form

King County Waste Monitoring Study
Set Out and Participant Count Form

Day: ____________________ **Route:** ____________________
Hauler: ____________________ ***n*=** ____________________
Jurisdiction: ____________________

G=Garbage **R=Recycling** **O=Organics**

1. Identify which bins are set out at a household
2. Cross off one number from the corresponding section for each set out
3. Circle the number from the corresponding section for each sampled set out
4. At the end of the route, record the number of set outs for each section in the "Total" box

If using the ipads to record set outs, at the end of the route, write down the number of set outs recorded for each combination of carts in the "Total" box in each section

G, R, O

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390
391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420
421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	**Total:**		

G, R

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	**Total:**		

G, O

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	**Total:**		

G

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330
331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	**Total:**		

R															O														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	61	76	77	78	79	80	81	82	83	84	85	86	87	88	89
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	76	91	92	93	94	95	96	97	98	99	100	101	102	103	104
91	92	93	94	95	96	97	98	99	100	101	102	**Total:**			91	92	93	94	95	96	97	98	99	100	101	102	**Total:**		

R, O

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	**Total:**		

Figure 76. Sample Label

<table>
<tr><td>DATE:
<u>11/12</u>
HAULER:
<u>CS</u>
DCA:
<u>501B</u></td><td><u>SAMPLE ID:</u>
<u>1101</u>
Stream: G
Bundle ____ of ____</td><td>SAMPLER:</td></tr>
<tr><td></td><td>JURISDICTION: Shoreline</td><td></td></tr>
</table>

Figure 77. Sample Tally Sheet

King County Monitoring Study
Residential Curbside Study 2017
Sample Tally Sheet

Compostable Items	Wt.1	Wt.2	Wt.3	Wt.4
Fruits and Vegetables, Edible				
Fruits and Vegetables, Non-edible				
Homegrown Fruits and Vegetables				
Meat, Edible				
Meat, Non-edible				
Mixed/Other Food Waste				
Compostable Paper				
Compostable Plastic				
Other Compostables				
Yard Debris				

Recyclable Items	Wt.1	Wt.2	Wt.3	Wt.4
Recyclable Paper				
Recyclable Plastic				
Recyclable Metal				
Recyclable Glass				

	Wt.1	Wt.2	Wt.3	Wt.4
Other Materials				

Sample ID: ______________________

Date: ______________________

(*circle one*)

Garbage **Recycle** **Organics**

Optional Information (fill in only if a made up sample ID is used)

Hauler: ______________________

Jurisdiction: ______________________

Route: ______________________

Notes:

Figure 78. Customer Hand Out

King County
Department of Natural Resources and Parks
Solid Waste Division

Residential Characterization Study

King County Solid Waste Division is sampling materials in garbage, recycling, and yard waste containers along randomly selected routes throughout King County as part of a study on recycling and composting in curbside carts. The study provides the County with data on how to better serve residents and achieve waste diversion goals. The sampling will take place in February, April, June, August, and October 2017.

Why is the County sampling waste?
The data we gather from this sampling will be used to better plan services, and recycling and composting education programs for residents across King County. This data will be used for educational purposes only and will not impact your garbage bill or regular service.

Why was I selected for the sampling?
Your household was randomly selected from among households residing along a waste collection route included in the study. No personal information from any household is examined or used in any way.

Can I opt-out of this study?
Yes. If you choose to opt out, we will have our team go past your house when we collect samples today and for the rest of the study.

-over-

Who is doing the sampling?
Staff from Cascadia Consulting Group, on behalf of King County.

How do I get more information?
For questions or concerns, please contact:

Alexander Rist
King County Solid Waste Division
206-477-5253; 711 (TTY Relay)

Thank you for participating in today's study.

This material will be provided in alternate formats upon request.

Printed on recycled paper

Figure 79. Customer Interaction Tracking Form

Date: **Hauler:** **Field Staff Name(s):**

Jurisdiction: **Given Handout? (circle one):** **Yes** **No**

What occurred between you and the resident?

- ○ Resident asked a question about activity/staff answered
- ○ Resident expressed concern and complained
- ○ Resident asked a question not related to study

Note:

How was the response of the resident?

○ Positive ○ Neutral ○ Negative

Did the resident request to opt-out of the study?

○ No ○ Yes

If Yes, please note address:

Appendix F: Detailed Composition Tables

Table 29. Detailed Composition, Single-family Embedded Service

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**37.0%**		**39,315**	**4.3%**		**2,510**	**94.2%**		**98,078**	**52.0%**		**139,903**
Fruits and Vegetables, Edible	5.2%	0.7%	5,502	0.3%	0.2%	147	1.4%	0.4%	1,497	2.7%	0.3%	7,146
Fruits and Vegetables, Non-edible	7.6%	0.9%	8,062	0.1%	0.0%	45	4.6%	1.3%	4,793	4.8%	0.6%	12,900
Homegrown Fruits and Vegetables	0.1%	0.1%	71	0.0%	0.0%	-	0.3%	0.2%	292	0.1%	0.1%	363
Meat, Edible	1.6%	0.3%	1,656	0.1%	0.1%	49	0.4%	0.2%	421	0.8%	0.1%	2,127
Meat, Non-edible	1.5%	0.2%	1,552	0.1%	0.1%	41	0.5%	0.2%	483	0.8%	0.1%	2,076
Mixed/Other Food Waste	12.2%	1.6%	12,978	1.4%	0.7%	819	2.7%	1.1%	2,809	6.2%	0.8%	16,607
Compostable Paper	7.2%	0.7%	7,633	1.7%	0.3%	1,014	2.4%	0.6%	2,450	4.1%	0.4%	11,096
Compostable Plastic	0.1%	0.1%	98	0.1%	0.1%	44	0.2%	0.1%	172	0.1%	0.0%	313
Other Compostables	0.8%	0.5%	881	0.1%	0.1%	50	0.1%	0.1%	150	0.4%	0.2%	1,081
Yard Debris	0.8%	0.4%	882	0.5%	0.8%	300	81.7%	4.8%	85,012	32.1%	1.9%	86,194
Recyclable	**10.6%**		**11,309**	**87.5%**		**51,048**	**0.7%**		**708**	**23.5%**		**63,064**
Recyclable Paper	4.4%	0.8%	4,697	58.6%	3.2%	34,187	0.5%	0.3%	491	14.6%	0.8%	39,376
Recyclable Plastic	3.0%	0.4%	3,151	9.4%	1.0%	5,505	0.1%	0.1%	90	3.3%	0.3%	8,747
Recyclable Metal	1.8%	0.4%	1,871	3.4%	0.5%	2,005	0.0%	0.0%	27	1.5%	0.2%	3,904
Recyclable Glass	1.5%	0.4%	1,589	16.0%	1.8%	9,350	0.1%	0.1%	99	4.1%	0.4%	11,038
Other Materials	**52.4%**		**55,731**	**8.2%**		**4,795**	**5.1%**		**5,310**	**24.5%**		**65,836**
Other Materials	52.4%	3.5%	55,731	8.2%	2.3%	4,795	5.1%	3.7%	5,310	24.5%	2.1%	65,836
Totals	**100%**		**106,355**	**100%**		**58,352**	**100%**		**104,096**	**100%**		**268,803**
Sample Count			451			355			277			1,083

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 30. Detailed Composition, Single-family Subscription Service

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**42.3%**		**48,128**	**2.9%**		**1,373**	**97.4%**		**64,303**	**50.0%**		**113,804**
Fruits and Vegetables, Edible	6.0%	0.8%	6,859	0.2%	0.2%	95	1.5%	0.6%	982	3.5%	0.5%	7,935
Fruits and Vegetables, Non-edible	7.1%	1.0%	8,057	0.1%	0.1%	58	2.0%	0.7%	1,323	4.1%	0.5%	9,438
Homegrown Fruits and Vegetables	0.0%	0.0%	17	0.0%	0.0%	7	0.2%	0.2%	113	0.1%	0.1%	137
Meat, Edible	2.9%	1.1%	3,255	0.1%	0.1%	37	0.5%	0.2%	305	1.6%	0.5%	3,597
Meat, Non-edible	2.2%	0.6%	2,490	0.0%	0.0%	9	0.3%	0.1%	175	1.2%	0.3%	2,673
Mixed/Other Food Waste	14.7%	1.5%	16,712	1.0%	0.5%	494	1.7%	0.7%	1,099	8.0%	0.8%	18,305
Compostable Paper	6.7%	0.6%	7,685	1.3%	0.3%	608	1.7%	0.4%	1,095	4.1%	0.3%	9,389
Compostable Plastic	0.0%	0.0%	39	0.0%	0.0%	2	0.1%	0.0%	54	0.0%	0.0%	95
Other Compostables	0.3%	0.1%	354	0.1%	0.1%	52	0.6%	0.9%	422	0.4%	0.3%	828
Yard Debris	2.3%	1.3%	2,660	0.0%	0.0%	12	88.9%	3.2%	58,734	27.0%	1.1%	61,406
Recyclable	**11.4%**		**13,024**	**87.1%**		**41,745**	**0.4%**		**260**	**24.2%**		**55,029**
Recyclable Paper	4.1%	0.6%	4,722	50.4%	2.9%	24,163	0.3%	0.1%	191	12.8%	0.7%	29,076
Recyclable Plastic	3.1%	0.3%	3,545	11.4%	1.6%	5,464	0.1%	0.1%	54	4.0%	0.4%	9,063
Recyclable Metal	2.1%	0.3%	2,362	4.8%	0.6%	2,298	0.0%	0.0%	11	2.0%	0.2%	4,670
Recyclable Glass	2.1%	0.7%	2,396	20.5%	2.4%	9,821	0.0%	0.0%	4	5.4%	0.6%	12,220
Other Materials	**46.3%**		**52,708**	**10.0%**		**4,799**	**2.2%**		**1,483**	**25.9%**		**58,990**
Other Materials	46.3%	2.9%	52,708	10.0%	2.4%	4,799	2.2%	2.0%	1,483	25.9%	1.7%	58,990
Totals	**100%**		**113,860**	**100%**		**47,917**	**100%**		**66,046**	**100%**		**227,823**
Sample Count			311			274			141			726

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 31. Detailed Composition, Single-family Weekly Collection

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**37.7%**		**57,931**	**3.6%**		**2,857**	**94.7%**		**124,571**	**51.0%**		**185,359**
Fruits and Vegetables, Edible	5.2%	0.7%	7,930	0.2%	0.1%	146	1.4%	0.4%	1,863	2.7%	0.3%	9,939
Fruits and Vegetables, Non-edible	7.1%	0.8%	10,873	0.1%	0.1%	78	3.7%	1.0%	4,926	4.4%	0.5%	15,877
Homegrown Fruits and Vegetables	0.0%	0.1%	59	0.0%	0.0%	-	0.1%	0.1%	70	0.0%	0.0%	130
Meat, Edible	1.8%	0.3%	2,727	0.1%	0.1%	79	0.4%	0.1%	527	0.9%	0.1%	3,333
Meat, Non-edible	1.9%	0.4%	2,865	0.1%	0.1%	45	0.4%	0.1%	492	0.9%	0.2%	3,402
Mixed/Other Food Waste	13.1%	1.5%	20,053	1.2%	0.6%	924	2.4%	0.9%	3,167	6.6%	0.7%	24,144
Compostable Paper	7.0%	0.6%	10,760	1.5%	0.3%	1,177	2.1%	0.5%	2,700	4.0%	0.3%	14,637
Compostable Plastic	0.1%	0.0%	77	0.1%	0.1%	46	0.1%	0.0%	155	0.1%	0.0%	277
Other Compostables	0.6%	0.4%	998	0.1%	0.0%	47	0.4%	0.5%	505	0.4%	0.2%	1,550
Yard Debris	1.0%	0.6%	1,588	0.4%	0.6%	316	83.8%	4.1%	110,167	30.8%	1.5%	112,071
Recyclable	**11.5%**		**17,606**	**87.3%**		**68,602**	**0.6%**		**827**	**23.9%**		**87,035**
Recyclable Paper	4.4%	0.6%	6,837	56.5%	2.8%	44,358	0.4%	0.2%	582	14.2%	0.7%	51,777
Recyclable Plastic	3.0%	0.3%	4,678	10.1%	0.9%	7,905	0.1%	0.1%	114	3.5%	0.2%	12,698
Recyclable Metal	2.1%	0.3%	3,153	4.0%	0.5%	3,103	0.0%	0.0%	35	1.7%	0.2%	6,290
Recyclable Glass	1.9%	0.5%	2,938	16.8%	1.7%	13,236	0.1%	0.1%	96	4.5%	0.4%	16,270
Other Materials	**50.8%**		**78,101**	**9.0%**		**7,092**	**4.6%**		**6,090**	**25.1%**		**91,283**
Other Materials	50.8%	2.9%	78,101	9.0%	2.2%	7,092	4.6%	3.1%	6,090	25.1%	1.7%	91,283
Totals	**100%**		**153,638**	**100%**		**78,552**	**100%**		**131,488**	**100%**		**363,677**
Sample Count			410			376			208			994

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 32. Detailed Composition, Single-family Every Other Week Collection

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**44.2%**		**29,421**	**3.8%**		**1,051**	**97.6%**		**37,733**	**51.3%**		**68,204**
Fruits and Vegetables, Edible	6.6%	1.0%	4,421	0.3%	0.4%	97	1.6%	0.5%	612	3.9%	0.5%	5,130
Fruits and Vegetables, Non-edible	7.9%	1.1%	5,244	0.1%	0.1%	24	3.2%	0.8%	1,242	4.9%	0.6%	6,511
Homegrown Fruits and Vegetables	0.0%	0.1%	30	0.0%	0.0%	7	0.9%	0.7%	336	0.3%	0.2%	373
Meat, Edible	3.3%	1.7%	2,176	0.0%	0.0%	8	0.5%	0.2%	196	1.8%	0.9%	2,380
Meat, Non-edible	1.7%	0.4%	1,155	0.0%	0.0%	6	0.4%	0.2%	171	1.0%	0.2%	1,332
Mixed/Other Food Waste	14.4%	1.5%	9,594	1.4%	0.7%	399	2.0%	0.6%	766	8.1%	0.8%	10,759
Compostable Paper	6.8%	0.7%	4,559	1.6%	0.4%	450	2.2%	0.5%	860	4.4%	0.4%	5,869
Compostable Plastic	0.1%	0.1%	60	0.0%	0.0%	0	0.2%	0.1%	74	0.1%	0.0%	134
Other Compostables	0.4%	0.3%	247	0.2%	0.2%	56	0.1%	0.1%	55	0.3%	0.2%	358
Yard Debris	2.9%	1.8%	1,935	0.0%	0.0%	3	86.5%	2.9%	33,421	26.6%	1.2%	35,359
Recyclable	**10.1%**		**6,700**	**87.2%**		**24,178**	**0.4%**		**147**	**23.3%**		**31,025**
Recyclable Paper	3.9%	0.6%	2,587	50.8%	2.9%	14,070	0.3%	0.2%	105	12.6%	0.7%	16,763
Recyclable Plastic	3.0%	0.3%	2,013	11.0%	2.4%	3,049	0.1%	0.1%	30	3.8%	0.5%	5,092
Recyclable Metal	1.6%	0.3%	1,069	4.3%	0.6%	1,182	0.0%	0.0%	4	1.7%	0.2%	2,255
Recyclable Glass	1.5%	0.4%	1,031	21.2%	2.7%	5,876	0.0%	0.0%	8	5.2%	0.6%	6,915
Other Materials	**45.7%**		**30,457**	**9.0%**		**2,489**	**2.0%**		**773**	**25.4%**		**33,719**
Other Materials	45.7%	3.4%	30,457	9.0%	1.9%	2,489	2.0%	1.7%	773	25.4%	1.8%	33,719
Totals	**100%**		**66,577**	**100%**		**27,718**	**100%**		**38,653**	**100%**		**132,948**
Sample Count			352			253			210			815

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 33. Detailed Composition, Single-family Embedded Service with Weekly Collection

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**35.3%**		**27,277**	**4.5%**		**2,050**	**93.1%**		**76,451**	**51.7%**		**105,778**
Fruits and Vegetables, Edible	4.9%	0.9%	3,799	0.2%	0.1%	86	1.3%	0.5%	1,102	2.4%	0.4%	4,986
Fruits and Vegetables, Non-edible	7.0%	1.2%	5,431	0.1%	0.0%	34	4.9%	1.6%	4,004	4.6%	0.8%	9,469
Homegrown Fruits and Vegetables	0.1%	0.1%	58	0.0%	0.0%	-	0.1%	0.1%	67	0.1%	0.1%	125
Meat, Edible	1.5%	0.4%	1,192	0.1%	0.1%	49	0.4%	0.2%	291	0.7%	0.2%	1,533
Meat, Non-edible	1.3%	0.3%	1,004	0.1%	0.1%	38	0.5%	0.2%	393	0.7%	0.1%	1,435
Mixed/Other Food Waste	11.9%	2.1%	9,223	1.6%	0.9%	707	2.9%	1.3%	2,400	6.0%	1.0%	12,330
Compostable Paper	7.0%	0.9%	5,423	1.7%	0.4%	755	2.4%	0.7%	1,944	4.0%	0.5%	8,121
Compostable Plastic	0.1%	0.0%	47	0.1%	0.1%	43	0.2%	0.1%	125	0.1%	0.0%	215
Other Compostables	0.9%	0.7%	698	0.1%	0.1%	38	0.1%	0.1%	99	0.4%	0.3%	835
Yard Debris	0.5%	0.3%	403	0.7%	1.0%	299	80.4%	6.0%	66,026	32.6%	2.4%	66,728
Recyclable	**10.7%**		**8,293**	**86.9%**		**39,334**	**0.8%**		**640**	**23.6%**		**48,268**
Recyclable Paper	4.6%	1.0%	3,513	59.3%	4.0%	26,845	0.5%	0.4%	446	15.1%	1.0%	30,803
Recyclable Plastic	2.9%	0.5%	2,257	9.5%	1.3%	4,310	0.1%	0.1%	79	3.2%	0.3%	6,646
Recyclable Metal	1.8%	0.5%	1,364	3.3%	0.7%	1,511	0.0%	0.0%	25	1.4%	0.2%	2,899
Recyclable Glass	1.5%	0.5%	1,159	14.7%	2.2%	6,669	0.1%	0.2%	91	3.9%	0.5%	7,919
Other Materials	**53.9%**		**41,625**	**8.6%**		**3,881**	**6.1%**		**5,047**	**24.7%**		**50,553**
Other Materials	53.9%	4.6%	41,625	8.6%	3.0%	3,881	6.1%	4.7%	5,047	24.7%	2.6%	50,553
Totals	**100%**		**77,195**	**100%**		**45,266**	**100%**		**82,138**	**100%**		**204,599**
Sample Count			212			190			119			521

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 34. Detailed Composition, Single-family Embedded Service with EOW Collection

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**41.3%**		**12,038**	**3.5%**		**460**	**98.5%**		**21,628**	**53.2%**		**34,125**
Fruits and Vegetables, Edible	5.8%	0.9%	1,703	0.5%	0.7%	62	1.8%	0.6%	395	3.4%	0.5%	2,160
Fruits and Vegetables, Non-edible	9.0%	1.3%	2,630	0.1%	0.1%	11	3.6%	0.9%	789	5.3%	0.7%	3,430
Homegrown Fruits and Vegetables	0.0%	0.1%	13	0.0%	0.0%	-	1.0%	1.1%	225	0.4%	0.4%	238
Meat, Edible	1.6%	0.4%	464	0.0%	0.0%	-	0.6%	0.4%	129	0.9%	0.2%	594
Meat, Non-edible	1.9%	0.5%	548	0.0%	0.0%	3	0.4%	0.1%	90	1.0%	0.2%	641
Mixed/Other Food Waste	12.9%	1.7%	3,756	0.9%	0.4%	112	1.9%	0.5%	409	6.7%	0.8%	4,277
Compostable Paper	7.6%	0.9%	2,210	2.0%	0.5%	259	2.3%	0.5%	506	4.6%	0.5%	2,975
Compostable Plastic	0.2%	0.2%	51	0.0%	0.0%	0	0.2%	0.1%	48	0.2%	0.1%	99
Other Compostables	0.6%	0.6%	183	0.1%	0.1%	12	0.2%	0.2%	51	0.4%	0.3%	246
Yard Debris	1.6%	1.2%	479	0.0%	0.0%	1	86.5%	2.8%	18,986	30.3%	1.1%	19,466
Recyclable	**10.3%**		**3,016**	**89.5%**		**11,713**	**0.3%**		**67**	**23.0%**		**14,796**
Recyclable Paper	4.1%	0.7%	1,185	56.1%	3.0%	7,342	0.2%	0.1%	46	13.4%	0.7%	8,573
Recyclable Plastic	3.1%	0.4%	894	9.1%	1.1%	1,196	0.1%	0.0%	11	3.3%	0.3%	2,100
Recyclable Metal	1.7%	0.4%	508	3.8%	0.5%	494	0.0%	0.0%	3	1.6%	0.2%	1,004
Recyclable Glass	1.5%	0.4%	430	20.5%	2.7%	2,681	0.0%	0.0%	8	4.9%	0.6%	3,119
Other Materials	**48.4%**		**14,106**	**7.0%**		**914**	**1.2%**		**263**	**23.8%**		**15,283**
Other Materials	48.4%	3.8%	14,106	7.0%	1.4%	914	1.2%	0.8%	263	23.8%	1.8%	15,283
Totals	**100%**		**29,159**	**100%**		**13,087**	**100%**		**21,958**	**100%**		**64,204**
Sample Count			239			165			158			562

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 35. Detailed Composition, Single-family Subscription Service with Weekly Collection

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**40.2%**		**30,745**	**2.3%**		**782**	**97.7%**		**48,197**	**50.1%**		**79,725**
Fruits and Vegetables, Edible	5.4%	0.9%	4,141	0.2%	0.2%	60	1.5%	0.8%	764	3.1%	0.5%	4,965
Fruits and Vegetables, Non-edible	7.1%	1.2%	5,443	0.1%	0.2%	45	1.8%	0.7%	870	4.0%	0.6%	6,358
Homegrown Fruits and Vegetables	0.0%	0.0%	-	0.0%	0.0%	-	0.0%	0.0%	2	0.0%	0.0%	2
Meat, Edible	2.0%	0.5%	1,543	0.1%	0.1%	29	0.5%	0.2%	238	1.1%	0.2%	1,810
Meat, Non-edible	2.5%	0.9%	1,883	0.0%	0.0%	6	0.2%	0.1%	94	1.2%	0.4%	1,983
Mixed/Other Food Waste	14.2%	2.0%	10,874	0.6%	0.3%	206	1.5%	0.9%	743	7.4%	1.0%	11,823
Compostable Paper	7.0%	0.7%	5,336	1.3%	0.3%	417	1.5%	0.5%	741	4.1%	0.4%	6,495
Compostable Plastic	0.0%	0.0%	30	0.0%	0.0%	1	0.1%	0.0%	28	0.0%	0.0%	60
Other Compostables	0.4%	0.1%	290	0.0%	0.0%	8	0.8%	1.2%	418	0.5%	0.4%	716
Yard Debris	1.6%	1.1%	1,205	0.0%	0.0%	9	89.8%	3.8%	44,299	28.6%	1.3%	45,513
Recyclable	**12.2%**		**9,340**	**88.0%**		**29,280**	**0.4%**		**180**	**24.4%**		**38,800**
Recyclable Paper	4.3%	0.8%	3,320	52.4%	3.6%	17,434	0.3%	0.2%	132	13.1%	0.9%	20,886
Recyclable Plastic	3.2%	0.3%	2,425	10.8%	1.2%	3,611	0.1%	0.1%	35	3.8%	0.3%	6,071
Recyclable Metal	2.4%	0.4%	1,800	4.8%	0.7%	1,609	0.0%	0.0%	10	2.1%	0.3%	3,419
Recyclable Glass	2.3%	1.0%	1,795	19.9%	2.8%	6,626	0.0%	0.0%	4	5.3%	0.7%	8,424
Other Materials	**47.6%**		**36,357**	**9.7%**		**3,224**	**2.0%**		**973**	**25.5%**		**40,553**
Other Materials	47.6%	3.6%	36,357	9.7%	3.1%	3,224	2.0%	2.3%	973	25.5%	2.0%	40,553
Totals	**100%**		**76,442**	**100%**		**33,286**	**100%**		**49,350**	**100%**		**159,078**
Sample Count			198			186			89			473

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

Table 36. Detailed Composition, Single-family Subscription Service with EOW Collection

	Garbage			Recycling			Organics			Generation		
Material	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons	Est. %	+ / -	Est Tons
Compostable	**46.5%**		**17,383**	**4.0%**		**591**	**96.5%**		**16,105**	**49.6%**		**34,079**
Fruits and Vegetables, Edible	7.3%	1.7%	2,718	0.2%	0.3%	35	1.3%	0.8%	217	4.3%	0.9%	2,970
Fruits and Vegetables, Non-edible	7.0%	1.7%	2,614	0.1%	0.1%	13	2.7%	1.4%	453	4.5%	1.0%	3,080
Homegrown Fruits and Vegetables	0.0%	0.1%	17	0.0%	0.1%	7	0.7%	0.7%	111	0.2%	0.2%	135
Meat, Edible	4.6%	3.1%	1,711	0.1%	0.1%	8	0.4%	0.3%	67	2.6%	1.7%	1,786
Meat, Non-edible	1.6%	0.6%	607	0.0%	0.0%	3	0.5%	0.3%	81	1.0%	0.3%	690
Mixed/Other Food Waste	15.6%	2.2%	5,839	2.0%	1.4%	287	2.1%	1.2%	357	9.4%	1.3%	6,482
Compostable Paper	6.3%	1.0%	2,349	1.3%	0.5%	191	2.1%	1.0%	354	4.2%	0.6%	2,894
Compostable Plastic	0.0%	0.0%	8	0.0%	0.0%	0	0.2%	0.1%	26	0.1%	0.0%	35
Other Compostables	0.2%	0.1%	64	0.3%	0.4%	44	0.0%	0.0%	4	0.2%	0.1%	113
Yard Debris	3.9%	3.0%	1,456	0.0%	0.0%	2	86.5%	5.7%	14,435	23.1%	2.2%	15,893
Recyclable	**9.8%**		**3,684**	**85.2%**		**12,465**	**0.5%**		**80**	**23.6%**		**16,228**
Recyclable Paper	3.7%	0.9%	1,402	46.0%	4.8%	6,728	0.4%	0.3%	60	11.9%	1.1%	8,190
Recyclable Plastic	3.0%	0.5%	1,119	12.7%	4.4%	1,853	0.1%	0.1%	19	4.4%	1.0%	2,992
Recyclable Metal	1.5%	0.4%	562	4.7%	1.1%	688	0.0%	0.0%	1	1.8%	0.3%	1,251
Recyclable Glass	1.6%	0.7%	601	21.8%	4.5%	3,195	0.0%	0.0%	-	5.5%	1.0%	3,796
Other Materials	**43.7%**		**16,351**	**10.8%**		**1,576**	**3.1%**		**510**	**26.8%**		**18,436**
Other Materials	43.7%	5.3%	16,351	10.8%	3.3%	1,576	3.1%	3.8%	510	26.8%	3.1%	18,436
Totals	**100%**		**37,418**	**100%**		**14,631**	**100%**		**16,695**	**100%**		**68,744**
Sample Count			113			88			52			253

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.